Westinghouse Non-Proprietary Class 3

WCAP-14129
Revision 2-NP-A

Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays

Westinghouse Electric Company LLC

WCAP-14129, Rev. 2-NP-A

RELIABILITY ASSESSMENT OF WESTINGHOUSE TYPE AR RELAYS USED AS SSPS SLAVE RELAYS WOG PROGRAM MUHP-7040

August 2000

by

B. J. Metro

Edited by
C. M. Peta

Revision 2 Edited by
R. M. Span

This report (WCAP-14129 Revision 2-NP-A) supersedes and replaces all earlier versions of WCAP-14129)

WESTINGHOUSE ELECTRIC COMPANY LLC
Nuclear Services Division
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355

©2000 Westinghouse Electric Company
All Rights Reserved

LEGAL NOTICE

This report was prepared by Westinghouse Electric Company LLC as an account of work sponsored by the Westinghouse Owners Group (WOG) SRT Subgroup. Neither the WOG SRT Subgroup, any member of the WOG SRT Subgroup, Westinghouse Electric Company LLC, nor any person acting on behalf of any of them:

(A) Makes any warranty or representation whatsoever, express or implied, (I) with respect to the use of any information, apparatus, method, process, or similar item disclosed in this report, including merchantability and fitness for a particular purpose, (II) that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or (III) that this report is suitable to any particular user's circumstance; or

(B) Assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if the WOG SRT Subgroup or any WOG SRT Subgroup representative has been advised of the possibility of such damages) resulting from any selection or use of this report or any information apparatus, method, process, or similar item disclosed in this report.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 12, 2000

RECEIVED
JUL 18 2000
H. A. SEPP

Mr. H. A. Sepp, Manager
Regulatory and Licensing Engineering
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, PA 15230-0355

SUBJECT: REVIEW OF WESTINGHOUSE TOPICAL REPORTS WCAP-13877, REVISION 2-P AND WCAP-13878-P, REVISION 2 ON SOLID STATE PROTECTION SYSTEM (SSPS) SLAVE RELAYS (TAC NO. MA7264)

Dear Mr. Sepp:

The NRC staff has completed its review of the subject Westinghouse Electric Company (WEC) topical reports (TRs) which were submitted by letter dated November 5, 1999. The NRC staff had previously reviewed and approved Revision 1 of these TRs. A May 31, 1996, letter from Bruce A. Boger of the NRC to Tom Green, Chairman of the Westinghouse Owners Group (WOG), documents the NRC's acceptance of WCAP-13878, Revision 1, and an October 26, 1998, letter from Thomas E. Essig of the NRC to Louis F. Liberatori of the WOG documents the NRC acceptance of WCAP-13877, Revision 1. However, WEC subsequently discovered certain errors in the TRs and therefore submitted Revision 2 of these TRs to the NRC for review and approval. WEC has further determined that the changes do not affect the conclusions of the WCAPs and the NRC safety evaluations. The NRC staff has reviewed the changes and finds them acceptable. The enclosed safety evaluation (SE) confirms the acceptability of the proposed changes.

Pursuant to 10 CFR 2.790, we have determined that the enclosed SE does not contain proprietary information. However, we will delay placing the SE in the public document room for a period of ten (10) working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

We do not intend to repeat our review of the matters described in the reports, and found acceptable, when the reports appear as references in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to matters described in the reports.

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," we request that Westinghouse Electric Company publish accepted versions of the topical reports, proprietary and non-proprietary, within 3 months of receipt of this letter. The accepted versions shall incorporate this letter and the enclosed SE between the title page and the abstract. It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, and

original report pages that were replaced. The accepted versions shall include an "-A" (designating accepted) following the report identification symbol.

Should our criteria or regulations change so that our conclusions as to the acceptability of the reports are invalid, Westinghouse Electric Company and/or the applicants referencing the topical reports will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical reports without revision of their respective documentation.

Sincerely,

Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 694

Enclosure: Safety Evaluation

cc w/encl:
Mr. Andrew Drake, Project Manager
Westinghouse Owners Group
Westinghouse Electric Company
Mail Stop ECE 5-16
P.O. Box 355
Pittsburgh, PA 15230-0355

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

WESTINGHOUSE ELECTRIC COMPANY TOPICAL REPORTS

WCAP-13877 AND WCAP-13878

RELIABILITY ASSESSMENT OF WESTINGHOUSE TYPE AR RELAYS

USED AS SSPS SLAVE RELAYS

1.0 INTRODUCTION

By letter dated November 5, 1999, Westinghouse Electric Company (WEC) submitted Topical Reports (TRs) WCAP-13877, Revision 2-P, "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays," and WCAP-13878-P, Revision 2, "Reliability Assessment of Potter & Brumfield MDR Series Relays." The NRC staff had previously reviewed and accepted Revision 1 of these TRs. A May 31, 1996, letter from Bruce A. Boger of the NRC to Tom Green, Chairman of the Westinghouse Owners Group (WOG), documents the NRC acceptance of WCAP-13878-P, Revision 1, and an October 26, 1998, letter from Thomas E. Essig of NRC to Louis F. Liberatori of WOG documents the NRC acceptance of WCAP-13877, Revision 1-P. However, WEC subsequently discovered certain errors in the TRs and therefore revised these TRs and submitted the revisions to NRC for review and approval. The revisions (1) use the correct Arrhenius equation to calculate the total service life for the relays energized 20 percent of the time (Section 8.2.2 and Appendix C of WCAP-13878-P, Revision 2, and Appendix D of WCAP-13877 Revision 2-P), and (2) change the aging reference temperature of nylon Zytel 101 from 160°C to 175°C and the activation energy from 1.37 eV to 0.8787 eV. The revisions also correct typographical and numerical errors in the text associated with the changes in the tables.

2.0 EVALUATION

The proposed changes to the TRs and the staff's evaluation of the changes are discussed below:

1. Proposed change

   Correct Arrhenius equation to calculate the service lives of slave relays energized 20 percent of the time.

   Evaluation

   The original aging assessment of solid state protection system (SSPS) slave relays used a non-conservative Arrhenius equation for calculating the service life for a defined duty cycle other than 0 percent and 100 percent. The original equation assumed that when a device is energized for a certain fraction of its calculated service life, the

remaining fraction of the energized condition can then be expanded into a much longer time in a de-energized condition. These two times are not related to the duty cycle which is a fraction of the total service. For example, a relay with 20 percent duty cycle is energized for 20 percent of its total service life and de-energized for 80 percent. Revision 2 of the WCAPs use the correct Arrhenius equation to calculate the total service life of the SSPS slave relays for any defined duty cycle. This results in shorter service lives of all materials at a 20 percent duty cycle. The staff's evaluation of this change is discussed in items 3 and 4 below. Small numerical differences appear in the TRs for the 0 percent and 10 percent duty cycles because of rounding off of numbers and differences in calculation software. The staff finds the application of the revised more conservative Arrhenius equation acceptable.

2. Proposed change

The aging reference temperature and activation energy of nylon Zytel 101.

Evaluation

In Revision 1 (Table 8-1), both TRs use the incorrect aging reference temperature of 160°C, instead of 175°C. The correction lengthens the service life of nylon Zytel 101. However, WCAP-13878P, Revision 1 also uses the incorrect activation energy of 1.37 eV, instead of 0.8787 eV. This correction will shorten the service life of the nylon Zytel 101 for all duty cycles. WCAP-13877, Revision 1-P uses the correct activation energy. The staff finds the corrections acceptable. The staff's evaluation of this change is discussed in items 3 and 4 below.

3. Specific Changes to WCAP-13878-P

The changes discussed in items (1) and (2) affect WCAP-13878-P, Revision 2, and the staff's corresponding evaluation as follows:

The service life of materials is significantly shortened for a 20 percent duty cycle, but the affected materials are not essential for operation of the relay.

The service life of neoprene rubber (Tables 8-4, 8-4a, 8-4b, 8-5, 8-5a and 8-5b, Section 8.3.1) and polyvinyl chloride (PVC) (Tables 8-8, 8-8a, and 8-8b, Section 8.1.2.2) is considerably shortened for a 20 percent duty cycle. However, PVC has not been used in motor-driven rotary (MDR) relays used as slave relays in the WEC SSPS, and the failure of the neoprene rubber will likely not result in the failure of MDR relays. Neoprene rubber has been used in lead wire grommets for MDR relays manufactured up to December 1988. The purpose of the rubber grommets is to minimize abrasion of the lead wire during handling and installation. The grommets are not essential for the operation of the relay and WEC has determined that even after complete disintegration of the grommets, failure of the MDR relay is neither expected nor likely and therefore the shortened service life of neoprene rubber does not affect the conclusions of the WCAP and the staff's SEs. Therefore, the staff finds it acceptable.

The recalculated service life values are greater than 40 years for a 20 percent duty cycle.

WCAP 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 have been revised to give new calculated service lives. However, since the new calculated service lives in these tables are all greater than 40 years, the revision does not affect the conclusions of the staff's previous SE.

The service life of nylon Zytel 101 is significantly shortened for all duty cycles.

WCAP Tables 8-10, 8-10a, and 8-10b have been revised to give the new calculated service lives of the MDR relays based on 50 percent retention of tensile strength. The recalculated service lives are all less than the original calculated service lives. The MDR relay cam is made of nylon Zytel 101. The total force applied to all four lobes of a cam would not exceed 400 grams. The 50 percent retension of tensile strength reduces the tensile strength to a value of approximately 1350 psi. Based on the engineering judgement, WEC has determined, because of the low cam loads and the absence of reported cam failures, the recalculated service lives do not change the conclusions of the WCAP and the staff's SE. Therefore, the staff finds it acceptable.

Tables are intentionally left blank.

WCAP Tables 8-11, 8-11a, 8-11b, 8-17, 8-17a, 8-17b, 8-19, 8-24, 8-24a, and 8-24b are intentionally left blank either because the service lives are accurately given in other tables or because the properties of the materials are not critical for the operation of the relay. Therefore, this change has no impact on the conclusions of the WCAP or the staff's SE.

4. Specific changes to WCAP-13877

The changes discussed in items (1) and (2) affect WCAP-13877, Revision 2-P as follows:

Changes in the calculated service lives of ARD relays.

Section 8.3.3 of WCAP-13877 discuss the service life values of the ARD relay that failed at North Anna. The recalculated service lives are more conservative than the actual time the ARD relay was in service. Therefore, the recalculated service lives of the ARD relays do not change the conclusions of the WCAP or the staff's SE.

Recalculated service lives of AR relay based on nylon Zytel 101.

Tables 8-3 and 8-4 have been revised to give the new calculated service lives of AR relays. The recalculated service lives are greater than the original calculated values. This change is discussed in Section 8.3.4 and does not affect the WCAP recommendations or the staff's SE.

Recalculated service lives > 40 years.

Tables 8-6 through 8-15 were revised to give new calculated service lives. However, since the recalculated service lives are > 40 years, the revision does not affect the conclusions of the staff's SE.

Small decreases in service lives.

Tables 8-16 and 8-17 were revised to give new calculated service lives. According to the revised calculation, a 5°C temperature rise results in a small decrease (5.1 percent maximum) in the service lives of the relays with a 20 percent duty cycle. Since the staff's previous SE requires each plant to determine the qualified life of the relays based on the plant-specific environmental conditions, the revision does not affect the conclusions of the staff's SE.

3.0 CONCLUSION

On the basis of the staff's review of WCAP-13878-P, Revision 2 and WCAP-13877, Revision 2-P, the staff concludes that the changes do not affect the conclusions of the staff's safety evaluations of Revision 1 of the WCAPs. The previous safety evaluations are still applicable to Revision 2 of the WCAPs, and the plant-specific TS change request for an extended surveillance test interval should meet the requirements identified in the previous staff safety evaluations.

Principal Contributor: Hukam Garg

Date: July 12, 2000

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 26, 1998

Mr. Louis F. Liberatori Jr., Chairman
Westinghouse Owners Group
Consolidated Edison Co. of NY, Inc.
Indian Point Unit 2
Broadway and Bleakley Avenue
Buchanan, NY 10511

SUBJECT: REVIEW OF WESTINGHOUSE OWNERS GROUP TOPICAL REPORTS WCAP-13877 REVISION 1, WCAP-14129 REVISION 1, AND WCAP-13900, REVISION O, "ESFAS SUBGROUP RELAY TEST INTERVAL EXTENSION"

Dear Mr. Liberatori:

The NRC staff has completed its review of the subject topical reports prepared by Westinghouse Electric Corporation for the Westinghouse Owners Group. The enclosure provides the staff's safety evaluation report (SER) approving these topical reports for reference in plant specific license amendment requests. The topical reports describe the Westinghouse Owners Group Program MUHP-7040 Revision O, which was completed as an industry effort to demonstrate the acceptability of engineered safety feature actuation system (ESFAS) subgroup relay test interval extension.

The enclosed SER was prepared by the Division of Reactor Controls and Human Factors and accepts topical reports WCAP-13877, "Reliability Assessment of Westinghouse Type AR Series Relays," Revision 1, dated August 1998 (proprietary version), WCAP-14129, Revision 1, dated August 1998 (non-proprietary version), and WCAP-13900, "Extension of Slave Relay Surveillance Test Intervals," dated April 1994, for the Type AR relays. The Potter & Brumfield (P&B) MDR relays included in WCAP-13900 have been previously accepted by the staff in a separate SER dated May 31, 1996.

WCAP-13877, Rev. 1, describes the Westinghouse analyses that justify extending surveillance intervals for the ESFAS Westinghouse Type AR relays. The NRC staff finds that data and analyses presented in WCAP-13877, Rev. 1, support the proposed refueling interval staggered test for ESFAS Westinghouse Type AR relays as proposed in WCAP-13900. However, as stated in the staff's SER, if two or more Westinghouse Type AR ESFAS subgroup relays fail in a 12-month period, the referencing licensee should reevaluate the adequacy of the extended surveillance interval. The reevaluation should consider the design, maintenance, and testing of all Westinghouse Type AR ESFAS subgroup relays. If the licensee determines that the interval is inadequate for detecting a single relay failure, the interval should be decreased and should be such that the licensee can detect an ESFAS subgroup relay failure prior to the occurrence of a second failure.

RECEIVED
OCT 29 1998
WOG PROJECT OFFICE

Additionally, plants that use Westinghouse Type AR relays for ESFAS subgroup relay applications and are proposing test interval extensions based on WCAP-13877, Rev. 1 and WCAP-13900, Rev. 0 should also:

1. Confirm the applicability of the WCAP-13877, analyses to their plant.

2. Ensure that the contact loading analysis for Type AR relays has been performed to determine the acceptability of these relays.

3. Determine the qualified life for the Type AR relays based on plant specific environmental conditions.

4. Establish a program to evaluate the adequacy of the proposed test interval if two or more AR relays fail in a 12-month period.

Should you have any questions or wish further clarifications please call Hukam Garg at (301) 415-2929.

Sincerely,

Ralph E. Architzel for

Thomas H. Essig, Acting Chief
Generic Issues and Environmental Project Branch
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Enclosure: As stated

cc: See attached

DISTRIBUTION
Project File
PUBLIC
PGEB/rf
OGC
ACRS
JRoe/DMatthews
TEssig
PWen
RMartin

Mr. J. Andrachek
Westinghouse Electric Corporation
Mail Stop East Bay 4-10
P.O. Box 355
Pittsburgh, PA 15230-0355

Mr. Jack Bastin, Director
Regulatory Affairs
Westinghouse Electric Corporation
11921 Rockville Pike
Suite 107
Rockville, MD 20852

Mr. Andrew Drake, Project Manager
Westinghouse Owners Group
Westinghouse Electric Corporation
Mail Stop ECE 5-16
P.O. Box 355
Pittsburgh, PA 15230-0355

Mr. Hank Sepp, Manager
Regulatory and Licensing Engineering
Westinghouse Electric Corporation
Mail Stop ECE 4-07A
P.O. Box 355
Pittsburgh, PA 15230-0355

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

TECHNICAL SPECIFICATION CHANGES REGARDING SURVEILLANCE TEST INTERVAL EXTENSION FOR SSPS SLAVE RELAYS

WESTINGHOUSE OWNERS GROUP TOPICAL REPORTS WCAP-13877, 14129 AND 13900

1.0 INTRODUCTION

By letter dated February 28, 1996, the Tennessee Valley Authority (TVA), as the lead plant licensee, submitted proposed Technical Specification (TS) changes for the Watts Bar Nuclear Plant (WBNP) based on generic Westinghouse Owners Group (WOG) topical reports. The proposed changes would allow surveillance test interval extension for solid state protection system (SSPS) slave relays. Currently at WBNP and other Westinghouse plants, slave relays for the Engineered Safety Features Actuation System (ESFAS) which includes the SSPS are tested quarterly with the exception of some relays which were previously approved by the NRC to be tested every 18 months. The proposed changes to the TS would extend the test interval for all Westinghouse Type AR slave relays in Westinghouse plant ESFAS to 18 months based on historically good operating experience and acceptable performance of AR relays.

ENCLOSURE

In order to justify these TS changes, TVA provided generic Westinghouse Topical Reports, WCAP-13877, Rev. O "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," dated January 1994, (proprietary version) (Ref.1), WCAP-14129, Rev. O dated January 1994 (non-proprietary version), (Ref. 2) and WCAP-13900, Rev. O "Extension of Slave Relay Surveillance Test Intervals," dated April 1994 (Ref. 3). Following review of the above topical reports, the staff, by letter dated September 3, 1996, (Ref. 4) requested additional information and TVA responded by letters dated October 2, 1997, and December 12, 1997, (Refs. 5 and 6). A further request for additional information was submitted to TVA by letter dated January 27, 1998, and TVA responded by letter dated March 30, 1998, (Ref. 8) with revised pages to WCAP-13877 and WCAP-14129. The WOG by letter dated September 1, 1998, submitted Rev. 1 to WCAP-13877 and WCAP-14129 incorporating these revisions (Ref. 9).

2.0 BACKGROUND

The NRC staff formed a Task Group in August 1983 to investigate problems concerning surveillance testing required by TS and to recommend improvements. The results of the study were published in November 1983 in NUREG-1024, "Technical Specifications - Enhancing the Safety Impact" (Ref. 10). NUREG-1024 recommended that the staff 1) review the bases for TS test frequencies, 2) ensure that the TS required tests promote safety and do not degrade equipments; and 3) review surveillance tests to ensure that they do not unnecessarily burden personnel.

The Technical Specifications Improvement Program (TSIP) was established in December 1984 to provide the framework for addressing the NUREG-1024 recommendations, and for rewriting and improving the TS. As an element of the TSIP, TS surveillance requirements were comprehensively examined as recommended in NUREG-1024. The results of the TSIP effort are presented in NUREG-1366, "Improvements to Technical Specifications Surveillance Requirements" (Ref. 11). The study concluded that, while some testing at power is essential, safety can be improved, equipment degradation decreased, and unnecessary personnel burden prevented by reducing the amount of testing performed at power. These three conclusions formed the basis for the four criteria that justify changes to surveillance intervals as follows:

Criterion 1 - The surveillance could lead to a plant transient,

Criterion 2 - The surveillance results in unnecessary wear to equipment.

Criterion 3 - The surveillance results in radiation exposure to plant personnel that is not justified by the safety significance of the surveillance,

Criterion 4 - The surveillance places an unnecessary burden on plant personnel because the time required is not justified by the safety significance of the surveillance.

In order to utilize the results of the TSIP, the WOG initiated WOG Program MUHP-7040 to extend the surveillance interval for ESFAS subgroup relays. WCAP-13900 and the supporting information in WCAP-13877 is a result of these WOG efforts.

3.0 EVALUATION

The subject topical reports cover AR relays with AC coil (except for AR 660 relays) and with ARLA-type mechanical latch assemblies. They address the following areas concerning AR relays:

(a) Design Review

(b) Review of Generic Communications

(c) Failure Modes and Effects Analysis

(d) Aging Assessment

(e) Failure Experience

3.1 Design Review

The design review described in WCAP-13877 determined that AR relays have been designed for a lifecycle capability and temperature greater than specified for the SSPS slave relay applications and design changes implemented since the initial application of these relays in SSPS circuits have enhanced their reliability.

3.2 Review of Generic Communications

NRC generic communications (information notices, circulars and bulletins) and Westinghouse Technical Bulletins applicable to Westinghouse AR relays and their performance were reviewed and considered in the Failure Modes and Effects Analysis (FMEA) and aging assessment discussed in Sections 3.3 and 3.4 respectively.

Most relay performance deficiencies identified in WCAP-13877 were not applicable to Type AR relays used in SSPS slave relay applications. However, the concern with excess loading on relay contacts was not evaluated because it was based on the plant specific relay application. Therefore, the staff will require each licensee referencing WCAP-13900 and WCAP-13877 to perform a contact loading analysis for AR relays to determine their acceptability in their specific application.

3.3 Failure Modes and Effects Analysis

The FMEA presented in WCAP-13877 is based on guidance from IEEE Standard 352-1987 (Ref. 12) and identified temperature induced age related material degradation mechanisms which could affect relay operability. It also described the likelihood of certain relay failure modes in SSPS applications, based on duty cycle and environmental conditions. The replacement of these relays at certain predetermined intervals can minimize or preclude age/temperature related failures of concern. The replacement interval for these relays is discussed in section 3.4.

3.4 Aging Assessment

In WCAP-13877, Westinghouse addressed the relay aging issue by discussing time/temperature aging degradation of organic materials used in Westinghouse Type AR relays. Westinghouse used failure data for the ARD (DC) relay coils to determine the qualified life of AR (AC) relays used in SSPS applications, because there are no actual failures of the AR relay coils identified. Westinghouse justified this on the basis of the

similarity of materials and manufacturing process for the ARD and AR relays. The staff agrees with the Westinghouse justification and finds this acceptable.

The operating life of a relay depends on the ambient temperature at the location of the relay and temperature rise of the internal components of the relay. Westinghouse performed Arrhenius calculations for aging analyses to determine the replacement interval of the AR relays based on anticipated service conditions. For normally energized AR relays, Westinghouse used a normal ambient temperature of 80°C in the calculations based on the following assumptions:

- 32° internal cabinet temperature,
- 40° internal component temperature rise, and
- 8° cabinet temperature rise

Based on these assumptions, Westinghouse calculated the qualified life of normally energized relays to be 5.3 years. However, if the assumption of cabinet temperature rise is reduced to 5°C and 3°C then the resultant qualified life will be 6.8 years and 8.1 years respectively.

Westinghouse recommended that the qualified life for periodically energized (50%) AR relays be limited to 20 years unless sound technical bases can be cited to extend the useful life. This is a conservative assumption and consistent with industry recommendations.

Westinghouse also calculated the qualified relay life based on temperature data taken at the Farley Nuclear Plant and determined the service life for different duty cycles to be as follows:

- 100% normally energized. These relays should be replace after 19 years and if any of the relays fail after 14 years, all should be replaced.

- 20% normally energized. The service life for these relays can be extended to 40 years.

- 0% normally energized. The service life for these relays can also be extended to 40 years.

Based on the above Westinghouse aging assessment and the variability in relay service life because of the range of potential plant specific environments, the staff requires each licensee referencing WCAP-13900 and WCAP-13877 to establish the service life of AR relays for their plant based on the specific ambient environmental conditions at the relay location.

3.5 Failure Experience

WCAP-13877 presents an analysis of the failure experience of Type AR relays used in the SSPS application. The data for this analysis was derived from the Nuclear Plant Reliability Data System database and was supplemented by data from a WOG survey of Westinghouse designed plants. Based on this analysis, Westinghouse identified a total of

39 failures, of the Type AR relays. Out of these 39 failures, 22 are identified as failures caused by either technician error or improper test setup. Out of the remaining 17 equipment failures, 6 were in AR relays without latches and 11 were in AR relays with latches. Westinghouse calculated the failure rate of AR relays without latches at 1.39E-04 failures/demand or 4.40E-08 failures/hour and the failure rate of AR relays with latches at 3.92-04 failures/demand or 1.10E-07 failures/hour. Also, Westinghouse identified a slight increase in the failure rate for relays with a surveillance test interval (STI) of 18 months compared to relays with a STI of 3 months or 1 month. Out of the 17 equipment failures, 7 failures occurred in relays with STI of 18 months.

Based on the above failure data, in WCAP-13877, Westinghouse assumed a conservative failure rate of 5.3E-07 failures/hour in the core damage frequency (CDF) assessment for a STI of 18 months for SSPS slave relays even though the actual failure rate based on experience data is 1.10E-07 failures/hour for relays with a latch assembly and 4.40E-08 failures/hour for relays without a latch. Thus, the analysis of risk presented in WCAP-13877 is conservative.

The staff initially had some concern with the Westinghouse designation of the "non-failures" for some failure events listed in Table 9-8 of WCAP-13877. However, based on the margin between the failure rate assumed in the CDF calculation and the failure rate based on the actual failure experience, the staff determined that even if these "non-failures" were to be included in the failure rate calculation of the relays, it would not have changed the overall risk associated with the 18 month STI. However, because of the uncertainty in the calculations, particularly with regard to potential common mode failure,

the staff requires that if two or more Type AR relays in the SSPS application fail in a 12-month period, the licensee should reevaluate the adequacy of the extended STI. This reevaluation should consider design, maintenance and testing of all AR Type relays. If the licensee determines that the STI is inadequate for detecting a single relay failure, the STI should be decreased. The revised STI should be such that the licensee can detect a SSPS subgroup relay failure prior to the occurrence of a second failure.

4.0 CONCLUSION

Based on the staff review of WCAP-13877 Rev. 1 and WCAP-14129 Rev. 1 as applied to the STI extension for AR slave relays proposed in WCAP-13900, the staff concludes that the failure data and analysis provided for Type AR relays used in SSPS applications, support the proposed test interval extension to each refueling outage or 18 months.

Additionally, licensees referencing WCAP-13900 and WCAP-13877 Rev. 1 in plant specific TS change amendment requests for test interval extensions involving Type AR relays for SSPS applications should:

(1) Confirm the applicability of the WCAP-13877 Rev. 1, analyses to their plant.

(2) Ensure that the contact loading analysis for Type AR relays has been performed to determine the acceptability of these relays.

(3) Determine the qualified life for the Type AR relays based on plant-specific environmental conditions.

(4) Establish a program to evaluate the adequacy of the proposed test interval if two or more AR relays fail in a 12-month period.

5.0 REFERENCES

1. Westinghouse Topical Report WCAP-13877, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays" (proprietary version) dated June 1994, transmitted to NRC by D. V. Kehoe (Tennessee Valley Authority for Watts Bar) letter dated February 28, 1996.

2. Westinghouse Topical Report WCAP-14129, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays" (non-proprietary version) dated June 1994, transmitted to NRC by D. V. Kehoe (Tennessee Valley Authority for Watts Bar) letter dated February 28, 1996.

3. Westinghouse Topical Report WCAP-13900, "Extension of Slave Relay Surveillance Test Intervals," dated April 1994, transmitted to NRC by Gregory M. Rueger (Pacific Gas and Electric Company for Diablo Canyon) letter DCL-94-254, dated November 14, 1994.

4. Robert E. Martin (NRC) letter to Oliver J. Kingsley (TVA), dated September 3, 1996, "Request for Additional Information on Slave Relay Test Frequency, Watts Bar.

5. J. A. Scalice, (TVA) letter to USNRC, dated October 2, 1996, "Response to NRC Request for Additional Information on Slave Relay Test Frequency Relaxation Amendment."

6. J. A. Scalice, (TVA) letter to USNRC dated December 12, 1997, "Response to NRC Request for Slave Relay Test Frequency Relaxation Amendment."

7. Robert E. Martin (NRC) letter to O. J. Zeringue (TVA) dated January 27, 1998, "Request for Additional Information On Slave Relay Test Frequency, Watts Bar."

8. R. T. Purcell (TVA) letter to USNRC, dated March 30, 1998, "Response to NRC Request for Additional Information on Slave Relay Test Frequency Extension."

9. Charlie W. Touchstone (WOG), letter to USNRC, dated September 1, 1998, "Submittal of WCAP-13877, Rev. 1, (Proprietary) and WCAP-14129, Rev. 1, (Non-Proprietary), "Reliability Assessment of Westinghouse Type AR Relays used as SSPS Slave Relays WOG Program MUHP-3040, August 1998 (MUHP 7042)."

10. NUREG-1024, "Technical Specification - Enhancing the Safety Impact," dated November 1983.

11. NUREG-1366, "Improvement to Technical Specification Surveillance Requirements," dated December 1992.

12. IEEE Std. 352-1987, "IEEE Guide to General Principles of Reliability Analysis of Nuclear Power Generating Stations Safety Systems."

LEGAL NOTICE

"This report was prepared by Westinghouse as an account of work sponsored by the Westinghouse Owners Group (WOG). Neither the WOG, any member of the WOG, Westinghouse, nor any person acting on behalf of any of them:

(A) Makes any warranty or representation whatsoever, express or implied, (I) with respect to the use of any information, apparatus, method, process, or similar item disclosed in this report, including merchantability and fitness for a particular purpose, (II) that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or (III) that this report is suitable to any particular user's circumstance; or

(B) Assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if the WOG or any WOG representative has been advised of the possibility of such damages) resulting from any selection or use of this report or any information apparatus, method, process, or similar item disclosed in this report."

ACKNOWLEDGEMENTS

The following personnel are recognized for their extended efforts in the preparation of this report and for their team participation and support in the validation of material for this report.

S. Layciah	Westinghouse Electric Corporation
P. M. Kushnar	Westinghouse Electric Corporation
R. B. Miller	Westinghouse Electric Corporation
R. M. Span	Westinghouse Electric Corporation
J. D. Campbell	Westinghouse Electric Corporation
L. Bush	Commonwealth Edison Company - WOG
H. Pontious	Commonwealth Edison Company - WOG
M. Edison	Southern Nuclear Operating Company - WOG

TABLE OF CONTENTS

Section	Title	Page
FORWARD		ix
1.0	INTRODUCTION	1-1
2.0	SCOPE	2-1
2.1	RELAYS EXCLUDED FROM SCOPE	2-1
3.0	METHODOLOGY	3-1
3.1	DESIGN REVIEW	3-2
3.2	DESIGN DEVELOPMENT TESTING REVIEW	3-2
3.3	DRAWING REVIEW	3-2
3.4	DISASSEMBLY AND INSPECTION	3-3
3.5	QUALIFICATION TEST EXPERIENCE REVIEW	3-3
3.6	FAILURE HISTORY REVIEW	3-3
3.7	GENERIC ISSUES REVIEW	3-5
3.8	AGING ASSESSMENT	3-5
4.0	DESCRIPTION OF TYPE AR RELAY PRODUCT LINE	4-1
4.1	RELAY COIL ASSEMBLIES	4-1
4.2	CONTACT BLOCK ASSEMBLIES	4-2
4.3	ADDER BLOCK	4-5
4.4	RELAY OPERATION	4-5
4.5	RELAY OPERATING MODES	4-6
4.6	ARLA LATCH ATTACHMENT	4-6
5.0	TYPE AR RELAY DESIGN REVIEW	5-1
5.1	DESIGN LIFE	5-1
5.2	MECHANICAL OPERABILITY	5-2
5.3	ELECTRICAL OPERABILITY	5-2
5.4	DESIGN CHANGES	5-3
5.5	SUMMARY	5-7
6.0	REVIEW OF GENERIC COMMUNICATIONS	6-1
6.1	COILS POTTED WITH EPOXY RESINS	6-1
6.2	SAND-BASED COIL POTTING MATERIALS	6-2
6.3	NORMALLY ENERGIZED DC COILS	6-2
6.4	CONTACT BLOCK ASSEMBLY BINDING	6-3
6.5	EXCESS LOADS ON RELAY CONTACTS	6-3
6.6	INSUFFICIENT TRAVEL OF RELAY CONTACTS	6-4
6.7	LATCH ATTACHMENT SEISMIC QUALIFICATION	6-5
6.8	LUBRICANTS	6-6
6.9	MATERIALS DEGRADATION	6-6
6.10	DUST	6-7

TABLE OF CONTENTS (Cont)

Section	Title	Page
7.0	FAILURE MODES AND EFFECTS ANALYSIS RESULTS	7-1
7.1	FMEA TABLE FORMAT	7-1
8.0	AGING ASSESSMENT	8-1
8.1	AGING OF NORMALLY ENERGIZED vs. NORMALLY DE-ENERGIZED RELAYS	8-1
8.2	THERMOGRAVIMETRIC ANALYSIS (TGA)	8-2
8.3	END-OF-LIFE FAILURE	8-5
8.4	GLASS-FILLED PHENOLIC	8-11
8.5	GLASS-FILLED POLYESTER	8-12
8.6	OMEGA-INSULATION	8-13
8.7	NEOPRENE RUBBER	8-14
8.8	MAGNETIC NEOPRENE RUBBER	8-15
8.9	CHLORINE/CHLORIDE OUT-GASSING OF NEOPRENE RUBBERS	8-16
8.10	CONCLUSION	8-16
9.0	FAILURE EXPERIENCE	9-1
9.1	STATISTICAL ASSESSMENT OF RELAY FAILURE DATA	9-2
9.2	REPORTS OF SSPS SLAVE RELAY FAILURES	9-4
9.3	NON-VERIFIABLE REPORTS OF SSPS SLAVE RELAY FAILURES	9-5
10.0	CONCLUSIONS OF FMEA	10-1
10.1	GENERAL CONCLUSIONS	10-1
10.2	RELAY BINDING	10-1
10.3	RELAY COIL ASSEMBLIES	10-3
10.4	CONTACT BLOCK ASSEMBLIES	10-5
10.5	CONTACTS	10-7
10.6	LATCH ATTACHMENT	10-8
10.7	OTHER FACTORS	10-9
11.0	BASIS FOR ASSESSING SLAVE RELAY RELIABILITY	11-1
12.0	ANALYSIS SUMMARY	12-1
13.0	CONCLUSIONS	13-1
14.0	REFERENCES	14-1
14.1	GENERIC COMMUNICATIONS ON RELAYS	14-2
14.2	GENERIC COMMUNICATIONS RELATED TO ESFAS SYSTEMS	14-6
14.3	WESTINGHOUSE TECHNICAL BULLETINS	14-7
14.4	WESTINGHOUSE DRAWINGS	14-8
14.5	MAINTENANCE WORK REQUESTS (MWR)	14-9

TABLE OF CONTENTS (Cont)

Section	Title	Page
APPENDIX A	- TYPE AR RELAY DATA SHEETS	A-1
APPENDIX B	- WOG SURVEY DATA SHEETS	B-1
APPENDIX C	- Type ARD Failure at North Anna	C-1
APPENDIX D	- Arrhenius Equation for Aging at One or More Temperatures	D-1
APPENDIX E	- CORRESPONDENCE	E-1

- AW-00-1413, "Application for Withholding Proprietary Information from Public Disclosure," Dated 8/15/00
- AW-99-1369, "Application for Withholding Proprietary Information from Public Disclosure," Dated 11/9/99
- CAW-99-1319, "Application for Withholding Proprietary Information from Public Disclosure," Dated 2/2/99
- NRC issuance of amendment letter dated 12/30/98
- TVA license scope change letter dated 12/11/98
- Letter WOG-SRT-98-005 dated 9/1/98 (Submittal of copies of WCAP-13877, Rev. 1 and WCAP-14129, Rev. 1 to NRC.)
- TVA RAI response dated 3/30/98
- NRC RAI dated 1/27/98
- TVA relay contact loading letter dated 12/12/97
- TVA RAI response dated 10/2/97
- NRC RAI dated 9/3/96
- TVA LAR 2/28/96

LIST OF TABLES

Table	Title	Page
TABLE 5-1	AR RELAY COMPONENT NON-METALLIC MATERIALS	5-8
TABLE 5-2	ARD COIL POTTING MATERIALS	5-9
TABLE 7-1	FMEA FOR WESTINGHOUSE TYPE AR RELAY DC COIL	7-3
TABLE 7-2	FMEA FOR WESTINGHOUSE TYPE AR RELAY AC COIL	7-5
TABLE 7-3	FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY	7-6
TABLE 7-4	FMEA FOR WESTINGHOUSE TYPE AR RELAY (4-POLE) ADDER BLOCK	7-12
TABLE 7-5	FMEA FOR WESTINGHOUSE TYPE AR RELAY ARLA (MECHANICAL) LATCH ASSEMBLY	7-14
TABLE 8-1	AMBIENT TEMPERATURES AT SSPS LOCATION	8-18
TABLE 8-2	FARLEY SSPS TEMPERATURE (°F) DATA SUMMARY	8-19
TABLE 8-3	SERVICE LIFE OF FNP SSPS SLAVES BASED UPON SERVICE LIFE OF NYLON ZYTEL 101 (Ambient Temperatures)	8-20
TABLE 8-4	SERVICE LIFE OF FNP SSPS SLAVES BASED UPON SERVICE LIFE OF NYLON ZYTEL 101 (Cabinet Temperatures)	8-21
TABLE 8-5	TYPE AR RELAY MATERIALS & AGING DATA	8-22
TABLE 8-6	SERVICE LIFE FOR GLASS FILLED PHENOLIC (Ambient Temperatures)	8-23
TABLE 8-7	SERVICE LIFE FOR GLASS-FILLED PHENOLIC (Cabinet Temperatures)	8-24
TABLE 8-8	SERVICE LIFE FOR GLASS-FILLED POLYESTER (Ambient Temperatures)	8-25
TABLE 8-9	SERVICE LIFE FOR GLASS-FILLED POLYESTER (Cabinet Temperatures)	8-26
TABLE 8-10	SERVICE LIFE FOR OMEGA-INSULATION (Ambient Temperatures)	8-27
TABLE 8-11	SERVICE LIFE FOR OMEGA-INSULATION (Cabinet Temperatures)	8-28
TABLE 8-12	SERVICE LIFE FOR NEOPRENE RUBBER (Ambient Temperatures)	8-29
TABLE 8-13	SERVICE LIFE FOR NEOPRENE RUBBER (Cabinet Temperatures)	8-30
TABLE 8-14	SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Ambient Temperatures)	8-31
TABLE 8-15	SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Cabinet Temperatures)	8-32
TABLE 8-16	SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Ambient Temperatures)	8-33
TABLE 8-17	SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Cabinet Temperatures)	8-34
TABLE 9-1	AR SLAVE RELAY ACTUATION DATA	9-12
TABLE 9-2	AR SLAVE RELAY LATCH FAILURE DATA	9-13
TABLE 9-3	SERVICE HOURS OF AR RELAYS	9-14
TABLE 9-4	SERVICE HOURS OF AR LATCHING RELAYS	9-15
TABLE 9-5	FAILURE RATE SUMMARY	9-16
TABLE 9-6	RELAY EVENTS	9-17
TABLE 9-7	RELAY FAILURES	9-20
TABLE 9-8	RELAY NON-FAILURES	9-22
TABLE 9-9	CROSS-REFERENCE BETWEEN WCAP SECTIONS AND TABLES 9-7 AND 9-8	9-24

LIST OF FIGURES

Figure	Title	Page
4-1	Completely Assembled - Type AR Relay (Top) and ARD Relay (Bottom)	4-9
4-2	Type AR440 Relay with Four-Pole Contact Block Assembly	4-10
4-3	AR Coil Block Assembly (Top) and ARD Coil Block Assembly (Bottom) - Top View	4-11
4-4	AR Relay with Contact Block Assembly Removed (Top) and AR Relay with Coil Block Removed from Mounting Bracket (Bottom)	4-12
4-5	ARD Relay with Contact Block Assembly Removed (Top) and ARD Relay with Coil Block Removed from Mounting Bracket (Bottom)	4-13
4-6	Contact Cartridge Assemblies	4-14
9-1	Distribution of Relay Actuations - AR Relays, All Test Intervals, All Failure Types	9-25
9-2	Distribution of Relay Actuations - AR Relays, All Test Intervals, Not including Latch Failures	9-26
9-3	Distribution of Relay Actuations - AR Latching Relays, All Test Intervals	9-27
9-4	Distribution of Relay Service Times - AR Relays, All Test Intervals, All Failure Types	9-28
9-5	Distribution of Relay Service Times - AR Relays, All Test Intervals Non-Latching Failures	9-29
9-6	Distribution of Relay Service Times - AR Latching Relays, All Test Intervals	9-30

ACRONYMS

AC	-	Alternating Current
AMP	-	Ampere
AR	-	Westinghouse Type AR Relay (with AC Coil)
ARD	-	Westinghouse Type ARD Relay (with DC Coil)
ARMLA	-	Magnetic Latch Attachment For AR Relay
ARLA	-	Mechanical Latch Attachment With 120 Volt AC Coil
ASC	-	Auxiliary Safeguards Cabinet (also ASGC)
BF	-	Westinghouse Relay (with AC Coil)
BFD	-	Westinghouse Relay (with DC Coil)
DC	-	Direct Current
EPRI NP	-	Electric Power Research Institute Nuclear Power
EQ	-	Equipment Qualification
ERP	-	Emergency Response Procedure
ESFAS	-	Engineered Safety Features Actuation System
FAT	-	Factory Acceptance Test
FMEA	-	Failure Mode and Effects Analysis
FNP	-	Farley Nuclear Plant
HVAC	-	Heating Ventilating and Air Conditioning
LER	-	Licensee Event Report
IEEE	-	Institute of Electrical and Electronic Engineers
INPO	-	Institute of Nuclear Power Operations
I&E	-	Instrumentation and Electronics
MDR	-	Motor-driven Rotary Relay Manufactured by Potter & Brumfield
ND	-	Normally De-Energized
NE	-	Normally Energized
NC	-	Normally Closed
NO	-	Normally Open
NPRDS	-	Nuclear Plant Reliability Data System
NRC	-	Nuclear Regulatory Commission
NRMA	-	National Relay Manufacturers Association
NSIDTB	-	Nuclear Services Integration Division Technical Bulletin
NSDTB	-	Nuclear Services Division Technical Bulletin
NUREG/CR	-	
P&B	-	Potter & Brumfield
RCS	-	Replacement Component Services
RO	-	Reactor Operations
SI	-	Safety Injection
STC	-	Safeguard Test Cabinet (also SGTC)
SSPS	-	Solid State Protection System
TGA	-	Thermogravimetric Analyses
WOG	-	Westinghouse Owners Group

FORWARD

Revision 2 of this report has the corrections listed below. The changes were found to be acceptable via the safety evaluation attached to NRC Letter from Stuart A. Richards to H. A. Sepp (Westinghouse Electric Company), "Review of Westinghouse Topical Reports WCAP-13877, Revision 2-P and WCAP-13878-P, Revision 2 on Solid State Protection System (SSPS) Slave Relays (TAC NO. MA7264)", dated July 12, 2000. The letter (with attached safety evaluation) is located immediately behind the title page.

1. A corrected form of the Arrhenius equation was used to calculate service lives at energization times other than at 0% and 100%. A few small calculational differences for 0% and 100% energization times appear due to differences in calculational software and rounding of numbers.

2. The aging reference temperature to calculate the service life of Nylon Zytel 101 was corrected.

All significant changes incorporated in this revision are highlighted by side bars in the page margins on the right side (typographical errors are not noted).

1.0 INTRODUCTION

The objective of this Reliability Assessment is to establish a basis for determining the reliability of the Westinghouse type AR relay. This evaluation is comprised of a Failure Mode and Effects Analysis (FMEA) and an aging assessment of the type AR relay. The evaluation is intended to aid in the determination of maintenance and surveillance intervals consistent with reliability goals. A particular objective is to demonstrate that a refueling-based surveillance interval (18 to 24 months) would not adversely affect the reliability of Solid State Protection System (SSPS) slave relays utilized in ESFAS functions.

2.0 SCOPE

The scope of this analysis is the Westinghouse type AR relay when used in the SSPS slave relay application (i.e., when discussing the impacts of relay failure on a system, the reference case is the SSPS slave relay function). The analysis addresses several configurations (e.g., type AR440, with or without the ARLA latch attachment) and the two operating modes (normally energized (NE) or normally de-energized (ND)) of the type AR relays. Parts of this FMEA will apply to all type AR relays. However, only AR440 and AR880 relays are used in SSPS slave relay applications.

The type ARD relay is a member of the type AR relay family. Depending on the context found in this report, "AR" will either refer to the type AR family or an AC coil relay; "ARD" will always designate a DC coil AR relay. ARD relays are not used in SSPS applications.

The AR relay can be analyzed as consisting of three fundamental components. These major building blocks are the coil block assembly, the contact block assembly, and a latch assembly (optional). Only the type ARLA mechanical latch attachment is evaluated in this report.

2.1 RELAYS EXCLUDED FROM SCOPE

This analysis can be applied to all type AR relays, except the AR660 relay, which was not considered in this report. The ARMLA latch assembly currently available but not qualified for applications in "high seismic" plants (References 14.1-22, 14.3-7 and 14.3-8) was not analyzed in this report.

3.0 METHODOLOGY

The methodology used to perform a reliability assessment of the Westinghouse type AR relay included an FMEA and aging assessment. In a typical, high-level FMEA (e.g., of a control system), a relay might be shown as a "subsystem" or "component". This approach simplifies considerations of relay operability to a generic level and establishes the concept that relay reliability is also generic. For the purposes of this FMEA, however, the Westinghouse type AR relay itself is designated as the "system", allowing for a more detailed evaluation at the relay's component levels.

The following steps were followed in the thorough preparation of the FMEA:

- Design Review
- Design Development Testing Review
- Drawing Review
- Disassembly and Inspection
- Qualification Test Experience Review
- Failure History Review
- Generic Issues Review

General guidance for the FMEA was taken from IEEE Standard 352-1987 (Reference 14-1). Results of the FMEA are presented in table format in Section 7.0 of this report. The FMEA tables identify temperature-induced age-related material degradation mechanisms applicable to the relay component materials. The FMEA also includes remarks which qualify applicability and likelihood of certain type AR relay failure modes in the SSPS application. The intent is to address the failures that result from material degradation; this includes material degradation which can cause secondary failure mechanisms. Section 8.0 presents the aging assessment of the type AR relay component materials.

3.1 DESIGN REVIEW

The design review consisted of an in-depth review of the files of the cognizant AR relay design engineer. The files included engineering tests performed in the development of the type AR relay product line and examples of periodic product testing performed to verify the ultimate capability of the AR relays. Discussions with the design expert were ongoing, occurring over several months during this evaluation. These discussions resulted in substantial contribution to the completeness of the design review.

3.2 DESIGN DEVELOPMENT TESTING REVIEW

Review of the design development testing was intended to establish a benchmark for expectations of reliability. In addition, this portion of the FMEA provides a bases for discounting certain postulated failure modes. The development tests were conducted on an as-needed basis to verify the type AR relay product line would meet specific design objectives. For example, the type AR relay was designed to meet Ford Motor Company requirements specifying that industrial control relays must be capable of 10 million cycles of no load operation. Section 5.2, Mechanical Operability, provides manufacturer product line testing of randomly selected AR relays.

3.3 DRAWING REVIEW

A review of the top-level assembly drawings was performed (References 14.4-1 through 14.4-9) to augment the subsequent disassembly and inspection effort, and to verify component material types.

The FMEA for the ARLA latch attachment was based solely on review of drawings, (References 14.4-1 through 14.4-8) because the ARLA latch is obsolete and no specimen could be located for disassembly and inspection. (See Section 5.4.1)

3.4 DISASSEMBLY AND INSPECTION

Both used and new type AR relays were disassembled and examined to determine likely failure modes. Specimens were readily available and represented features and options available in the type AR relay product line (excluding the relays specified in Section 2.0). Specimens included the following catalog models: AR440AR, ARD4T, AR440A, and ARD880S.

3.5 QUALIFICATION TEST EXPERIENCE REVIEW

The Westinghouse generic Equipment Qualification (EQ) programs experience, which include the type AR relay, contributed significantly to the determination and assessment of failure modes that are related to temperature/age-degradation. Materials aging analysis is used to address failure modes and effects for which little data, if any, is available on which to base a quantitative analysis of reliability.

3.6 FAILURE HISTORY REVIEW

Failure history of type AR relays in the SSPS slave relay application was gathered to:

- Establish a quantitative reliability basis specific to the SSPS slave relay application;
- Demonstrate that type AR relays in the SSPS slave application would have a greater quantitative reliability than industrial control relays used in typical commercial industrial applications reflected in sources such as IEEE Std. 500-1984 (Reference 14-2);
- Demonstrate that reliability of the type AR relays in the SSPS slave relay application is independent of the test intervals (i.e., quarterly versus "at-refueling"); and
- Facilitate comparison with the FMEA results to justify qualitatively the expectations of superior performance of type AR relays when used as SSPS slave relays.

Failure history of type AR relays was gathered from several sources. Primary sources were the Nuclear Plant Reliability Data System (NPRDS) and a survey of the Westinghouse designed SSPS plants which as conducted by the Westinghouse Owner's Group (WOG) slave relay test interval extension subgroup. The failure history is discussed and compared to the FMEA for type AR relays in Section 9.0 .

The NPRDS database was searched using criteria developed to identify reports involving SSPS slave relays. The intent was to focus attention only on relays which have similar operating requirements and service conditions. However, the quantitative value of the NPRDS data is limited due to utility reporting inconsistencies. Where available, Licensee Event Reports (LERs) referenced in the NPRDS database entries were reviewed to clarify what actually happened to the relays. A number of the NPRDS entries were found to be "problems encountered during the performance of SSPS slave relay tests" rather than specific failure of the SSPS slave relays. Reliance on the NPRDS database was minimal beyond early efforts to assess the feasibility for determining a specific quantitative reliability for type AR relays in the SSPS slave relay application.

The WOG survey gathered data from domestic operating plants which could be used to compare the reliability of SSPS slave relays when tested at three month and eighteen month intervals. The data was requested for SSPS slave relays and for type AR relays used in applications with similar service requirements and conditions, such as the Auxiliary Safeguards Cabinet (ASC) or the Safeguards Test Cabinet (STC) (however, STCs are normally equipped with Potter & Brumfield MDR rotary relays.). Respondents completed the sheets and tables found in Appendix B of this report.

The FMEA also considers failures which have occurred in other applications of type AR relays. The failure modes/mechanisms, along with the necessary and sufficient conditions which give rise to their occurrence, were identified by the AR relay design engineer. The FMEA includes a remarks column which qualifies applicability and likelihood of certain type AR relay failure modes in the SSPS slave relay application.

3.7 GENERIC ISSUES REVIEW

Nuclear Regulatory Commission (NRC) generic communication (i.e., Bulletins, Circulars, Information Notices) also provided a broad range of lessons learned from relay failures reported in the nuclear industry. References 14.1-1 through 14.1-49 provide detailed discussion of relay failure modes and mechanisms, their effects, and root cause analyses for a variety of relays. Also reviewed were Westinghouse Technical Bulletins, References 14.3-1 through 14.3-10 which have applicability to type AR relays in the SSPS. The lessons were applied in the analysis of the type AR relays as used in the SSPS slave relay application. Generic documents with direct applicability to type AR relays are discussed in Section 6.0, Review of Generic Communication.

References 14.2-1 through 14.2-15 are NRC generic communications which discuss general problems with Engineered Safety Features Actuation System (ESFAS).

3.8 AGING ASSESSMENT

Standard approaches to relay reliability are based on empirical methods which determine a number of failures expected per number of demands (e.g., 10,000 or one million). Implicit in this statement of reliability are the premises that relays, particularly those of the industrial control type,

- Operate frequently;
- Will wear out before component materials are degraded by other factors of environment; and
- Fail upon demand for operation.

The first two premises do not apply in the case of the SSPS slave relays. The SSPS slave relays operate infrequently, most often in response to test demands. There is little likelihood that the SSPS slave relays will wear-to-failure within the current 40-year life of a nuclear plant. The third premise, which is in part derived from the other two, is the catch-all for "stand-by failures" which may arise from age-related

degradation of relay materials. In the case of the SSPS slave relays, so-called stand-by failures are more likely to be the dominant failure mechanism.

The aging assessment addresses the time/temperature degradation of organic materials used in Westinghouse type AR relays. The intent is to demonstrate the age-related degradation of the relay is sufficiently slow such that detection of age-related failures is equally effective at the refueling-based test interval as it is at the quarterly test interval.

The FMEA provides a thorough design analysis of the type AR relay, its failure history, materials performance data and thermogravimetric analyses (TGA). In addition to the typical information found in an FMEA, this study includes the aging assessment of the type AR relay.

4.0 DESCRIPTION OF TYPE AR RELAY PRODUCT LINE

The basic type AR relay consists of a coil assembly and contact block assembly (See Figure 4-1). The AR line includes both alternating current (AC) and direct current (DC) actuated relays designed to operate at nominal voltages of 120 VAC, 48 VDC or 120 VDC (others are available). An AR440 relay consists of a coil assembly that is AC current actuated and a four-pole contact block assembly (See Figure 4-2). An AR880 relay is an AR440 relay equipped with an "adder block", which is an additional four-pole contact assembly. ARD440 and ARD880 relays substitute a DC coil for the AC coil. The DC coil assembly and AC coil assembly differ in size (height from the mounting base) and configuration. The two relay types are similar in outward appearance, consist of the same materials, and are interchangeable with respect to the four-pole contact block assembly. All SSPS ESF functions are accomplished using the AR 120 VAC relays which are powered from the 120 VAC vital (1E) bus. The relays are train-associated and located in redundant SSPS cabinets.

All type AR relays can be equipped with a latch assembly. The AR440 and AR880 styles equipped with latches are used in many SSPS slave relay applications. The particular latch assembly qualified for use in the SSPS is the ARLA latch. The ARLA, a mechanical latch assembly, is now obsolete and has been replaced by the ARMLA latch, a permanent magnet latch assembly.

4.1 RELAY COIL ASSEMBLIES

Both AC and DC coils consist of coils of polyamide/polyimide insulated magnet wire cast or potted, respectively, into a glass-polyester case (or block). A pair of coil terminations are cast into opposite sides of the coil block case. In an assembled relay, screws are inserted through the contact block assembly and the coil block into threaded holes in the metal mounting bracket (See Figure 4-3).

For the purposes of this analysis the relay return spring and the interface of the armature (AC Coil) with the crossbar or the plungers (DC coil) are considered part of the contact block assembly.

4.1.1 AC Coil Assembly

The AC coil assembly consists of two series-connected random-wound coils of insulated magnet wire wound on separate nylon bobbins. The coils and bobbins are injected-molded into a glass-polyester block (no potting material is used). The upper half armature is mechanically attached to the crossbar and the armature is restrained by the return spring. The lower-half armature is attached to the mounting bracket. When the relay coil is energize, the upper-half armature is drawn into the coil bobbins and rests on the lower-half armature (See Figure 4-4).

4.1.2 DC Coil Assembly

The DC coil assembly consists of two series-connected random-wound coils of insulated magnet wire on separate coil bobbins. The coils and bobbins are potted into a glass-polyester block with an epoxy compound (other potting materials have been used in non-Class 1E service). A pair of metal plungers are inserted into the nylon coil bobbins (the plungers are the functional equivalent of the AC coil assembly upper-half armature). The plungers are mechanically attached to the cross bar and the plungers are restrained by the return spring. Inserted from the base of the coil block (and into the coil bobbins) are a pair of prongs which are an integral part of the mounting bracket. When the relay coil is energized, the plungers are drawn into the coil bobbins and rest on the prongs (See Figure 4-5).

4.2 CONTACT BLOCK ASSEMBLIES

The principal components of the contact block assembly are the cover, crossbar, and a set of contact cartridge assemblies. Other components include the armature pin, armature sponge, and return spring. The contact block assembly cover houses the interface with the coil assembly and provides adequate space for the mechanical movement of the relay.

4.2.1 Cover

The cover is injection molded phenolic. Inserted into the phenolic are threaded metallic connectors for attachment of the various screws. The cover performs four functions:

- Houses the mechanical interface of the crossbar and upper-half armature (AC coil) or plunger (DC coil).
- Guides the movement of the crossbar;
- Provides mechanical attachment, protection, and electrical separation for the contact cartridges; and
- Provides threaded holes for the attachment of the optional adder block or latch attachment.

4.2.2 Crossbar

The crossbar is illustrated in Figures 4-1, 4-4, and 4-5. It is inserted through a slot in the cover of the contact block assembly (it is not mechanically attached to the cover). It slides through the cover slot when acted upon by the relay coil or return spring. The crossbar is effectively captured in the cover by insertion of the contact cartridges and it is the movement of the crossbar that actually changes the state of the contact cartridges.

The crossbar is physically attached to upper-half armature (AC coil) or the plungers (DC coil) by the armature pin. The armature pin is inserted through holes in the crossbar and the moving parts of the coil assembly. The armature sponge is glued to the crossbar at its interface with the moving parts of the coil assembly. The armature sponge assists in maintaining the friction fit of the armature pin.

The original design permitted movement of the armature pin which facilitated repair of the relay, allowing the replacement of the coil assembly. Currently, the armature pin is bonded with epoxy to the

crossbar in type AR relays which are to be commercially dedicated for Class 1E service. This practice is not a manufacture design change. The principal purpose is to prevent field maintenance or modification of the Class 1E relays. Also the practice of "gluing" the armature pin in place will eliminate one of the postulated relay failure modes (see Table 7-3 Note 1).

4.2.3 Contact Cartridges

The contact cartridge is depicted in Figure 4-6. Contact cartridges are designed to be used interchangeably in the contact block assembly or adder block. The cartridges are designed to be replaced, as necessary, as part of normal maintenance.

The contacts used in type AR relays are a "knife-edge" design. On one surface of a contact pair there is a raised line of material which spans the contact surface along the diameter. The opposing surface is flat. The knife-edge design improves contact making and minimizes the impact of any corrosion that might occur on a flat contact surface.

The contact cartridges are inserted into the cover and through the openings in the crossbar. The contact cartridges are attached to the cover by a pair of screws. The screws are inserted diagonally through holes in the cartridge body at points projecting from either side of the cover, and are mated with metallic threaded connectors mechanically inserted into the phenolic cover. These screws also serve as the wire termination points for the cartridges.

Each contact cartridge serves as a single pole. A contact cartridge can be installed in either of two orientations to establish a normally open (NO) or normally closed (NC) pole (a given relay contact or pole is NC if it "makes" when the relay is in the de-energized position.) A label on the side of the contact block assembly instructs the user on installation of the contact cartridges to achieve either a NO or NC pole. The user can configure any type AR relay to have any combination of NO and NC contact poles.

The contact cartridges are equipped with an internal spring on which moving contacts ride. The contact cartridge spring maintains contact position, assuring both good contact and minimal contact bounce or chatter.

4.3 ADDER BLOCK

The adder block provides four additional poles and is functionally identical to the four-pole contact block assembly. The adder block consists only of a cover, cross bar and a set of contact cartridges. The adder block is designed to rest on the contact block assembly. It is attached to the contact block assembly by two screws which mate with square nuts pressed into the contact block assembly cover. Correct alignment of the adder block is assured by mating with the bosses on the contact block assembly.

The adder block crossbar rests on the crossbar of the contact block assembly. They are joined by a screw inserted through the adder block crossbar and mated into a threaded connection in the contact block assembly crossbar.

4.4 RELAY OPERATION

Type AR relays are designed to operate without the aid of gravity. The de-energized contact state is maintained (or restored) by a return spring. When the relay coil is energized, the upper-half armature (AC coil) or plungers (DC coil) are drawn into the coil block assembly, overcoming the resistance of the return spring. The crossbar is pulled along by the action of the relay coil assembly, causing the change of state in the contact cartridges.

A type AR relay equipped with a latch is also energized (relay coil) to change contact state. When the coil is energized the latch plunger (i.e., the carrier assembly) follows the contact block crossbar and is engaged. The latch maintains the energized contact state even when the relay coil is subsequently de-energized (e.g., when the ESF actuation signal is removed). The latch is disengaged, or "unlatched" by a momentary energization of the latch magnet assembly, which is a coil (e.g., unlatching power is provided by momentary actuation of the associated ESF reset switch on the Main Control Board). Operation of the ARLA latch mechanism is further explained in Section 4.6.

4.5 RELAY OPERATING MODES

For the purposes of this analysis, the AR relay is considered to have two operating modes. These modes are normally energized (NE) and normally de-energized (ND).

A relay is considered to be normally energized (NE) if its coil is continuously energized to maintain a desired contact position under normal plant or system operating conditions. A normally energized SSPS slave relay is, therefore, de-energized to perform its safety-related function.

A relay is considered to be normally de-energized (ND) if its coil is de-energized under normal plant operating conditions. Most SSPS relays are ND. A normally de-energized SSPS slave relay is, therefore, energized to perform its safety-related function.

Latching relays are normally de-energized. Typically, a latching relay is used in the control of ESF functions where the loss of relay power or input actuation signal must not cause an inadvertent reset, or where a deliberate operator action is required to reset/terminate the function, such as Containment Isolation.

4.6 ARLA LATCH ATTACHMENT

The ARLA latch attachment is designed to mate with the contact block assembly or adder block. This latch attachment can be attached to the contact block assembly by two screws which mate with square nuts pressed into the contact block assembly cover. The latch attachment can also be attached over an adder block by inserting longer screws through holes in the adder block and into the contact block assembly. Correct alignment of the latch attachment is assured by mating with the bosses on the contact block assembly or adder block. The latch is not mechanically attached to the crossbar of the contact block assembly or adder block.

The principal components of the ARLA latch mechanism are the latch carrier assembly, latch armature assembly, and latch magnet frame assembly. The latch carrier assembly performs the latch function (i.e.,

"makes the latch"). The magnet frame assembly provides electromotive force to the armature assembly for performing of the "unlatch" function.

4.6.1 Latch Carrier Assembly

The latch carrier assembly consists of several moving parts. These parts include a carrier (a polycarbonate shaft), a pair of hardened steel latch arms, a torsion spring, a pin, and a bearing. The latch arms are pinned into the carrier and physically separated by the bearing. The arms are 180 ° opposed and mechanically linked by the latch arm spring. When not physically restrained by the upper armature sleeve, the spring forces the latch arms apart causing the arms to project from either side of the carrier.

4.6.2 Latch Magnet Frame Assembly

The latch magnet frame assembly consists primarily of a coil and bobbin. The AC and DC coil assemblies are similar. Each is a single coil of insulated magnet wire random wound on the coil bobbins. The coils and bobbins are captured in the phenolic latch cover. The latch magnet frame also includes a cylinder which surrounds the carrier assembly, maintaining the latch arms in a retracted position.

4.6.3 Latch Armature

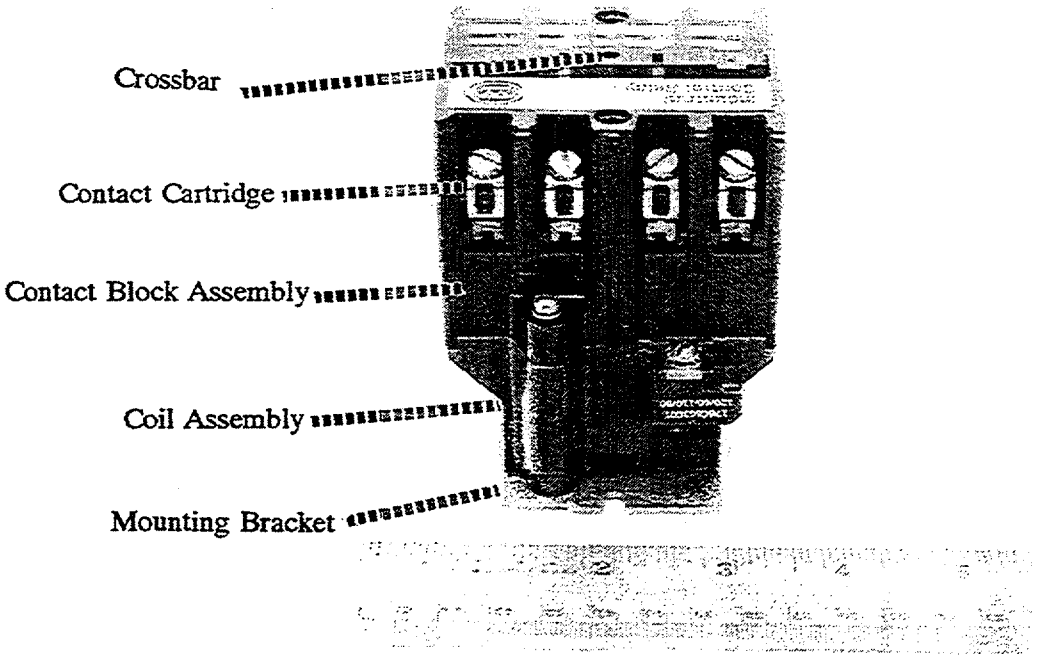
The latch armature is a flanged cylinder. It is partially inserted into the latch magnet frame assembly and surrounds the lower portion of the latch carrier assembly. When acted upon by momentary energization of the latch coil, the latch armature is drawn into the latch magnet assembly making contact with the stationary cylinder.

4.6.4 Latch Operation

The latch carrier assembly is under spring tension when not engaged. When the relay is energized, the crossbar is towed into the contact block assembly overcoming the relay return spring in the process. The carrier assembly spring presses the carrier such that it travels with the crossbar. When travel is complete, the latch arms have traveled below the edge of the magnet frame cylinder. Once below the cylinder, the

latch arms are forced out of the carrier by a torsion spring. When extended, the latch arms abut the base of the cylinder and prevent the carrier assembly from returning to the unlatched position. This feature prevents the relay crossbar from returning to its de-energized position.

The ARLA mechanism is unlatched by momentary energization of the latch coil. The field created by the coil draws the armature assembly surrounding the lower portion of the carrier assembly into (away from the relay) the latch magnet frame assembly. As such, the armature assembly is pulled over the latch arms forcing them to retract into the carrier. The relay return spring can now return the relay crossbar to the de-energized position. At the same time, the relay return spring pushes the latch carrier assembly to its unlatched position. The relay return spring then maintains the crossbar in the de-energized position, and the latch plunger assembly in the unlatched position. When the latch coil is de-energized, the armature assembly is spring-returned to its original position. The carrier assembly is once again lodged in the magnet frame assembly cylinder. The latch arms are again restrained by the cylinder.



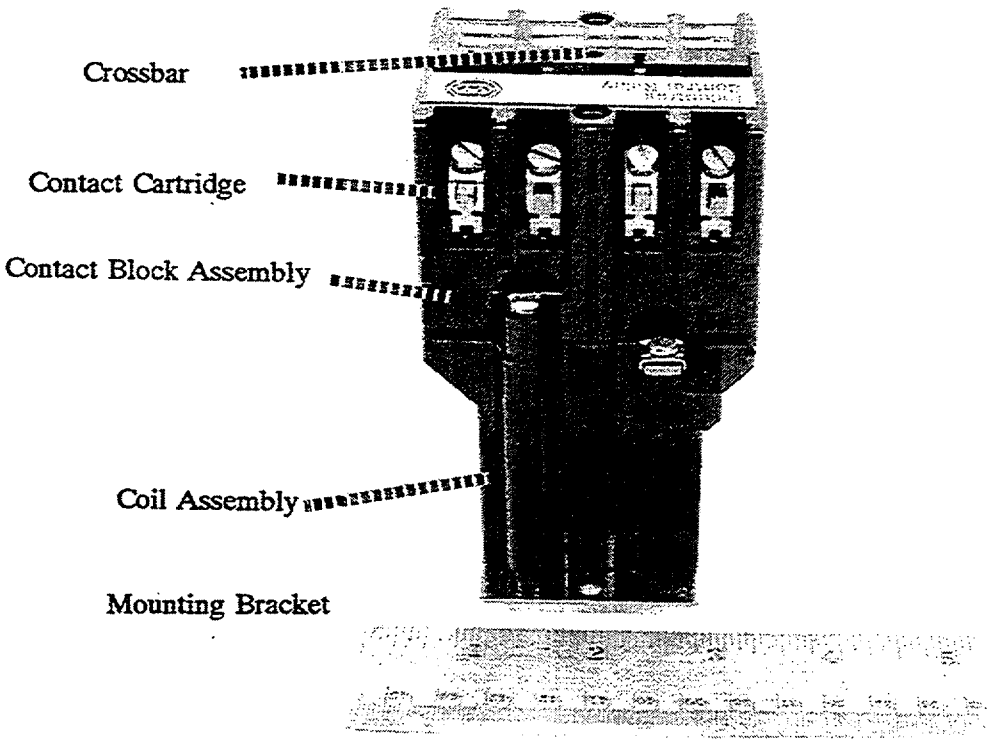


Figure 4-1: Completely Assembled - Type AR Relay (Top) and ARD Relay (Bottom)

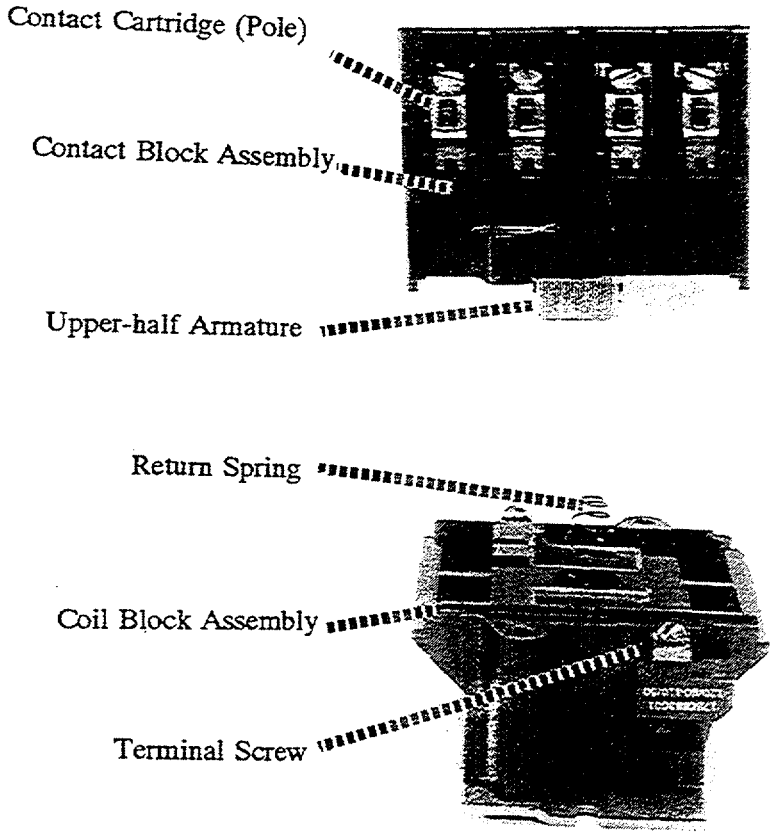
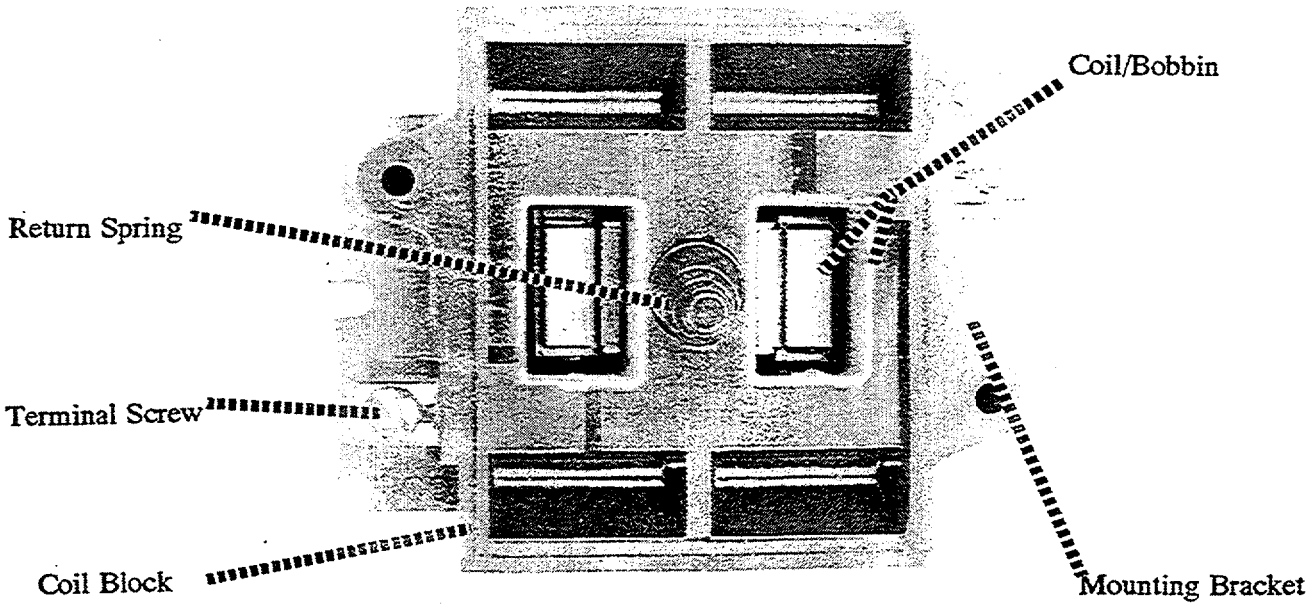


Figure 4-2: Type AR440 Relay with Four-Pole Contact Block Assembly



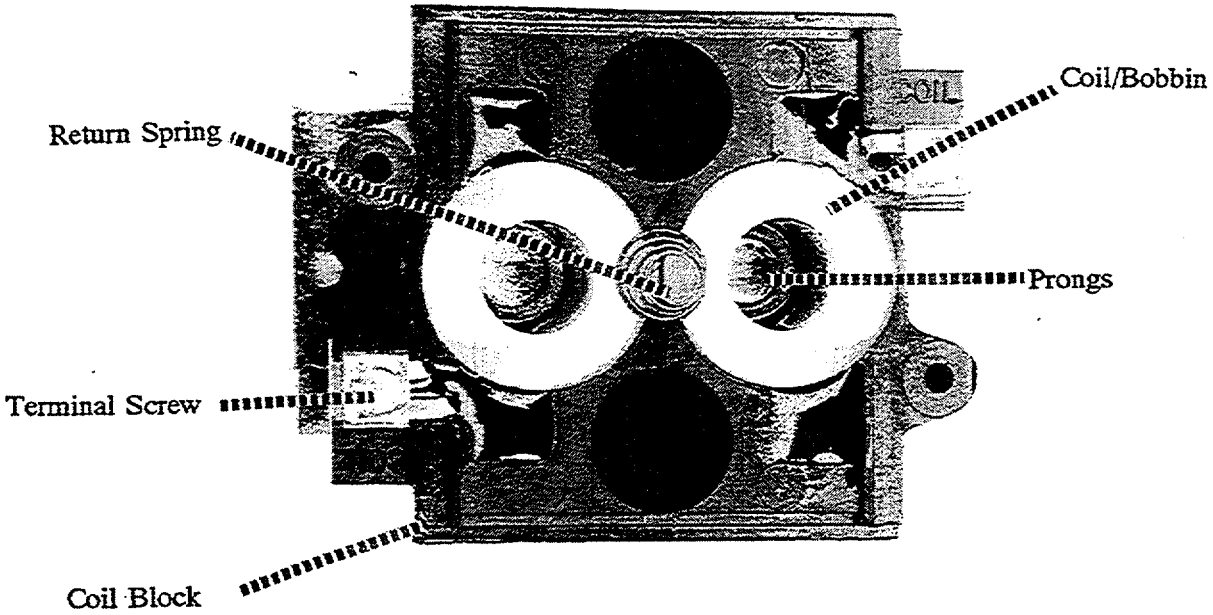


Figure 4-3: AR Coil Block Assembly (Top) and ARD Block Assembly (Bottom) - Top View

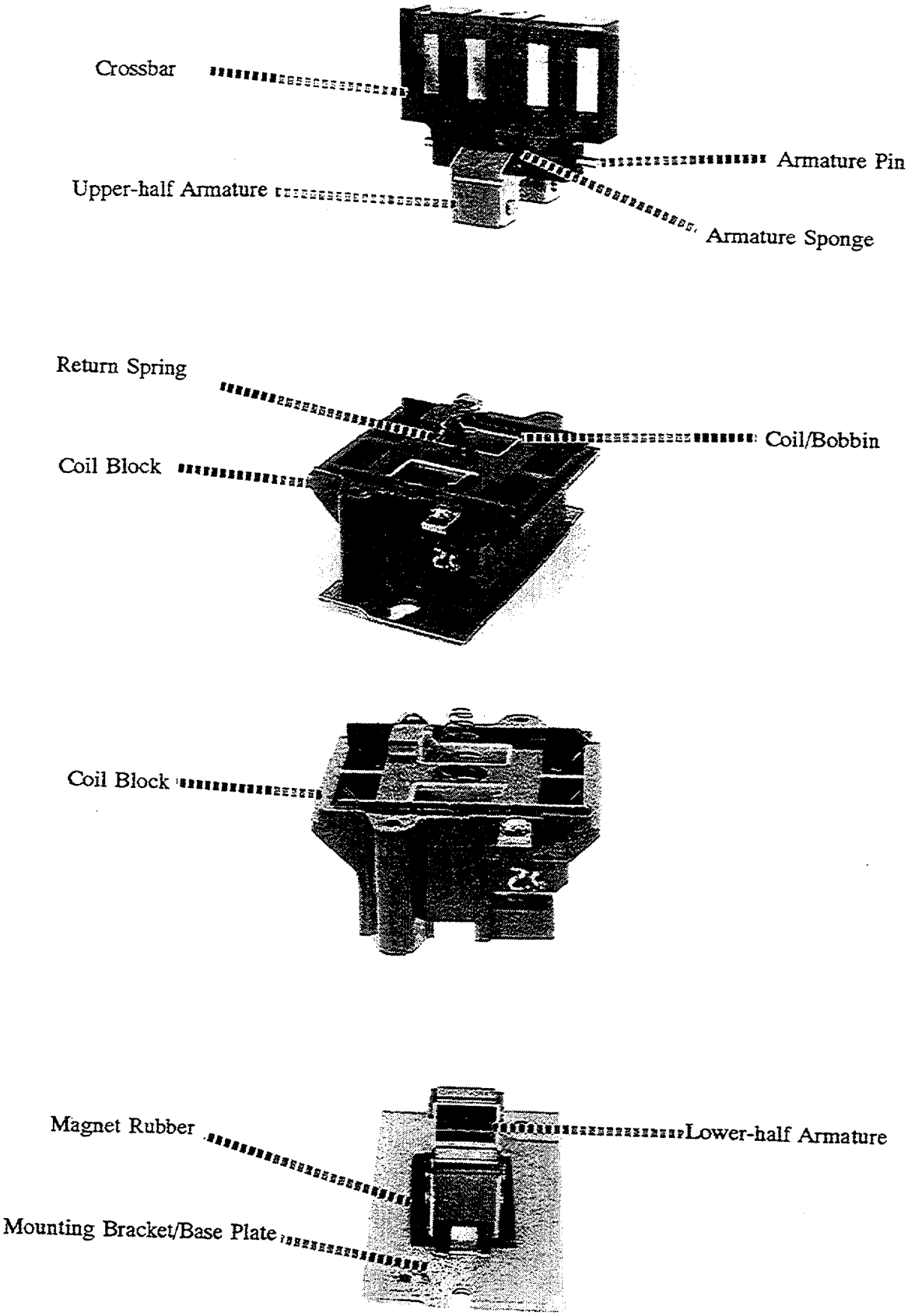


Figure 4-4: AR Relay with Contact Block Assembly Removed (Top) and AR Relay with Coil Block Removed from Mounting Bracket (Bottom)

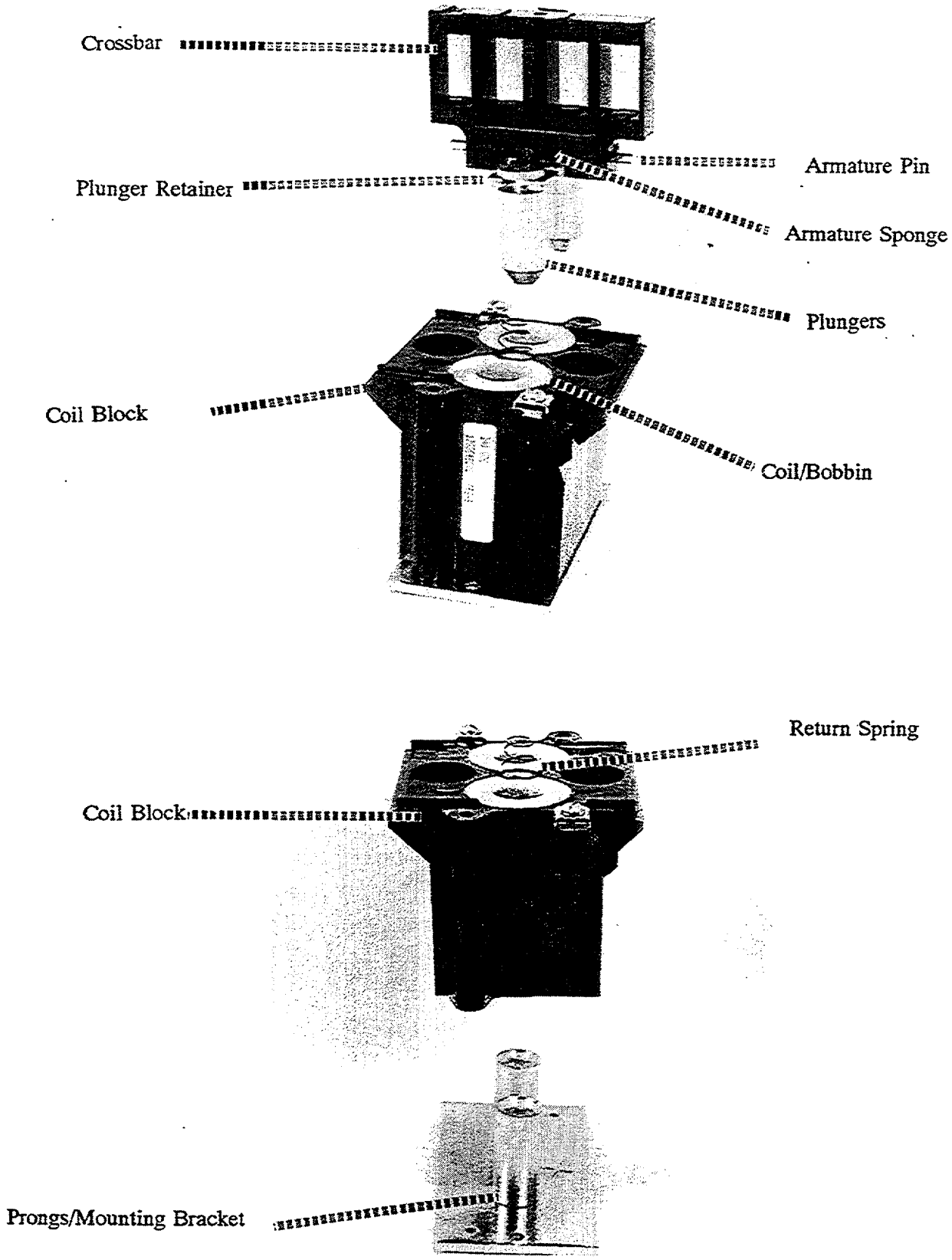


Figure 4-5: ARD Relay with Contact Block Assembly Removed (Top) and ARD Relay with Coil Block Removed from Mounting Bracket (Bottom)

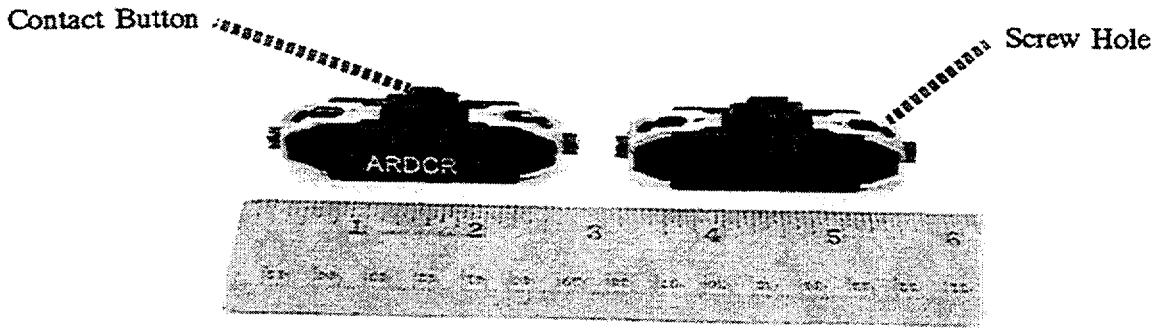


Figure 4-6: Contact Cartridge Assemblies

5.0 TYPE AR RELAY DESIGN REVIEW

The Westinghouse type AR relays have a design life and cycle capability greatly in excess of that required for the SSPS slave relay application. The following sections summarize results of the design review which supports this conclusion.

5.1 DESIGN LIFE

The design objective for type AR relays is the capability to endure 10 million cycles of operation. This was demonstrated in the original prototype testing and continues to be demonstrated in current monthly tests of random samples selected during manufacturing. The SSPS slave relays have an estimated duty life of 1000 cycles of operation over a forty-year plant life, based on startup testing, surveillance testing, and any valid or inadvertent trip demands.

The ARLA latch attachment will reach end-of-life conditions prior to performing 10 million cycles of operation. A conservative number of 100,000 is suggested by the latch attachment design engineer based on reported failures from commercial/industrial users of the relays. This limit is imposed for latches used in high-cycle demand applications where high ambient temperature will also reduce the effectiveness of the [ ][a,c] used in the latch attachment.

Material selection in the design of the type AR relay considered both high temperatures expected in and around electrical system cabinets and the temperature rise for high duty cycle and normally energized service. The non-metallic materials are listed in Tables 5-1 and 5-2. The manufacturer states that the relay is suitable for service in ambient environments which do not exceed 100 °C (212°F). The shelf life specified by Westinghouse Replacement Component Services (RCS) is 40 years when stored at ambient temperatures at or below 120 °F.

Further discussion of type AR relay aging and temperature endurance is deferred to Section 8.0, Aging Assessment.

5.2 MECHANICAL OPERABILITY

[

]a,b,c

Early prototype testing was run-until-failure. After 11 million cycles of operation, the first failure observed was breakage of the crossbar (mechanical fatigue). The damaged relay was removed and testing continued on the remaining specimens. After 19 million cycles of operations a second crossbar failure occurred, and testing was terminated. The remaining specimens were operable when testing was halted.

Since initial manufacture of the type AR relay product line, ten or more randomly selected specimens have been tested each month to demonstrate the mechanical capability of performing at least ten million failure free cycles of operation. However, for a number of years, the cycle life objective was revised to five million cycles of operation to reduce the costs of testing. This decision was later reversed; the 10 million cycle life testing objective remains in effect to demonstrate mechanical operability and reliability.

5.3 ELECTRICAL OPERABILITY

Electrical operability of the AR relay contacts was demonstrated during the prototype testing and continues to be affirmed in monthly tests. [

]a,b,c At each make, the contacts experience the load of other relay coils, one of which is being energized by the making of the contact. At each break,

the contacts experience other coil loads, one of which is de-energized by the contact breaking. Thus, each of the contacts experiences 10 million make/break cycles under load during the test.

These monthly product tests are not intended to demonstrate full-load capability of the contacts. Full-load electrical operability of the relay contacts was demonstrated by separate design/development tests in which the contacts were required to make under a 60 Amp load and then break under 6 Amp (AC) load (the full load ratings). The design objective was not 10 million cycles of full-load operation, but rather to determine the best available contacts. These tests were also run until failure. In a series of tests comparing the contacts procurable from several manufacturers, it was observed that a particular manufacturer's contacts experienced two failures after only 750,000 cycles of operation. These were deemed unsuitable, withdrawn from further consideration, and none were used in production of type AR relays. The contacts selected for the AR relays exhibited greater reliability.

Contact cartridges are designed to be replaceable as a routine maintenance item in high demand, high cycle life applications. However, it is likely that other factors of environment and usage may necessitate contact replacement over the expected 10 million cycle life of the type AR relays. In the SSPS slave relay applications, it is very unlikely that contacts would require replacement within the life of the plant, primarily due to the very low number of operating cycles estimated.

Section 6.5 discusses reported cases of excessive contact loading. Excessive contact loading is applicable to both the type AR relay as well as the MDR Series Relays used as SSPS slave relays.

5.4 DESIGN CHANGES

Significant design changes for the type AR relay are summarized below. Most are upgrades to the product line based on field experience. Each design change contributed to further enhance the AR relay design objectives by improving relay reliability.

5.4.1 ARLA Latch Mechanisms

Manufacture of the ARLA (mechanical) latch mechanism was discontinued (Oct. 10, 1974). The decision to discontinue the mechanical latch mechanism was in response to poor reliability in high demand, i.e., high cycle life, applications in commercial/industrial service. [

]a,b,c

- The ARLA latch mechanism is not adjustable and it is sensitive to manufacturing variance in other relay components. (Tolerance mismatch in the type AR 880 configurations can result in insufficient travel to permit proper latch operation, which may affect the latching or unlatching of the ARLA latch mechanism). The manufacturer had received numerous reports of latch "failure" which were determined to result from the tolerance mismatch making certain latches and relays incompatible.

  [

]a,b,c

At the end of die life the components cast in them have reached maximum tolerance. The relay crossbars, in particular, have a sensitivity to the gradual increase in tolerance. [

]a,b,c

The latch mechanism is also subject to variances in manufacturing tolerances. In the extreme case where the relay crossbar(s) and latch mechanism components are at their maximum tolerances, travel may be insufficient to permit consistent latch making. The manufacturer should be contacted regarding any cases were latch mechanisms exhibit intermittent making.

Cases of tolerance mismatch between the relay crossbar(s) and latch mechanisms will typically occur in the field when relays and latches are procured separately, or when either the relay or latch mechanism are replaced. In either case, the tolerance mismatch of the components is considered to be an infant mortality type failure which can be corrected, preferably by the manufacturer.

- [

-

]a,b,c

The ARLA latch mechanism has been replaced by the ARMLA (magnetic) latch mechanism. The ARMLA latch mechanism does not have seismic qualification for use in Class 1E applications. This in noted in I&E Notice 82-55 (Reference 14.1-22) and Westinghouse Technical Bulletin NSD-TB-82-03 (Reference 14.3-7). Also See Section 6.7, Latch Attachment Seismic Qualification.

5.4.2 Contact Cartridges

A design change reduced the thickness of the contact button - the contact cartridge component which is moved by the crossbar (See Figure 4-6). Reference 14.3-3, dated July 21, 1977, discusses the potential impact on electrical contact making in safety-related applications of type AR relays equipped with a latch attachment. In brief, the back travel of relays after latching may unmake contacts. This concern has been eliminated by utility actions in response to Westinghouse Technical Bulletin NSD-TB-77-10, (Reference 14.3-3).

Reference 14.3-3 also mentions adverse impact of overtightening the contact cartridge screw(s). The contact cartridge screw performs a dual function. The screw fastens the contact cartridge to the contact block and is also the electrical termination point. Excessive tightening of the contact cartridge screw intended to assure good electrical contact, can cause a deformation of the cartridge assembly which in turn could prevent the contacts from making properly.

[

]a,b,c

5.4.3 Relay Magnet Sideplates

[

]a,b,c

5.4.4 DC Coil Potting Material

Changes in the potting material and methods for DC coil assemblies are presented in Table 5-2. The Westinghouse type AR relays with DC coils (i.e., ARD relays) are not used in SSPS slave relay applications, however, this information/history is pertinent when we compare the end-of-life failures of the ARD to the AR end-of-life postulations.

A sand-based potting was used in some styles of type ARD relay coils. The sand-based potting was eliminated as an available option for commercial grade items in September of 1981. This coil design was not used in Class 1E service in Westinghouse designed systems. References 14.1-37 and 14.1-38 discuss concerns for safety-related application of the sand-based potted coils by other vendors.

In 1991 it was learned that the epoxy potting compound of some DC coil assemblies would soften and flow inside the relay causing the relays to bind. NRC IN 91-45 (Reference 14.1-42) discusses the concern for uncured epoxy potting material in normally energized Westinghouse type ARD (DC coil) relays. The type AR relays are not subject to this concern (see Section 6.1, Coils Potted with Epoxy Resins). In February of 1993, the potting of DC coils was eliminated. In current manufacture, DC coil assemblies are molded into the glass-filled polyester coil block by the same process as used in the manufacture of the AC coil assemblies.

5.5 SUMMARY

The AR relays have a cycle life capability greatly in excess of that required for the SSPS slave relay application. The maximum temperature experienced by the type AR slave relays in the SSPS cabinets is far less than the manufacturers' recommended temperature for reliable AR relay operation. In addition, design changes have enhanced the reliability of the type AR relay. The principal issue of reliability in the SSPS slave relay application is the very low cycle demand and the extended period(s) during which no demand is expected. The AR slave relay high reliability is also supported by the aging analysis (Section 8.0, Aging Analysis) and other factors of relay reliability (Section 10.0, Conclusions of FMEA).

a,b,c

TABLE 5-1 AR RELAY COMPONENT NON-METALLIC MATERIALS		

a,b,c

TABLE 5-2 ARD COIL POTTING MATERIALS

6.0 REVIEW OF GENERIC COMMUNICATIONS

This section discusses the generic communication documents applicable to the Westinghouse type AR relay and its use in the SSPS. All reference document titles are found in Section 14.

References 14.1-1 to 14.1-49 and 14.2-1 to 14.2-15 are the NRC generic communications reviewed as part of the FMEA and aging assessment of type AR relays. All were reviewed with the intent of considering any relay failure modes or mechanisms identified for relays that might also apply to the type AR relay. References 14.3-1 to 14.3-10 are the Westinghouse Technical Bulletins which have applicability to the type AR relay or its use in the SSPS.

Documents with direct applicability to type AR relays are discussed in the following subsections.

Issues affecting Westinghouse type BF relays are also considered below because of their similarity with type AR relays in materials and methods of manufacture.

6.1 COILS POTTED WITH EPOXY RESINS

Problems with epoxy potting materials in normally energized relays have been the subject of a number of generic communications. At issue is the softening and flowing of epoxy potting material due to the heat rise of the normally energized relay coil. The problem was observed in type BFD relays (i.e., a type BF relay with DC coil) and is reported in Reference 14.1-4 ("Relay Failures - Westinghouse BFD Relays"). References 14.1-8, 14.1-12, 14.1-21, 14.1-42, 14.3-2, 14.3-4, 14.3-5 and 14.3-6 provide additional details and include the manufacturer's recommendations for detection and resolution of the concern.

Reference 14.1-42 ("Possible Malfunction of Westinghouse ARD, BFD, and NBFD Relays, and A200 DC and DPC 250 Magnetic Contactors") discusses the softening and flowing of the epoxy potting material in normally energized relays with DC coils. Attached to Reference 14.1-42 is a copy of the Westinghouse letter notifying the Nuclear Regulatory Commission (NRC) pursuant to the reporting requirements of 10 CFR Part 21. The root cause was determined to be variances in the mixing of the two-part epoxy compound during manufacture. The uncured epoxy potting of normally energized DC

coils will soften, flow, and ultimately cause excessive resistance to relay change-of-state. In extreme cases, the relay will bind.

Reference 14.1-42 clarifies that the epoxy softening problem observed in normally energized type BFD relays may also occur in normally energized type ARD relays. Concern is limited to the DC coil assembly used in the type AR relay product line (Also see Section 5.4.4).

Type AR relay AC coils are injection molded, not potted, and only type AR (AC coil version) relays are used as SSPS slave relays. Therefore, this issue is not applicable to those AR relays located in the SSPS that perform ESF functions.

6.2 SAND-BASED COIL POTTING MATERIALS

A sand-based potting was used in some styles of type ARD relay coils. Reference 14.1-37 ("Degradation of Westinghouse ARD Relays") describes the failure mechanism which results from granules of sand being drawn into the coil bobbin and impeding movement of the plunger. This DC coil design was not used in Class 1E service in Westinghouse designed systems, including the SSPS output relay cabinets. References 14.1-37 and 14.1-38 discuss concerns for safety-related application of the sand-based potted coils by other vendors.

6.3 NORMALLY ENERGIZED DC COILS

Reference 14.1-16 ("Westinghouse NBFD Relay Failures in Reactor Protection Systems at Certain Nuclear Power Plants") discussed failures reported for normally energized type BFD relays. The root cause is the combination of heat rise and the inductive voltage spike that occurs when the coil de-energizes (References 14.3-5 and 14.3-6). This failure mode has been observed only in normally energized SSPS applications of the Type BFD relay. No similar occurrences have been observed in type ARD relays, or for relays used in SSPS applications.

Only type AR (AC coil version) relays are used as SSPS slave relays and relatively few are NE. One example of a NE SSPS slave relay is the K629, Source Range Block relay. The aging evaluation found in Section 8 considers the time/temperature effects of both the NE and ND type AR relays.

6.4 CONTACT BLOCK ASSEMBLY BINDING

Reference 14.1-12 ("Failures of Westinghouse BF (ac) and BFD (dc) Relays") discusses a failure mode of Type BF and BFD relays which is applicable to type AR and ARD relays. The reported malfunctions were caused by the pin that connects the plunger to the operating head rubbing against the contact block. Westinghouse resolved this concern in BF relays by gluing the armature pin to the crossbar (Reference 14.3-2).

A similar circumstance can occur in type AR and ARD relays as shown, (see "Armature Pin") on Table 7-3. This failure mechanism has been observed in type AR relays, but only after millions of operations. Failure is also dependent on the "roughness" of the armature pin ends. [

]a,b,c

This failure mode is not expected in SSPS slave relays because of the very low demands estimated for the service life.

6.5 EXCESS LOADS ON RELAY CONTACTS

Reference 14.1-45 reports cases of excessive contact loading in Potter & Brumfield MDR rotary relays in various applications. Noted are the differences between the current ratings of contacts used with direct current and the rating of contacts used with alternating current. Failures of the MDR relay contacts were due to consideration of only resistive loads and failure to consider inductive loads. Reference 14.1-45 characterizes the reported failures as misapplication of P&B MDR relays.

Reference 14.3-10 was issued by Westinghouse in response to reports of excess contact loading failures which occurred in MDR relays used as SSPS slave relays. The concern is for circuits in which the MDR relay contacts are required to open in response to ESFAS signals, de-energizing normally energized solenoid valves with DC coils (specifically, Valcor and Target Rock solenoid valves). References 14.3-10 states that the concern also applies to type AR relays required to perform a similar function.

Situations of excessive contact loading should be corrected by circuit modification. For the purposes of this evaluation, it is assumed that any previously existing cases have been eliminated by circuit modification. This failure mode is included in the FMEA (Section 7, Table 7-3). However, incidents of such failure have been omitted in the calculation of relay reliability (See Section 9.0).

6.6 INSUFFICIENT TRAVEL OF RELAY CONTACTS

Westinghouse issued Technical Bulletin NSD-TB-77-10 (Reference 14.3-3) to communicate problems encountered during Factory Acceptance Tests (FATs) of the SSPS and Auxiliary Safeguards Cabinet (ASC) on type AR relays with latches. A design change in the thickness of the "moveable button" of the contact cartridge reduced the "overtravel" of the contacts. Overtravel is the concept of improved contact making through spring retention and therefore provides more resistance to vibration (minimizes chances of "contact chattering"). This issue was a particular problem for relays equipped with latches. After initial contact making there is the backtravel to the point of latch engagement. In some cases, the backtravel permitted contacts to reopen even though the relay remained in the latched position. Reference 14.3-3 provides instructions for identifying relay vintages subject to the concern.

Reference 14.3-3 also discusses the adverse consequence of overtightening the contact cartridge screws. This effect can cause deformation in the stationary portion of the contact cartridge assembly, which results in further reduction of the contact overtravel.

Subsequently, the NRC I&E Bulletin 77-02 (Reference 14.1-5) ("Potential Failure Mechanism in Certain Westinghouse AR Relays with Latch Attachments") was issued communicating the same concerns. The Bulletin requested nuclear utilities to consider the potential for any safety-related application impact of type AR relays, and to take necessary actions to preclude concern.

Concern for the impact of the manufacturing change in contact cartridge dimensions has been effectively resolved by actions in response to References 14.1-5 and 14.3-3 (AR Relays with Latch Attachments: Solid State Protection Systems and Auxiliary Safeguards Cabinets"). However, both concerns are reflected in the FMEA results (Section 7.0, Tables 7-3 and 7-4). There remains the possibility that manufacturing variances in the contact cartridge or other relay components could appear in relays of later vintages. Equally, the overtightening of the contact cartridge screws may occur at any time through routine maintenance or replacement of the cartridge. Either case should be detectable in post-maintenance testing, however.

For the purposes of this evaluation, insufficient contact travel resulting from tolerance mismatch is considered an infant mortality. Discovery by Westinghouse during the SSPS FATs and communication via Reference 14.3-3 precluded the failure mechanisms from occurring in SSPS slave relays. No cases of similar occurrence have been reported in response to the WOG survey of SSPS slave relays (See Section 9.0). Both failure mechanisms, reduced overtravel of contacts and overtightening of contact cartridge screws, are readily detectable. Post-maintenance testing will assure that contact intermittence due to mismatch of tolerances does not affect the reliability of relays in service.

6.7 LATCH ATTACHMENT SEISMIC QUALIFICATION

Section 5.4.1 discussed the obsolescence of the ARLA latch attachment. Westinghouse Technical Bulletin NSD-TB-82-03 (Reference 14.3-7) communicated concern that the manufacturer's replacement, the ARMLA latch attachment, was not seismically qualified for safety-related applications in the SSPS or ASC. Reference 14.3-7 further explains that the P&B MDR rotary relay is the only qualified replacement, if needed, for type AR latching relays.

NRC I&E Notice 82-55 (Reference 14.1-22), repeated this concern, including Reference 14.3-7 as an attachment and additional detail was communicated in Westinghouse Technical Bulletin NSD-TB-82-03, Rev. 1 (Reference 14.3-8). Review of the NPRDS data base and information gathered through the WOG survey include LERs filed by plants which had installed the ARMLA in the SSPS and then later removed them from service. The Westinghouse AR relay with ARLA latch is still acceptable for SSPS applications along with the P&B MDR relay.

The ARMLA latch attachment is not used in the SSPS slave relay applications.

6.8 LUBRICANTS

Reference 14.1-14 ("Service Advice for General Electric Induction Disc Relays") discusses the failure of GE relays which rely on petroleum jelly as a lubricant. The petroleum jelly was found to migrate under high temperature conditions. At room temperature, the petroleum jelly acted as an adhesive increasing relay pick-up times.

There is no lubricant used in type AR relays, but the ARLA latch attachment does require lubrication. Petroleum jelly was considered as a potential replacement for the lithium-based grease originally used in type ARLA latch mechanism (See Section 5.4.1). However, prototype testing by the manufacturer showed unacceptable results and the ARLA latch attachment is lubricated with stearic acid, not petroleum jelly. Factory acceptance testing and field experience continue to demonstrate reliable lubricant performance in the ARLA latch attachment.

6.9 MATERIALS DEGRADATION

The FMEA results of Section 7.0 include consideration of failure modes and mechanisms that might arise from degradation products of type AR relay component materials. The aging assessment of the type AR relay includes review of available Thermogravimetric Analyses (TGAs) applicable to neoprene rubber and Nylon Zytel 101 (See Section 8.0). Both materials are likely out-gassers. Other organic materials of the type AR relay and the ARLA latch attachment are not subject to significant dimensional change, weight loss, or loss of flexural strength in response to high temperature, or as a factor of long-term aging. As such, there is little likelihood of significant out-gassing or evolution of aggressive species (e.g., hydrochloric acid).

No reports of type AR relay failures due to out-gassing of degradable materials have been identified. The thermogravimetry of neoprene rubber indicates that chlorine or hydrochloric acid will be evolved as part of the age/temperature degradation process. However, the impact on the type AR SSPS slave relay's is minimal. See further discussion in Sections 8.0 and 9.0.

Based on conclusions of the aging assessment, a replacement interval is recommended in Section 8.3.4 for normally energized type AR relays. It is intended that relay reliability will be optimized by replacement prior to the occurrence of significant aging degradation. Normally energized relays should be replaced more frequently. The actual replacement interval should be based on the aging assessment (Section 8.3) and calculations using plant-specific temperature data. Section 8.3.4 includes an example calculation performed for the Farley Nuclear Plant.

6.10 DUST

Reference 14.1-37 ("Degradation of Westinghouse ARD Relays") mentions that increased contact resistance observed in Westinghouse type ARD relays was attributed to dust. Dust, among other things, can degrade contact performance. In extreme cases, dust can cause type AR relays to bind. Relay binding due to excessive dust and dirt has been observed in type AR relays used in mining applications. Such extremes of dust, dirt and debris are not expected in the SSPS slave relay applications. The FMEA includes consideration of both the potential failure mode and the remote probability of such occurrence in the SSPS slave relays. Section 10.7, Others Factors, also addresses dust as a time/temperature dependent failure mechanism.

7.0 FAILURE MODES AND EFFECTS ANALYSIS RESULTS

The results of the Failure Modes and Effects Analysis (FMEA) for Westinghouse type AR relays are presented in Tables 7-1 through 7-5. Each table addresses a different fundamental component of the type AR relay.

Tables 7-1 and 7-2 are the FMEA for DC and AC coil assemblies, respectively. Tables 7-3 and 7-4 are the FMEA for the 4-pole contact block assembly and the adder block, respectively. Table 7-5 is the FMEA for the ARLA latch assembly.

It is intended that two or more of the tables will apply to any particular AR relay. For example, the FMEA of an AR440A relay, which consists of an AC coil and 4-pole contact block, is the combination of Tables 7-2 and 7-3. The FMEA for an ARD880S relay, which consists of a DC coil, 4-pole contact block, an adder block, and overlap contacts (designated by the "S" in the model numbers) is the combination of Tables 7-1, 7-3, and 7-4.

The tables identify temperature-induced and age-related failure mechanisms of relay components. Also included are considerations of adverse impacts due to material degradation products. These are based on review of thermogravimetric analyses reviewed as part of the aging assessment (Section 8.0). Qualifying remarks are included to gage the significance of postulated degradation mechanisms with respect to SSPS slave relay service. Further discussions are deferred to Section 8.0.

7.1 FMEA TABLE FORMAT

[

]a,b,c,e

[

]a,b,c,e

a,b,c,e

TABLE 7-1 FMEA FOR WESTINGHOUSE TYPE AR RELAY DC COIL

a,b,c,e

TABLE 7-1 FMEA FOR WESTINGHOUSE TYPE AR RELAY DC COIL

a,b,c,e

TABLE 7-2 FMEA FOR WESTINGHOUSE TYPE AR RELAY AC COIL

TABLE 7-3 FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY

a,b,c,e

a,b,c,e

TABLE 7-3 FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY

a,b,c,e

TABLE 7-3 FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY

a,b,c,e

TABLE 7-3 FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY

a,b,c,e

TABLE 7-3 FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY

a,b,c,e

TABLE 7-3 FMEA FOR WESTINGHOUSE TYPE AR RELAY 4-POLE CONTACT BLOCK ASSEMBLY

a,b,c,e

TABLE 7-4 FMEA FOR WESTINGHOUSE TYPE AR RELAY (4-POLE) ADDER BLOCK

a,b,c,e

TABLE 7-4 FMEA FOR WESTINGHOUSE TYPE AR RELAY (4-POLE) ADDER BLOCK

a,b,c,e

TABLE 7-5 FMEA FOR WESTINGHOUSE TYPE AR RELAY ARLA (MECHANICAL) LATCH ASSEMBLY

a,b,c,e

TABLE 7-5 FMEA FOR WESTINGHOUSE TYPE AR RELAY ARLA (MECHANICAL) LATCH ASSEMBLY

a,b,c,e

TABLE 7-5 FMEA FOR WESTINGHOUSE TYPE AR RELAY ARLA (MECHANICAL) LATCH ASSEMBLY

8.0 AGING ASSESSMENT

The aging assessment addresses the time/temperature degradation of organic materials used in Westinghouse type AR relays. The intent is to demonstrate that the age-related degradation of the relay is sufficiently slow that failure detection is equally effective at three-month intervals and refueling-based test intervals. The recommended approach to maximizing reliability is to minimize test frequency, monitor and control relevant environmental factors, and determine AR slave relay replacement intervals on the basis of accurate service life predictions. These predictions should be determined specifically for the relay's service, location and environment.

8.1 AGING OF NORMALLY ENERGIZED vs. NORMALLY DE-ENERGIZED RELAYS

In most nuclear plant applications, and particularly for the SSPS slave relay application, aging degradation is the single greatest challenge to operability and reliability. The typical SSPS slave relay is normally de-energized, operates only in ESFAS actuation demands or during periodic testing, and is protected from the damaging effects of debris and contamination. The typical SSPS slave relay is protected from the extremes of high ambient temperature and high relative humidity by HVAC equipment in the protected areas where the SSPS is normally installed (Table 8-1 lists the WOG participants' SSPS Ambient Temperature Ranges). In addition, most plants provide redundant, Class-1E-powered HVAC in the rooms where the SSPS is installed (e.g. power plant control room), further assuring minimal ambient temperature and humidity under all plant operating modes. In SSPS slave relay applications, the type AR relays experience environmental conditions which are milder than those specified by Westinghouse Replacement Components Services (RCS) shelf life requirements (i.e., <120°F for 40 years).

Aging effects apply equally to NE and ND relays. However, thermal aging effects are accelerated in NE relays by the coil assembly temperature rise (30 °C for the coil; smaller temperature rises apply to other relay components). Acceleration of thermal aging effects may also accelerate the effects of wear. For example, lubricants may become less effective. Such secondary aging degradation mechanisms may become significant in normally-energized relays and relays which experience high-cycle demands. These effects are of no consequence to the type AR SSPS slave relay which requires no lubrication. The

ARLA latch mechanism is lubricated. However, the relay coil is normally de-energized and experiences a minimal temperature rise (estimated as less than or equal to 5 °C) when energized (the relay latch coil is normally deenergized, and is only momentarily energized to release the latch mechanism).

8.2 THERMOGRAVIMETRIC ANALYSIS (TGA)

The aging assessment of the type AR relay product line includes review of available thermogravimetric analyses (TGAs) applicable to the temperature sensitive materials of the type AR relay and ARLA latch mechanism. The materials identified as likely out-gassers are neoprene rubber and Nylon Zytel 101. Other organic materials of the type AR relay and the ARLA latch attachment are not subject to significant dimensional change, weight loss, or loss of flexural strength in response to high temperature long term aging. As such, there is little likelihood of significant out-gassing or evolution of aggressive species (e.g., hydrochloric acid) from the phenolic (glass-filled) or polyester (glass-filled) materials. Therefore, the insignificant amount of out-gassing of phenolic (glass-filled) and polyester (glass-filled) will not affect the reliability of the type AR slave relay. Discussion of neoprene rubber and Nylon Zytel 101 are provided below.

8.2.1 Neoprene Rubber

Neoprene rubber is used for two components in the type AR relay, the magnet rubber and the armature sponge. Both parts are used in essentially non-critical functions. Even after a substantial loss of material properties, these two components are relatively insignificant to relay operation. Degradation of either part is, in itself, of little or no direct consequence to the relay. The relay will operate with either or both parts removed.

Degradation of these specific neoprene rubber components, however, is a minor secondary concern. TGA of the neoprene rubber indicates that chlorine or hydrochloric acid will evolve as result of the age/temperature degradation process. Chlorine may accelerate surface corrosion of metallic relay components, while hydrochloric acid will accelerate degradation of the Nylon Zytel 101 used in the relay coil bobbin.

The evolution of chlorine or hydrochloric acid occurs insignificantly, if at all, prior to depletion of the anti-oxidant compound included in the particular neoprene formulation used. How quickly these effects occur will be determined by the amount of these gases produced and the temperature of the relay.

The anti-oxidant is added to the rubber formulation during processing to stabilize the material from oxygen attack and degradation. It is this attacking which results in the formation of hydrochloric acid and chlorine by-products. [

]a,b,c A sample calculation of Neoprene life until out-gassing commences is presented in Section 8.9, Chlorine/Chloride Out-gassing of Neoprene Rubbers.

8.2.1.1 Assessment of Impact

The magnet rubber and armature sponge represents a minute fraction of the total relay, both in weight and volume. Very little chlorine and hydrochloric gas will evolve from the degradation of the neoprene components. In the absence of condensing relative humidity, most, if not all, of the evolved gases will be vented from the relay with little consequence to the coil bobbin or metallic surfaces. Eventually the evolution of gases will cease, leaving the neoprene rubber rigid and, to some degree, brittle. A specific end time for the reaction was not determined. However, it is reasonable to expect this will begin to occur in ten to twenty-three years in ND relays, and in less time in NE relays. (See calculations in Section 8.9).

8.2.1.2 Inspection of Used Type AR Relays

[

]a,b,c

It was concluded that evolution of chlorine and hydrochloric gases had minimal effect to none on the specimens viewed.

8.2.2 Nylon Zytel 101

The TGA of nylon indicates no evolution of an aggressive species as a result of the age/temperature degradation process. However, hydrochloric acid (HCl), which may evolve from the degradation of

the neoprene rubber armature sponge, may accelerate the degradation of the Nylon Zytel 101 coil bobbin. Degradation of the coil bobbin leads to the expected end-of-life failure postulated for normally energized type ARD relays addressed in Section 8.3.

8.3 END OF LIFE FAILURE

Because no actual failures of the AR (AC) relay coil were found, the failure data from ARD (DC) relay coils formed the basis for the AR qualified life calculations. Though the ARD relays are not used in the SSPS application, the ARD aging assessment is representative of expected type AR relay aging because of the similarity of materials and manufacturing processes. [

]a,b,c

The following sections summarize calculated estimates of relay life. Sections 8.3.1 and 8.3.2 overview the basis of qualified life established by Westinghouse for the type AR relays. Section 8.3.3 discusses a calculation of a recent end-of-life failure reported for two type ARD relays. Section 8.3.4 presents the

estimation of service life for type AR SSPS slave relays based on temperature data collected for the SSPS at the Farley Nuclear Plant.

The end-of-life failure described above is the basis for determining qualified life of the type ARD and AR relays. Based on the FMEAs (Section 7.0) and this aging assessment, it is concluded that [ ]a,b,c is the limiting time/temperature-dependent failure mechanism to be considered in assessing types ARD and AR relay service life.

8.3.1 Normally Energized Type AR Relays

[

]a,b,c

8.3.2 Periodically Energized Type AR Relays

[

]a,b,c

[

]a,b,c

Although a strict Arrhenius calculation may yield an extended qualified life, it is Westinghouse policy that care should be exercised in utilizing this extrapolation due to uncertainties in the methodology. It is cautioned that the Arrhenius time/temperature relationship relies on empirically determined activation energies of materials. This parameter has been determined for a number of materials to be a good approximation for small temperature extrapolations. Extrapolation of the Arrhenius model to time periods with temperatures beyond the range of materials test data is questionable, since extrapolation may result in large errors. Also, in some cases material samples utilized to determine activation energies may not account for uniqueness which arises from a given application or configuration of the material, for variances in the component manufacturing process, or the dynamic stresses associated with component functional modes. For this reason, it is recommended that calculated qualified lives based on this methodology should be limited to 20 years, unless sound technical bases can be cited. This position is consistent with industry guidelines such as IEEE Std. 98-1984, NUREG/CR-3156, and EPRI NP-1558 (References 14-9, 14-10, 14-11).

Thus, the current qualified life of type AR relays is limited to 20 years to be conservative. This conservatism increases for applications where:

[

]a,b,c

It is not unrealistic that type AR relays would have a useful life in excess of 40 years. However, this is dependent on other factors of environment that are not accounted for in the Arrhenius methodology. These are further discussed in Section 10.0.

8.3.3 End-of-Life Failures of Type ARD Relays

This section discusses the occurrence of end-of-life failures of type ARD relays recently reported for the North Anna plant. The INPO message reporting the failure of two normally energized Westinghouse ARD relays, model ARD440V, is reproduced as Appendix C of this report.

The failure mode and mechanism are the same as or similar to the end-of-life event on which Westinghouse based the qualified life of type AR relays. [

]a,b,c

Estimates of the failed relays service and conditions were attained:

- Relay duty cycle is estimated at 70 to 75%;
- Ambient temperature environment typically near 100 °F; and
- Relays were in service approximately 15 years.

The estimated data was input to Arrhenius calculations for purposes of comparison with the qualified life and an estimated life for SSPS slave relays. This assessment may have a significant margin of error and, therefore, should be regarded only for its value as a mathematical comparison.

[

]a,b,c

[

]a,b,c

8.3.4 Estimated Service Life of Type AR Relays

This section summarizes the calculation of reasonable service lives for type AR relays used as SSPS slave relays. Expected service lives are calculated based on the relay duty cycle (i.e., % of time that relay coil is energized), and ambient and internal temperature data recorded in the FNP SSPS cabinet output relay cabinet and main control room, where the SSPS cabinets are housed.

The service lives are calculated for three relay duty cycles:

- 100% - normally energized;
- 20% - normally energized; and
- 0% - normally energized.

The calculations are based on actual data taken for the Farley Nuclear Plant (FNP). [

]g

[

]g

Relays that are normally de-energized or have a duty cycle of 20% are not likely to fail due to temperature-induced age-related degradation of the relay coil bobbin. The calculated useful life of the coil bobbin in all cases of 0% or 20% duty cycles is much greater than 40 years. Considering only this failure mode, the estimated service life exceeds the 40-year plant life. However, most if not all normally energized relays can be expected to experience the coil-to-plunger binding failure some time during the 40-year plant life. If type ARD relays were installed in the SSPS cabinets, the estimated service life would be over 20 years (Tables 8-3, 8-4). Lacking empirical data for the AC coil relay, it is conservative to apply the service life calculated for the DC coil relay to normally energized SSPS slave relays. Considering the differences in AC and DC coil/plunger configurations, particularly the additional clearance between the coil and upper-half armature, the reported age of the ARD failures and that no type AR (AC coil) relay has been reported failed due to binding in the coil assembly, it is concluded that

the previously estimated 19-year service life (Rev. 1 of this WCAP) can be supported for normally energized type AR relays in the FNP SSPS cabinet output bays.

The FNP SSPS has relatively few normally-energized SSPS slave relays:

RELAY	APPLICATION
K628	Tied to P-11
K629	Source Range Block
K635	Generator Trip Input for Steam Dumps
K636	FW Isolation on Low T_{avg}
K637	FW Isolation on Low T_{avg}
K639	Loss of AC

Based on the above discussion, it is recommended that:

- These relays should be replaced after 19 years of service;
- If any of the relays (both trains, both plants) should fail after 14 years, all should be replaced.

8.4 GLASS-FILLED PHENOLIC

The primary non-metallic material of the contact and adder blocks is a glass-filled phenolic. Glass-filled phenolic materials are rated for continuous 40-year service at an ambient temperature of 125 °C. Higher temperatures can be endured with a consequent reduction in expected life.

The estimated temperature rise is a maximum of 30 °C for the relay coil assembly. The coil heat rise is estimated to cause a 10 °C or 15 °C rise in the contact block assembly. With these considerations, the manufacturer recommends that the relay has a useful service life of 40 years and may be used in ambient environments which do not exceed 100 °C (212 °F).

Using the FNP temperature data (Table 8-2) and the materials data (Table 8-5), the estimated service life of the glass filled phenolic has been calculated. Tables 8-6 and 8-7 summarize the conclusions of these

calculations. The calculated results range from 4446 to 40602 years. Such results are unrealistic and proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of failure mechanisms postulated to result from temperature-induced, age-related degradation of the glass-filled phenolic components.

It is postulated that swelling of the relay crossbars, contact block and/or the adder block would lead to excessive friction and, consequently, increased response time for the relay. The increase in response time would be a sign that relay binding is imminent for the contact block assemblies. Dimensional changes, swelling or shrinkage, in organic components are among the temperature-induced age degradation phenomena for many organic materials. Materials which experience dimensional change with aging generally are prone to weight loss or gain with time and temperature. However, phenolic materials are among the most dimensionally stable organic components. Glass-filled materials, and glass-filled phenolic in particular, have exceptional dimensional and weight stability. Significant changes in either dimension or weight would occur in proportion with the degradation of other material properties. Based on the calculation results in Tables 8-6 and 8-7, this is not likely within a forty year plant life. Rather, the advent of degradation which would signal a concern for dimensional changes in the AR relay components would occur in hundreds of years assuming that temperatures were maintained at levels typical of service in the SSPS output bays. For this reason, postulated failure modes/mechanisms which would cause an increase in relay response time are not considered credible for AR relays used as SSPS slave relays.

It is concluded that temperature-induced, age-related failures postulated for the adder cover and crossbar, contact block cover and crossbar, and contact cartridge assemblies will not occur in SSPS slave relays within the 40-year plant life.

8.5 GLASS-FILLED POLYESTER

The coil block assembly cover (or coil cover) is made of a glass-filled polyester. Glass-filled polyesters are rated for continuous 40-year service at an ambient temperature of 125 °C. Higher temperatures can be endured with a consequent reduction in expected life.

The estimated temperature rise is a maximum of 30 °C for the relay coil assembly when energized and is the maximum heat rise experienced by the coil cover in any type AR relay (AC or DC coil; all voltage ratings). With this consideration, the manufacturer recommends that the relay has a useful service life of 40 years and may be used in ambient environments which do not exceed 100 °C (212°F).

Using the FNP temperature data (Table 8-2) and the materials data (Table 8-5), the estimated service life of the glass-filled polyester has been calculated. Tables 8-8 and 8-9 summarize the conclusions of these calculations. The calculated results range from 1219 to 77519 years. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of failure mechanisms postulated to result from temperature-induced, age-related degradation of the glass-filled polyester components.

It is concluded that temperature-induced, age-related failures postulated for the coil cover will not occur in SSPS slave relays within the 40-year plant life.

8.6 OMEGA-INSULATION

The coil (magnet) wire is insulated with a material named Omega-Insulation (material is proprietary to Westinghouse). Omega-Insulation was developed specifically for high-temperature magnet wire applications and is rated for continuous 40-year service at an ambient temperature of 175 °C. Higher temperatures can be endured with a consequent reduction in expected life.

The estimated temperature rise is a maximum of 30 °C for the relay coil assembly when energized and is the maximum heat rise experienced by the coil wire in any type AR relay (AC or DC coil; all voltage ratings). Considering the coil insulation temperature rise, the manufacturer recommends that the relay has a useful service life of 40 years and may be used in ambient environments which do not exceed 100°C (212°F).

Using the FNP temperature data (Table 8-2) and the materials data (Table 8-5), the estimated service life of the Omega-Insulation has been calculated. Tables 8-10 and 8-11 summarize the conclusions of these

calculations. The calculated results exceed one million years even in normally energized relays. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of failure mechanisms postulated to result from temperature-induced, age-related degradation of the Omega-Insulation.

It is concluded that temperature-induced, age-related failures postulated for the coil magnet wire insulation will not occur in SSPS slave relays within the 40-year plant life.

8.7 NEOPRENE RUBBER

The armature sponge material is neoprene rubber (closed cell sponge type). The function performed by the armature sponge requires only that the sponge remain intact. The armature sponge is not essential to relay operability. However, its absence could reduce the mechanical operating life of the relay in high-cycle demand applications. More significant to the SSPS slave relay application, the by-products created by degradation of the neoprene rubber can accelerate the degradation of other relay components (See Section 8.2.1.). Further discussion and calculated threshold of chlorine/chloride out-gassing is presented in Section 8.9.

Neoprene rubbers (closed cell sponge types) are rated for continuous use at a temperature of 105 °C, but have an estimated 40-year life at 65 °C (for both tensile strength and elongation). Use at higher temperatures will result in more rapid loss of properties.

The estimated temperature rise is a maximum of 30 °C for the relay coil assembly. The coil heat rise is estimated to cause a 10 °C rise in the armature sponge. With these considerations, the manufacturer recommends that the relay has a useful service life of 40 years and may be used in ambient environments which do not exceed 100 °C (212 °F).

Using the FNP temperature data (Table 8-2) and the materials data (Table 8-5), the estimated service life of the neoprene rubber has been calculated. Tables 8-12 and 8-13 summarize the conclusions of these calculations specifically for the armature sponge. The calculated results range from 1304 to 20527 years (based on 100% retention of elongation). Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanisms considered.

It is concluded that failure modes/mechanisms postulated to result from temperature-induced, age-related degradation of the neoprene rubber armature sponge will not occur in SSPS slave relays within the 40-year plant life. The point at which chlorine/chloride out-gassing begins is assessed in Section 8.9.

8.8 MAGNETIC NEOPRENE RUBBER

The magnet rubber material is neoprene rubber with magnetic metal particles dispersed into the mix prior to vulcanization. The function performed by the magnet rubber requires that the rubber remain intact. More significant to the SSPS slave relay application, the by-products created by degradation of the Neoprene rubber can accelerate the degradation of other relay components (See Section 8.2.1). Further discussion and calculated threshold of chlorine/chloride out-gassing is presented in Section 8.9.

The type AR relay magnet rubber is made of a neoprene formulation typically used for gaskets and washers. It is rated for continuous use at a temperature of 70 °C, but has a 40-year life at 35 °C based on 100% retention of elongation. This criteria greatly exceeds the needs of the type AR relay. However, no other reference data for this material was available. An 80% loss (i.e., 20% retention) of elongation would be of no consequence to relay operability or reliability.

The estimated temperature rise is a maximum of 30 °C for the relay coil assembly. The coil heat rise is estimated to cause a 5 °C rise in the magnet rubber. With these considerations, the manufacturer recommends that the relay has a useful service life of 40 years and may be used in ambient environments which do not exceed 100 °C (212 °F).

Using the FNP temperature data (Table 8-2) and the materials data (Table 8-5), the estimated service life of the neoprene rubber has been calculated. Tables 8-14 and 8-15 summarize the conclusions of these calculations specifically for the magnet rubber. The calculated results range from 42 to 254 years (based on 60% retention of elongation). Substantially longer life would result from calculations based on a 20% retention of elongation data, if available.

It is concluded that failure modes/mechanisms postulated to result from temperature-induced, age-related degradation of the magnetic neoprene rubber will not occur in SSPS slave relays within the 40-year plant life. The point at which chlorine/chloride out-gassing begins in assessed is Section 8.9.

8.9 CHLORINE/CHLORIDE OUT-GASSING OF NEOPRENE RUBBERS

Neoprene rubber formulations include anti-oxidant compounds which delay the oxidation of the material and ultimately the beginning of chlorine/chloride out-gassing. The low-temperature extrapolation of Arrhenius time/temperature data for neoprene is most accurately indicative of the "age" at which neoprene rubbers will have depleted the anti-oxidant component. After comparing the calculated results for the neoprene rubbers discussed in Sections 8.7 and 8.8, it is clear that a conservative threshold "age of out-gassing" would be determined for the magnetic neoprene rubber material when used in type AR relays.

Using the FNP temperature data (Table 8-2) and the materials data (Table 8-5), the "age of out-gassing" for neoprene rubber has been calculated. Tables 8-16 and 8-17 tabulate the numerical results of the calculations specifically for the magnet rubber using the low-temperature Arrhenius extrapolation as a basis. The calculated results range from 6.4 to 23.1 years, however, it is unlikely that significant out-gassing begins until some time after each respective "age" shown in the tables. The principle concern is the rate of chlorine/chloride release. This, of course, is related to temperature and will be greatest for the short life-to-out-gassing cases shown in Tables 8-16 and 8-17. Conversely, those cases where lower temperatures indicate the longest life-to-out-gassing for neoprene will also release chlorine at a slower rate after the depletion of the anti-oxidant compound.

8.10 CONCLUSION

Normally energized relays experience significant self heating. The expected temperature rise for type AR relays when energized continuously is 10°C to 30°C (See Table 5-1). Actual temperature rises are dependent on relay component/part location with respect to the relay coil, and the ambient temperature. Relay temperature rise decreases expected service life and reliability by accelerating age/temperature

dependent degradation. This is why normally energized relays (relays with high duty cycle) generally exhibit shorter service life than normally de-energized relays.

To maintain a consistent level of reliability among NE and ND relays, NE relays will require replacement one or more times during a 40-year plant life. More specifically, a range of maintenance and surveillance intervals will be dependent upon the duty cycle of the relay application.

Type AR relays used as normally de-energized (ND) SSPS slave relays will not experience temperature-induced, age-related degradation sufficient to result in failure within the 40-year plant life. Degradation of critical components requires substantial time, and would result in no perceptible change in component performance. Degradation of non-critical components such as the armature sponge or magnet rubber, will result in perceptible changes to both appearance and material characteristics of these components, however, no adverse impact to relay performance or reliability would be visually, electrically, or mechanically detectable.

Type AR relays used as normally energized (NE) SSPS slave relays will experience temperature-induced, age-related degradation sufficient to result in failure within the 40-year plant life. An end-of-life failure mechanism observed in type ARD relays will necessitate replacement of NE relays, however, it is not clear that this end-of-life failure will occur in type AR relays (those actually used as SSPS slave relays) after the same temperature/time history. Lacking other experience or test data, it is recommended that NE type AR SSPS slave relays should be replaced based on actual plant temperature data. Based on the example for FNP type AR SSPS slave relays (Section 8.3.3), it is prudent to replace the NE SSPS slave relays (found in Section 8.3.4) after 19 years of service. Also, it is prudent to replace all NE type AR SSPS slave relays if a failure of any one occurs after 14 years of service. As this has not been the case to date, mandatory replacement at the 19 year interval is considered to be conservative for FNP.

TABLE 8-1 AMBIENT TEMPERATURES AT SSPS LOCATION

Plant	Ambient Temperature Range		Relay Types	Notes
	Low (°F)	High (°F)		
Beaver Valley 1 & 2	NR	NR	AR & MDR	
Braidwood 1 & 2	70	90	AR & MDR	
Byron 1 & 2	NR	NR	AR & MDR	
Callaway 1	65	75	MDR	
Catawba 1 & 2	65	80	AR	peak 90°F
Comanche Peak 1 & 2	70	80	AR	peak <80°F
Cook 1 & 2	NR	NR	AR	
Diablo Canyon 1 & 2	65	80	MDR	
Farley 1 & 2	Table 8-2	Table 8-2	AR	(a)
McGuire 1 & 2	70	80	AR	
Millstone 3	(b)	(b)	MDR	
North Anna 1 & 2	70	85	AR & MDR	
Salem 1 & 2	NR	NR	AR	
Seabrook	NR	NR	MDR	
Sequoyah 1 & 2	75	85	AR & MDR	
Shearon Harris	72	85	MDR	peak 79°F; setpoint 72.5°F
South Texas 1 & 2	NR	78	MDR	
Summer	NR	NR	AR	
Trojan	NR	NR	AR	
Vogtle 1 & 2	75	85	MDR	
Watts Bar 1 & 2	(c)	(c)	AR	
Wolf Creek	66	71	MDR	peak 74°F

NOTES:

NR Not reported.
(a) Temperatures inside and outside the SSPS were monitored from May '92 through July '93. See Table 8-2.
(b) Reported as 75°F. This is taken to be the setpoint value.
(c) No plant operating history data to report.

TABLE 8-2 FARLEY SSPS TEMPERATURE (°F) DATA SUMMARY

g

TABLE 8-3 SERVICE LIFE OF FNP SSPS SLAVES BASED UPON SERVICE LIFE OF NYLON ZYTEL 101 (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]g	5°F (2.8°C)	25.6	1
		3°F (1.6°C)	28.5	
		0°F (0°C)	33.1	
	[ ]g	5°F (2.8°C)	38.0	
		3°F (1.6°C)	42.6	
		0°F (0°C)	49.5	
20%	[ ]g	5°F (2.8°C)	>> 40	1,2
		3°F (1.6°C)	>> 40	
		0°F (0°C)	>> 40	
	[ ]g	5°F (2.8°C)	>> 40	
		3°F (1.6°C)	>> 40	
		0°F (0°C)	>> 40	
0% Normally De-energized	[ ]g	5°F (2.8°C)	>> 40	2
		3°F (1.6°C)	>> 40	
		0°F (0°C)	>> 40	
	[ ]g	5°F (2.8°C)	>> 40	
		3°F (1.6°C)	>> 40	
		0°F (0°C)	>> 40	

Notes:

1. Calculations include component temperature rise of 30°C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 107 to 1144 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year as a result of the specific failure mechanism considered.

TABLE 8-4 SERVICE LIFE OF FNP SSPS SLAVES BASED UPON SERVICE LIFE OF NYLON ZYTEL 101 (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]^{g}	28.8	1
		[ ]^{g}	43.8	
	2	[ ]^{g}	30.7	
		[ ]^{g}	45.9	
20%	1	[ ]^{g}	>> 40	1,2
		[ ]^{g}	>> 40	
	2	[ ]^{g}	>> 40	
		[ ]^{g}	>> 40	
0% Normally De-energized	1	[ ]^{g}	>> 40	2
		[ ]^{g}	>> 40	
	2	[ ]^{g}	>> 40	
		[ ]^{g}	>> 40	

Notes:

1. Calculations include component temperature rise of 30°C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 121 to 1043 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-5 TYPE AR RELAY MATERIALS & AGING DATA

COMPONENT MATERIAL	RELAY COMPONENTS	TEMPERATURE RISE (Note 1)	ACTIVATION ENERGY/ MATERIAL PROPERTY	AGING TEST REFERENCE DATA	NOTES
Neoprene Rubber	Armature Sponge	10°C	1.30 eV Elongation (100% Retention)	800 hrs. @ 120°C	
Neoprene Rubber (magnetic)	Magnet Rubber	5°C	1.18 eV Elongation (60% Retention)	200 hrs. @ 100°C	
Neoprene Rubber (magnetic) Low Temperature Extrapolation	Magnet Rubber	5°C	0.84 eV Elongation (60% Retention)	40,000 hrs. @ 40°C	2
Nylon Zytel 101	Coil Bobbin	30°C	0.8787 eV Tensile strength (50% Retention)	100 hrs. @ 175°C	
Omega Insulation	Coil Wire Insulation	30°C	1.78 eV Dielectric Strength (Note 3)	30,500 hrs. @ 205°C	
Phenolic (glass-filled)	Contact Block	10°C	0.82 eV Flexural Strength (50% Retention)	100 hrs. @ 290°C	4,5
	Adder Block	15°C			
Polyester (glass-filled)	Coil Cover	30°C	0.96 eV Flexural Strength (50% Retention)	100 hrs. @ 240°C	5

NOTES:

1. Expected temperature rise in component when relay is normally energized.
2. Aging test reference data is for low temperature extrapolation which is conservative and more realistic for component.
3. Based on IEEE 57 Dielectric Twist Test
4. Aging calculations are based on higher temperature rise expected for the adder block. This is conservative for type AR relays in 440 configuration.
5. Aging test reference data is an interpolation of Arrhenius plot - no test data points shown.

TABLE 8-6 SERVICE LIFE FOR GLASS FILLED PHENOLIC (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]g	5°F (2.8°C)	>>40	1
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
20%	[ ]g	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
0% Normally De-energized	[ ]g	5°F (2.8°C)	>>40	2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	

Notes:

1. Calculations include component temperature rise of 15 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 4446 to 40602 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-7 SERVICE LIFE FOR GLASS-FILLED PHENOLIC (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]^{g}	>>40	1
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
20%	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
0% Normally De-energized	1	[ ]^{g}	>>40	2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	

Notes:

1. Calculations include component temperature rise of 15 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 5021 to 37264 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-8 SERVICE LIFE FOR GLASS-FILLED POLYESTER (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]g	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
20%	[ ]g	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
0% Normally De-energized	[ ]g	5°F (2.8°C)	>>40	2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	

Notes:

1. Calculations include component temperature rise of 30 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 1219 to 77519 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-9 SERVICE LIFE FOR GLASS-FILLED POLYESTER (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]g	>>40	1,2
		[ ]g	>>40	
	2	[ ]g	>>40	
		[ ]g	>>40	
20%	1	[ ]g	>>40	1,2
		[ ]g	>>40	
	2	[ ]g	>>40	
		[ ]g	>>40	
0% Normally De-energized	1	[ ]g	>>40	2
		[ ]g	>>40	
	2	[ ]g	>>40	
		[ ]g	>>40	

Notes:

1. Calculations include component temperature rise of 30 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 1388 to 70112 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-10 SERVICE LIFE FOR OMEGA-INSULATION (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]^{g}	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]^{g}	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
20%	[ ]^{g}	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]^{g}	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
0% Normally De-energized	[ ]^{g}	5°F (2.8°C)	>>40	2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]^{g}	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	

Notes:

1. Calculations include component temperature rise of 30 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 3.85E+08 to 8.49E+11 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-11 SERVICE LIFE FOR OMEGA-INSULATION (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
20%	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
0% Normally De-energized	1	[ ]^{g}	>>40	2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	

Notes:

1. Calculations include component temperature rise of 30 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 4.90E+08 to 7.05E+11 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-12 SERVICE LIFE FOR NEOPRENE RUBBER (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]g	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
20%	[ ]g	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
0% Normally De-energized	[ ]g	5°F (2.8°C)	>>40	2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	

Notes:

1. Calculations include component temperature rise of 10 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 1304 to 20527 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-13 SERVICE LIFE FOR NEOPRENE RUBBER (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
20%	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
0% Normally De-energized	1	[ ]^{g}	>>40	2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	

Notes:

1. Calculations include component temperature rise of 10 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 1591 to 17917 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-14 SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]g	5°F (2.8°C)	>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
20%	[ ]g	5°F (2.8°C)	>>40	1,2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
0% Normally De-energized	[ ]g	5°F (2.8°C)	>>40	2
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	
	[ ]g	5°F (2.8°C)	>>40	
		3°F (1.6°C)	>>40	
		0°F (0°C)	>>40	

Notes:

1. Calculations include component temperature rise of 5 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 50 to 254 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-15 SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
20%	1	[ ]^{g}	>>40	1,2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	
0% Normally De-energized	1	[ ]^{g}	>>40	2
		[ ]^{g}	>>40	
	2	[ ]^{g}	>>40	
		[ ]^{g}	>>40	

Notes:

1. Calculations include component temperature rise of 5 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. ">> 40 yrs." indicates that numerical results range from 50.6 to 225 years. Such results are unrealistic. Proper interpretation should be that the relay is unlikely to fail over the 40-year plant life as a result of the specific failure mechanism considered.

TABLE 8-16 SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Ambient Temperatures)

DUTY CYCLE	AMBIENT TEMPERATURE	CABINET TEMPERATURE RISE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	[ ]g	5°F (2.8°C)	6.4	1
		3°F (1.6°C)	7.3	
		0°F (0°C)	8.6	
	[ ]g	5°F (2.8°C)	10.0	
		3°F (1.6°C)	11.4	
		0°F (0°C)	13.5	
20%	[ ]g	5°F (2.8°C)	9.5	1,2
		3°F (1.6°C)	10.8	
		0°F (0°C)	12.7	
	[ ]g	5°F (2.8°C)	14.9	
		3°F (1.6°C)	17.0	
		0°F (0°C)	20.2	
0% Normally De-energized	[ ]g	5°F (2.8°C)	10.8	2
		3°F (1.6°C)	12.2	
		0°F (0°C)	14.5	
	[ ]g	5°F (2.8°C)	17.0	
		3°F (1.6°C)	19.4	
		0°F (0°C)	23.1	

Notes:

1. Calculations include component temperature rise of 5 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. Calculation results are indicative of the depletion of the anti-oxidant compound; the beginning of chlorine/chloride out-gassing from the Neoprene rubber.

TABLE 8-17 SERVICE LIFE FOR MAGNETIC NEOPRENE RUBBER (Cabinet Temperatures)

DUTY CYCLE	NODE #	CABINET TEMPERATURE	SERVICE LIFE (yrs.)	NOTES
100% Normally Energized	1	[ ]g	7.3	1
		[ ]g	1.7	
	2	[ ]g	7.9	
		[ ]g	12.4	
20%	1	[ ]g	10.9	1,2
		[ ]g	17.6	
	2	[ ]g	11.7	
		[ ]g	18.5	
0% Normally De-energized	1	[ ]g	12.4	2
		[ ]g	20.1	
	2	[ ]g	13.3	
		[ ]g	21.2	

Notes:

1. Calculations include component temperature rise of 5 °C when energized. Calculation is based on the Arrhenius equation (Appendix D).
2. Calculation results are indicative of the depletion of the anti-oxidant compound; the beginning of chlorine/chloride out-gassing from the Neoprene rubber.

9.0 FAILURE EXPERIENCE

The failure experience for SSPS slave relays was derived from the NPRDS database and supplemented by a WOG survey of Westinghouse-designed plants. As expected, both sources reveal that type AR SSPS slave relay failures have been few and infrequent. Tables 9-1 and 9-2 summarize the point failure data for each of the plants responding to the survey and include the calculation of a failure rate for the type AR relay and the ARLA latch attachment, respectively. However, the statistical assessment of the data gathered concludes that both the actuation-based and time-based assessment of the data is statistically inconclusive. This is further discussed in Section 9.1.

Table 9-1 identifies the six (6) reported incidents of problems encountered during SSPS slave relay testing. Further investigation into some of these reports reveals that most were not verifiable by subsequent troubleshooting of the reported anomalies. A significant portion of incidents initially reported as SSPS slave relay failures were later found to be without basis or were attributed to causes unrelated to the relay itself.

Of the thirty-nine (39) events reported (found in Table 9-6), seventeen (17) did involve a failure of the type AR relays or the ARLA latch attachment. These include cases where relay or latch operability were verified by subsequent investigation and testing. Some of the events listed in Table 9-1 were unsubstantiated reports of anomalies observed during SSPS slave relay testing. Rare cases of recurrent events were determined to be the result of excessive contact loading or the sensitivity of the ARLA latch attachment to manufacturing tolerances of other relay components (the crossbars). The former is a matter of relay misapplication which is not indicative of relay reliability. The latter is recognized as a form of infant mortality arising from the incompatibly of a particular latch attachment with the relay on which it is installed (See Section 5.4.4).

Table 9-2 lists those events considered to be valid failures of type AR SSPS slave relays. Seventeen (17) of the thirty-nine (39) events reported are considered actual failures of the type AR relays or the ARLA latch mechanism. Seven (7) of these have been verified as actual failures. The remaining ten (10) have not be investigated fully at this time and are taken to be as-reported. Four (4) of the seventeen events involve reports that the ARLA latch attachment did not unlatch on demand. Such failures are not related to the automatic safety-related function, but may have consequence to plant safety in certain

applications. No failure of the ARLA latch attachment will prevent automatic ESFAS actuation. Once energized by a valid trip or ESFAS actuation signal, SSPS slave relays remain energized until the signal is removed/reset. SSPS slave relays equipped with latches must be reset manually from the control room. The latch attachment may also be relied upon to maintain ESFAS actuation through a loss of power event. However, if relays dropped out due to loss of power in concert with a failure of the latch to mate, the slave relays would be re-energized with the return of power so long as a valid trip or ESFAS actuation signal was provided by the SSPS logic.

Section 9.2 provides further discussion of representative failure events. Similarly some representative events discredited as actual failures are discussed in Section 9.3.

9.1 STATISTICAL ASSESSMENT OF RELAY FAILURE DATA

There are an insufficient number of relay failures in each of the test intervals to perform rigorous statistical calculations comparing the failure rate for relays tested at a 3-month interval with the failure rate for relays tested at an 18-month interval. The actuation-based failure rates at the 18-month test interval are more than twice the actuation-based failure rates at the 3-month test interval. With so small a population and so few failures in each category, a change in failure rate of less than an order of magnitude is not considered indicative of any real difference in the actual failure rate of the device.

Even though statistical comparisons and confidence boundaries will not provide meaningful information, engineering judgement can be applied using other tools to draw conclusions that we would expect to be confirmed if more data were available. In this case, the data was presented graphically to try to provide insight into factors affecting relay failures.

The number of operations accumulated for a relay were graphed against the total number of relays in all plants that have experienced that number of actuations. If the relay failure rate is a constant value, reflecting random failures rather than infant mortality or end-of-life failures, then graphing the number of actuations until failure for each of the failed relays should produce a scattering within the range of actuations which the bulk of the relays have experienced to date.

Figure 9-1 shows the expected effect of data scattered randomly in the large area under the curve that represents the range of actuations with the largest population of relays, with an exception. All of the relays have experienced at least a few actuations, none have been operated more than 100 times after plant entry into commercial service. Figure 9-1 shows a significant decline in population versus accumulated cycles of operation after only fifteen (15) operations. The relay actuation range from one (1) to four (4) has more failures than all higher actuation values. This would seem to indicate an infant mortality range for the relays, and infers a need for actuating the relay past this break-in period before installation in the plant.

The single infant mortality failure mechanism identified for the type AR relay product line results from a mismatch of tolerances affecting the ability of the latch to operate with the relay on which it is installed. To examine this further, Figures 9-2 and 9-3 show the valid failures versus the sample population for the type AR relay and the ARLA latch mechanism, respectively.

Figure 9-2 depicts the valid relay failures versus the total population on a per actuation basis. There is no cluster of infant mortality failures, but rather the expected scattering over the range of actuations.

Figure 9-3, depicts the valid latch failures versus the total population on a per actuation basis. As expected, there is an infant mortality cluster of failures reported attributed to the latch attachment. Most of these occur after a prior replacement of the latch. This implies that the tolerances may shift with the progressive age of the product manufacturing life. This also implies that it is the latch attachment, rather than the relay itself, that needs the break-in testing prior to installation within the plant.

Figures 9-4 through 9-6 depict the same data shown in Figures 9-1 through 9-3, respectively, from a time (hourly failure rate) perspective rather than an actuation (demand based failure rate) perspective. Again, the zero reference of the graph is plant entry into commercial service. In this case, as well, the infant mortality trend seems evident for the relay latches, whereas the relay itself seems to have a scattered, random failure history throughout the relay service life to date.

Tables 9-3, 9-4 and 9-5 present the Service Hours of AR relays, the Service Hours of AR Latching Relays, and the Failure Rate Summaries for the AR Relay and ARLA, respectively.

Figures 9-1 through 9-6 show no evidence of end-of-life failures that would be represented by a clustering of failures at some large number of actuations or some long service life value. This is particularly significant since all of the latch mechanisms were manufactured at least nineteen years ago. While some relays of more recent vintage may be included in the sample population, only a handful are of lesser age than the latch attachments. The relays were designed to undergo millions of actuations over their service life. In comparison, the SSPS slave relays making up the sample populations have accumulated orders of magnitude fewer actuations. The latch attachment, even with consideration of the cycle life estimate based on high-demand applications in high-ambient temperature are actuated several orders of magnitude less than their ultimate capability during the 40-year plant life.

In conclusion, though there are too few failures to draw any solid statistical conclusions, the minimal number of failures indicate a random scattering of failures representative of a constant low failure rate, and a minor infant mortality failure rate that can be readily detected and avoided with adequate post-installation testing.

9.2 REPORTS OF SSPS SLAVE RELAY FAILURES

Plant-specific data on reported type AR relay events is found in Table 9-6, and valid failures found in Table 9-7. Table 9-9 is a cross reference between Event ID numbers, WCAP Sections, Table 9-7, Table 9-8 Relay ID Numbers, Plant Names and Unit/Train designations. Table 9-8 provides a list of non-verifiable events.

9.2.1 Failures at Sequoyah

At Sequoyah Unit 2, October 4, 1983, Relay K615-A (880 configuration with latch) was replaced (relay and latch) in response to a reported test anomaly (Reference 14.5-1). The event is considered a valid failure due to the previous replacement of this relay latch attachment (See Section 9.3.1.2). This was the second test operation of the relay since the previous maintenance. It is suspected that the root cause was the tolerance incompatibility failure mechanism. Post-maintenance testing requirements in effect at the time of the December 1982 replacement did not require multiple actuations of the relay to verify operability (See Section 9.3.1.2).

At Sequoyah Unit 2, October 4, 1983, the latch attachment on relay K622-B (880 configuration with latch) was replaced when it failed to latch on demand (Reference 14.5-2). The event is considered a valid failure due to the previous replacement of this latch relay attachment (See Section 9.3.1.2). This was the second test operation of the relay since the previous maintenance. It is suspected that the root cause was the tolerance incompatibility failure mechanism. This event could be considered an infant mortality. Post-maintenance testing requirements in effect at the time of the December 1982 replacement did not require multiple actuations of the relay to verify operability.

At Sequoyah Unit 1, June 10, 1986, Relay K615-B (880 configuration with latch) was replaced after periodic testing when it did not unlatch on demand (Reference 14.5-3). The event is considered a valid failure because maintenance reports indicate that the failure was due to a spring misalignment in the ARLA latch mechanism. This report is questionable, however, because there is no adjustable spring in the ARLA latch attachment.

9.2.2 Failures at Farley

At Farley Unit 2, April 9, 1984, SSPS relay K620 (Train A) was replaced because it would not reset following removal of the actuation signal. The failure was discovered during on-line surveillance testing. During subsequent inspection of the failed relay a small piece of BAKLITE material was removed from the contact block assembly. Subsequently the relay performed upon demand. The root cause was binding caused by debris. Further investigation could not confirm the source of the foreign material. It was concluded that the BAKLITE piece had been in the relay since manufacture, equipment assembly, or construction.

9.3 NON-VERIFIABLE REPORTS OF SSPS SLAVE RELAY FAILURES

Plant-specific data on reported type AR relay events is found in Table 9-6 and non-verifiable events are found in Table 9-8. Table 9-9 is a cross reference between Event ID numbers, WCAP Sections, Table 9-7, Table 9-8 Relay ID Numbers, Plant Names and Unit/Train designations. Table 9-7 provides a list of valid failures.

9.3.1 Sequoyah

9.3.1.1 At Sequoyah Unit 1, September 15, 1981, after periodic testing, relays K603-A and K604-A failed to reset using the control room reset switch. Per Reference 14.5-13, the relays were reset in the cabinet and determined to be fully operational. Another MWR was issued to examine other suspect components.

9.3.1.2 At Sequoyah Unit 2, December 15, 1982, the latch attachments of relays K615-A, K615-B and K622-B (880 configuration with latch) were replaced following reports of test anomalies for each (Reference 14.5-7 and 14.5-8). Each of the latches removed from service were operated 600 times (latch/unlatch) with no recurrence of the failure. No root cause was determined. It is suspected that technician error may have contributed to the event. See discussion of subsequent (Oct. 4, 1983) events for relays K615-A and K622-B in Section 9.2.1.

9.3.1.3 At Sequoyah Unit 1, August 27, 1985, after periodic testing of relay K647-A (440 configuration with latch), it was reported the relay did not unlatch on demand (Reference 14.5-4). Subsequent investigation could not repeat the anomaly. No other test anomaly has been reported for this relay. It is suspected that technician error was the root cause.

9.3.1.4 At Sequoyah Unit 2, October 1, 1987, after periodic testing of relay K610-A (440 configuration with latch), it was reported the relay did not unlatch on demand (Reference 14.5-6). Subsequent investigation could not repeat the anomaly. No other test anomaly has been reported for this relay. It is suspected that technician error was the root cause.

9.3.1.5 At Sequoyah Unit 2, October 19, 1987, relay K622-B (880 configuration with latch) reportedly did not actuate in response to operation of the control hand switch (Reference 14.5-12). Subsequent investigation and testing did not repeat the anomaly. No other cause was identified. This event is attributed to operator error.

9.3.1.6 At Sequoyah Unit 2, November 2, 1987, the relay K622-A (880 configuration with latch) failed to latch on demand (Reference 14.5-9). The screw joining the crossbars of the contact block assembly and adder block was found to be loose. The failure mechanism was

determined to be insufficient travel of the adder block crossbar, which in turn caused insufficient travel to permit making of the ARLA latch attachment. The screw was tightened and the equipment returned to service. The root cause is considered to be an assembly error. As no prior reports of maintenance for relay K622-A could be found, it is concluded the assembly error occurred at the point of manufacture.

9.3.1.7 At Sequoyah Unit 2, October 19, 1987, after periodic testing of relay K620-B (880 configuration), it was reported that the relay did not actuate (Reference 14.5-11). Subsequent investigation could not repeat the anomaly. No other test anomaly has been reported for this relay. No failure mode or mechanism has been identified that caused intermittent operation of the relay coil. It is suspected that technician error was the root cause.

9.3.1.8 At Sequoyah Unit 2, June 19, 1988, relay K622-B (880 configuration with latch) was replaced after a fourth report of test anomaly (no further details available). The relay and latch were removed from service, and replaced by a P&B MDR rotary relay. No further problems with the relay were encountered. Previous events in December of 1982, October 1983, and October 1987, indicate recurrent problems with the K622-B relay at Sequoyah Unit 2. It would appear that the relay was marginally compatible with ARLA latch mechanism. That is, the tolerance mismatch was such that operation was randomly intermittent. The coincidence of other failure reports and repeated lack of verification cloud the issue. Prior maintenance efforts for K622-B focused attention on the ARLA latch attachment, not recognizing that the problem was with the relay. FMEA results in Section 7.0 identify this failure mechanism as occurring in the crossbar(s), most likely the adder block crossbar. Again, the failure mechanism suspected is an infant mortality failure type due to the apparent incompatibility between the relay and latch mechanism.

9.3.1.9 At Sequoyah Unit 1, November 6, 1989, Relay K615-B (880 configuration with latch) was replaced when it was concluded that commercial grade components were inadvertently installed during prior maintenance June 10, 1986. No failure of the relay was involved (Reference 14.5-5).

9.3.1.10 At Sequoyah Unit 1, April 6, 1990, during periodic testing, the PRT to Gas Analyzer valve (FCV-68-307) failed to closed upon receipt of a phase A signal as generated by SI-26.1A. The suspected root cause was a failure of the valve relay K606-A. Per Reference 14.5-14, the relay was found to be fully operational. Another MWR was issued to examine other suspect components.

9.3.1.11 At Sequoyah Unit 2, April 15, 1992, after periodic testing of relay K607-B (880 configuration with latch), the reported failure was that the relay did not actuate and latch (Reference 14.5-10). Subsequent investigation could not repeat the anomaly. No other test anomaly has been reported for this relay. It is suspected that technician error was the root cause.

During plant review of TVA MWRs, two MWRs which mention concern for slave relay operability were found. Both cases request maintenance of SSPS slave relays. These are not listed in Tables 9-3 and 9-5. In both cases, the MWRs conclude that no SSPS slave relay failure occurred.

9.3.2 Farley

At Farley, the plant staff reviewed the maintenance history for SSPS and STC (Safeguards Test Cabinet) for both Units 1 and 2 from 1984 through 1992. Nine (9) documented failures/problems were found and reviewed.

Of these failures, two (2) problems were not equipment failures, but a result of plant operating conditions and system/equipment alignment (MWRs 91958 & 157167). Three (3) failures required replacement of the 120 VAC Output Relay Power Fuses (MWRs 166971, 196658 & 214716). One (1) failure required replacement of STC test switch S814 (MWR 91837). Two (2) failures required replacement of STC test relays K813 and K814, which are Potter-Brumfield rotary relays (MWRs 85055 & 221666). One (1) failure required replacement of SSPS slave relay K620, which is a Westinghouse AR440 relay w/o latch attachment (See Section 9.2.2, for further discussion).

Similar to the Sequoyah experience, most events are considered the likely result of technician errors or reveal a lesser reliability of STC components.

9.3.3 Beaver Valley

Event ID Nos. 1 & 4 report that the ARLA latch mechanism of two relays did not unlatch on demand. It was later verified that both latches were operable. It was later determined that test set-up errors defeated the "unlatch demand" signal. No repair or replacement occurred. Both latches remain in service.

Event ID No. 5 reports that the relay contact(s) failed to make. This is interpreted to mean that a valid demand signal did not result in an indication that the relay contacts had closed completing the test actuation. Follow-up actions did not repeat the event. The relay was determined to be operable and remained in service. No repair or replacement occurred. Duquesne Light Company personnel concluded that the event was the result of technician error.

Event ID Nos. 6, 7, and 8 report the same contact failure occurring multiple times on relay K641 of the Unit 1 SSPS in Train B. ID Nos. 6 and 7 report the same symptom of the same cause on the same relay. Initially, ID No. 7 was determined to be a valid relay failure, and the relay was replaced. After replacement of the original relay, ID No. 8 reports the recurrence of the same contact problem. It was later determined that the relay contacts were overloaded. Contact overloading is not a failure of a relay. It is a design error/oversight and/or a misapplication of the relay. Thus, these events are not symptomatic of relay reliability; rather, they were signaling a problem that would have been detected by the contact loading study recommended to assure that relays are not "misapplied" (required to perform beyond their design limits). (Beaver Valley has performed a contact loading study and has made other "improvements" to preclude recurrence of contact overloading-related failures.)

9.3.4 North Anna

Event ID Nos. 20 and 21 report that two different relays failed to unlatch on demand. Efforts to determine a cause could not repeat the anomaly observed during testing. The latches remain in service and have continued to function properly. There is no failure mode for the latch mechanism that would result in a failure to unlatch exactly once. No repair was made, and the relay latches remained in service. Virginia Power reports that the cause was "undetermined." However, the coincidence of two such "unlikely" events indicates that the root cause was most probably a test or test set-up error, or an

intermittence in the test equipment which went unnoticed. Regardless of the cause, it is clear that the event is not a valid failure report.

Event ID No. 22 (See Table 9-7) reports an event with similar symptoms occurring as an isolated incident. No repair was made, and the relay latch remained in service. Virginia Power reports that the cause was "undetermined." Again, the most likely explanation of this event is test or test set-up error, or an intermittence in the test equipment which went unnoticed. However, event ID No. 22 was counted as a failure. This is viewed as a measure of conservatism.

9.3.5 Summary

In a majority of cases, the raw event data (Table 9-6), as provided by members of the Westinghouse Owner's Group (WOG) Slave Relay Test (SRT), indicated that:

- Data provided was not screened; data from maintenance logs was provided without regard for the significance or content.

- Test anomalies, other than failures of the relay, were included in the data.

- Certain problems were recurring.

Respondents were contacted following preliminary evaluation of the data (time and funds permitting). The "failure" and "root cause" classifications coded in columns of Table 9-8, when not provided by the respondent, were established during follow-up review efforts by the author or the respondents.

Most of the cases identified as non-failures in Sections 9.3.1 through 9.3.4 and listed on Table 9-8 did not result in either repair or replacement of the relays. In fact, most of the relays discussed are still in service today. Among the items listed in Table 9-8 are cases of recurrent reports where the same "deficient condition" was reported to affect the same relay. These cases were the product of misdiagnosed causes or repeated instances of the same error. As discussed in Section 9.3.1 through 9.3.4, such cases were results of design or application errors that would have been identified by a contact

loading study. They are not failures of the relays. Rather, the relay "problem" was symptomatic of another "failure."

Experience has shown that initial reports of "failure" should not be taken at face value. At least half of the Type AR relay "problem" reports identified in the survey were further investigated and found not to be relay failures. Note that failures reported by Braidwood, Byron, Catawba, and D.C. Cook, as listed in Tables 9-6 and 9-7, are questionable and have not been subject to further evaluation or investigation. It is believed that if detailed information were available, the seventeen failures "accepted as valid" would be further reduced in number.

TABLE 9-1 AR SLAVE RELAY ACTUATION DATA					
Plant/Units (Footnote)	**Test Period**	**Number of Relays**	**Actuations**	**Failures**	**Failure Rate**
Byron 1 & 2	2 3 18	14 115 14	768 4251 82	0 1 0	
Braidwood 1 & 2	3 18	130 4	4356 96	2 0	
Beaver Valley 1 & 2	1	166	5636	0	
Comanche Peak	3	166	1193	0	
Catawba 1 & 2	3	149	4095	0	
McGuire 1 & 2	3	160	6864	0	
Sequoyah 1 & 2 (1)	18	129	1088	0	
North Anna 1 & 2 (1)	18	152	2356	0	
D. C. Cook 1 & 2 (1)	18	184	3120	2	
Farley 1 & 2	1 18	40 88	8640 649	0 1	
	1 2 or 3 18	206 734 571	14276 21527 7391	0 3 3 Total=6	N/A 1.39E-04 4.06E-04

(1) Actuations estimated by Westinghouse.
(2) Actuation data is from initial criticality of the plant. Factory acceptance testing and pre-operability testing records were not reviewed.

TABLE 9-2 AR SLAVE RELAY LATCH FAILURE DATA					
Plant/Units (Footnote)	**Test Period**	**Number of Relays**	**Latch Actuations (4)**	**Failures**	**Failure Rate**
Byron 1 & 2	2 or 3 18	104 8	4026 40	0 0	
Braidwood 1 & 2	3	109	2848	0	
Beaver Valley 1 & 2	1	102	2914	2	
Comanche Peak	3	134	929	0	
Catawba 1 & 2	3	110	2510	5	
McGuire 1 & 2	3	112	4928	0	
Sequoyah 1 & 2 (1)	18	116	884	3	
North Anna 1 & 2 (1) (3)	18	92	1426	1	
D. C. Cook 1 & 2 (1) (2)	18	110	1872	0	
Farley	1 18	24 68	5189 512	0 0	
	1 2 or 3 18	126 569 394	8103 15241 4734	2 5 4 Total=11	2.47E-04 3.28E-04 8.45E-04

Notes:

(1) Actuations estimated by Westinghouse.
(2) Assume same % of latching relays as for North Anna.
(3) North Anna latch failure subject to verification.
(4) Actuation data is from initial criticality of the plant. Factory acceptance testing and pre-operability testing records were not reviewed.

TABLE 9-3 SERVICE HOURS OF AR RELAYS				
Plant	**Date Critical**	**Service Hours**	**Number of Relays**	**Relay Hours**
1 Month STI				
Beaver Valley 1	10-May-76	151344	83	1.26E+07
Beaver Valley 2	15-Aug-87	52608	83	4.37E+06
Farley 1	09-Aug-77	140400	20	2.81E+06
Farley 2	08-May-81	107568	20	2.15E+06
			Total =	2.19E+07
3 Month STI				
Braidwood 1	15-May-87	54816	65	3.56E+06
Braidwood 2	15-Mar-88	47496	65	3.09E+06
Byron 1	15-Feb-85	74472	65	4.84E+06
Byron 2	15-Jan-87	57696	64	3.69E+06
Catawba 1	15-Jan-85	75216	69	5.19E+06
Catawba 2	15-May-86	63576	74	4.70E+06
Comanche Peak	15-Apr-90	29232	83	2.43E+06
Comanche Peak	15-Mar-93	3672	83	3.05E+05
McGuire 1	15-Aug-81	105192	80	8.42E+06
McGuire 2	15-May-83	89880	80	7.19E+06
			Total =	4.34E+07
18 Month STI				
Braidwood 1	15-May-87	54816	2	1.10E+05
Braidwood 2	15-Mar-88	47496	2	9.50E+04
Byron 1	15-Feb-85	74472	8	5.96E+05
Byron 2	15-Jan-87	57696	6	3.46E+05
D. C. Cook 1	18-Jan-75	162816	92	1.50E+07
D. C. Cook 2	10-Mar-78	135288	92	1.24E+07
Farley 1	09-Aug-77	140400	44	6.18E+06
Farley 2	08-May-81	107568	44	4.73E+06
North Anna 1	05-Apr-78	134664	76	1.02E+07
North Anna 2	12-Jun-80	115488	76	8.78E+06
Sequoyah 1	04-Jul-80	114960	65	7.47E+06
Sequoyah 2	05-Nov-81	103224	64	6.61E+06
			Total =	7.26E+07

Note - Present is taken as August 15, 1993

TABLE 9-4 SERVICE HOURS OF AR LATCHING RELAYS				
Plant	**Date Critical**	**Service Hours**	**Number of Relays**	**Relay Hours**
1 Month STI				
Beaver Valley 1	10-May-76	151344	51	7.72E+06
Beaver Valley 2	15-Aug-87	52608	51	2.68E+06
Farley 1	09-Aug-77	140400	12	1.68E+06
Farley 2	08-May-81	107568	12	1.29E+06
			Total =	1.34E+07
3 Month STI				
Braidwood 1	15-May-87	54816	55	3.01E+06
Braidwood 2	15-Mar-88	47496	54	2.56E+06
Byron 1	15-Feb-85	74472	52	3.87E+06
Byron 2	15-Jan-87	57696	52	3.00E+06
Catawba 1	15-Jan-85	75216	55	4.14E+06
Catawba 2	15-May-86	63576	55	3.50E+06
Comanche Peak	15-Apr-90	29232	67	1.96E+06
Comanche Peak	15-Mar-93	3672	67	2.46E+05
McGuire 1	15-Aug-81	105192	56	5.89E+06
McGuire 2	15-May-83	89880	56	5.03E+06
			Total =	3.32E+07
18 Month STI				
Byron 1	15-Feb-85	74472	4	2.98E+05
Byron 2	15-Jan-87	57696	4	2.31E+05
D. C. Cook 1	18-Jan-75	162816	55	8.95E+06
D. C. Cook 2	10-Mar-78	135288	55	7.44E+06
Farley 1	09-Aug-77	140400	34	4.77E+06
Farley 2	08-May-81	107568	34	3.66E+06
North Anna 1	05-Apr-78	134664	46	6.19E+06
North Anna 2	12-Jun-80	115488	46	5.31E+06
Sequoyah 1	04-Jul-80	114960	58	6.67E+06
Sequoyah 2	05-Nov-81	103224	58	5.99E+06
			Total =	4.95E+07
Note - Present is taken as August 15, 1993				

TABLE 9-5 FAILURE RATE SUMMARY - AR RELAYS	
Failures per Demand	
1 Month STI	(0 Failures)/(14276 Actuations) = N/A Failures/Demand
3 Month STI	(3 Failures)/(21527 Actuations) = 1.39E-04 Failures/Demand
18 Month STI	(3 Failures)/(7391 Actuations) = 4.06E-04 Failures/Demand
All STI's	(6 Failures)/(43194 Actuations) = 1.39E-04 Failures/Demand
Failures per Hour	
1 Month STI	(0 Failures)/(2.19E+07 Relay Hours) = N/A Failures/Hr
3 Month STI	(3 Failures)/(4.34E+07 Relay Hours) = 6.91E-08 Failures/Hr
18 Month STI	(3 Failures)/(7.26E+07 Relay Hours) = 4.13E-08 Failures/Hr
All STI's	(6 Failures)/(1.38E+08 Relay Hours) = 4.40E-08 Failures/Hr
FAILURE RATE SUMMARY - AR RELAY LATCHES	
Failures per Demand	
1 Month STI	(2 Failures)/(8103 Actuations) = 2.47E-04 Failures/Demand
3 Month STI	(5 Failures)/(15241 Actuations) = 3.28E-04 Failures/Demand
18 Month STI	(4 Failures)/(4734 Actuations) = 8.45E-04 Failures/Demand
All STI's	(11 Failures)/(28078 Actuations) = 3.92E-04 Failures/Demand
Failures per Hour	
1 Month STI	(2 Failures)/(1.34E+07 Relay Hours) = 1.49E-07 Failures/Hr
3 Month STI	(5 Failures)/(3.32E+07 Relay Hours) = 1.51E-07 Failures/Hr
18 Month STI	(4 Failures)/(4.95E+07 Relay Hours) = 8.10E-08 Failures/Hr
All STI's	(11 Failures)/(9.61E+07 Relay Hours) = 1.10E-07 Failures/Hr

TABLE 9-6 - RELAY EVENTS										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURES	ROOT CAUSES	NOTES
1	Beaver Valley	1B	K601	A4L	1	184	6/4/91	UL	TE	Improper Test Setup
2	Beaver Valley	1B	K603	A4L	1	9	1/3/78	UL	S	Would not reset, spring misaligned
3	Beaver Valley	1B	K610	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
4	Beaver Valley	1B	K620	A4L	1	184	6/4/91	UL	TE	Improper test setup
5	Beaver Valley	1B	K632	A4	1	9	6/13/88	CO	TE	Non-repeatable, suspect tech error
6	Beaver Valley	1B	K641	A4	1	184	10/28/85	CO	CF	Contacts failed to open after test, problem self-c
7	Beaver Valley	1B	K641	A4	1		Replaced 10/24/90	CO	CF	Contacts failed to open after test, contacts 3-4 r
8	Beaver Valley	1B	K641	A4	1		Replaced 4/5/91	CO	CF	Contacts failed to open after test, contacts 3-4 r
9	Braidwood	1B	K602	A8L	3	33	Replaced 7/27/90	CO	CA	Contacts did not make - misaligned
10	Braidwood	2A	K648	A4	3	26	Replaced 4/10/82	N	B	Relay took 3 sec to reset, not a latching relay
11	Byron	1B	K632	A4	3	21	Replaced 8/1/88	CO	CF	Contacts replaced
12	Catawba	1A	K612	A4L-8	3	30 X	Repaired 2/85	L	LA	
13	Catawba	1A	K616	A4L-8	3	30 X	Replaced 1/85	L	U	
14	Catawba	1A	K619	A4L-8	3	13 X	Repaired 5/87	L	O	

TABLE 9-6 - RELAY EVENTS										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURES	ROOT CAUSES	NOTES
15	Catawba	1A	K636	A4L-8	3	30 X	Repaired 5/87	L	LA	Re-aligned
16	Catawba	1A	K643	A4L-8	3	15 X	Replaced 10/6/8	L	LA	
17	D.C. Cook	1A	K602	A	18	19	Repaired 7/28/83		CWR	Replaced contacts
18	D.C. Cook	2A	K629	A	18	15	Repaired 1/20/91		CWC	Replaced contacts
19	Farley	2A	K620	A8	18	11	Replaced 4/9/84	A	BD	Binding due to debris
20	North Anna	2B	K608	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
21	North Anna	2B	K610	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
22	North Anna	2B	K619	A8L	18	14	2/29/92	UL	U	Did not unlatch
23	Sequoyah	1A	K603				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
24	Sequoyah	1A	K604				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
25	Sequoyah	1A	K647	A4L	18	9	8/27/85	UL	U/TE	Did not unlatch, non-repeatable
26	Sequoyah	1B	K615	A8L	18	4	Replaced 6/10/86	UL	S	Did not unlatch on reset, spring misaligned
27	Sequoyah	1B	K615	A8L	18	2	Replaced 11/6/89	N	N	Replace old non-class 1E relay

TABLE 9-6 - RELAY EVENTS										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURES	ROOT CAUSES	NOTES
28	Sequoyah	2A	K610	A8L	18	8	10/1/87	UL	U/TE	Did not unlatch on reset, non-repeated
29	Sequoyah	2A	K615	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeatable, replaced latch
30	Sequoyah	2A	K615	A8L	18	1	Replaced 10/4/83	U	U	Probable failure to unlatch
31	Sequoyah	2A	K622	A8L	18	8	Repaired 11/2/87	L	AE	Loose Cross-bar Screw
32	Sequoyah	2B	K607	A8L	18	8	4/15/92	U	TE	Did not latch, non-repeated, parallel path circuit
33	Sequoyah	2B	K615	A8L	18	8	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
34	Sequoyah	2B	K620	A8	18	8	10/19/87	U	U/TE	Did not actuate, non-repeated
35	Sequoyah	2B	K622	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
36	Sequoyah	2B	K622	A8L	18	1	Replaced 10/4/83	L	U	Did not latch, replaced latch
37	Sequoyah	2B	K622	A8L	18	3	10/19/87	L	U	Did not latch, non-repeated
38	Sequoyah	2B	K622	A8L	18	1	Replaced 6/19/88	L	U	Did not latch
39	Sequoyah	1A	K606				4/6/90	U	U	Did not actuate, non-repeated
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

TABLE 9-7 - RELAY FAILURES										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURES	ROOT CAUSES	NOTES
2	Beaver Valley	1B	K603	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
3	Beaver Valley	1B	K610	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
9	Braidwood	1B	K602	A8L	3	33	Replaced 7/27/90	CO	CA	Contacts did not make - misaligned
10	Braidwood	2A	K648	A4	3	26	Replaced 4/10/82	N	B	Relay took 3 sec to reset, not a latching relay
11	Byron	1B	K632	A4	3	21	Repaired 8/1/88	CO	CF	Contacts Replaced
12	Catawba	1A	K612	A4L-8	3	30 X	Repaired 2/85	L	LA	
13	Catawba	1A	K616	A4L-8	3	30 X	Replaced 1/85	L	U	
14	Catawba	1A	K619	A4L-8	3	13 X	Repaired 5/87	L	O	
15	Catawba	1A	K636	A4L-8	3	30 X	Repaired 5/87	L	LA	Re-aligned
16	Catawba	1A	K643	A4L-8	3	15 X	Replaced 10/6/8	L	LA	
17	D.C. Cook	1A	K602	A	18	19	Repaired 7/28/83		CWR	Replaced contacts
18	D.C. Cook	2A	K629	A	18	15	Repaired 1/20/91		CWC	Replaced contacts
19	Farley	2A	K620	A8	18	11	Replaced 4/9/84	A	BD	Binding due to debris
22	North Anna	2B	K619	A8L	18	14	2/29/92	UL	U	Did not match
26	Sequoyah	1B	K615	A8L	18	4	Replaced 6/10/86	UL	S	Did not unlatch on reset, spring misaligned

TABLE 9-7 - RELAY FAILURES										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURES	ROOT CAUSES	NOTES
30	Sequoyah	2A	K615	A8L	18	1	Replaced 10/4/83	U	U	Probable failure to unlatch
36	Sequoyah	2B	K622	A8L	18	1	Replaced 10/4/83	L	U	Did not latch, replaced latch
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

TABLE 9-8 - RELAY NON-FAILURES										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATA	FAILURES	ROOT CAUSES	NOTES
1	Beaver Valley	1B	K601	A4L	1	184	6/4/91	UL	TE	Improper test setup
4	Beaver Valley	1B	K620	A4L	1	184	6/4/91	UL	TE	Improper test setup
5	Beaver Valley	1B	K632	A4	1	9	6/13/88	CO	TE	Non-repeatable, suspect tech error
6	Beaver Valley	1B	K641	A4	1	184	10/28/85	CO	CF	Contacts Failed to open after test, problem self-c
7	Beaver Valley	1B	K641	A4	1		Replaced 10/24/90	CO	CF	Contacts failed to open after test, contacts 3-4 r
8	Beaver Valley	1B	K641	A4	1		Replaced 4/5/91	CO	CF	Contacts failed to open after test, contacts 3-4 r
20	North Anna	2B	K608	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
21	North Anna	2B	K610	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
23	Sequoyah	1A	K603				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
24	Sequoyah	1A	K604				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
25	Sequoyah	1A	K647	A4L	18	9	8/27/85	UL	U/TE	Did not unlatch, non-repeatable
27	Sequoyah	1B	K615	A8L	18	2	Replaced 11/6/89	N	N	Replaced old non-class 1E relay
28	Sequoyah	2A	K610	A8L	18	8	10/1/87	UL	U/TE	Did not unlatch on reset, non-repeated
29	Sequoyah	2A	K615	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch

TABLE 9-8 - RELAY NON-FAILURES

ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATA	FAILURES	ROOT CAUSES	NOTES
31	Sequoyah	2A	K622	A8L	18	8	Repaired 11/2/87	L	AE	Loose cross-bar screw
32	Sequoyah	2B	K607	A8L	18	8	4/15/92	U	TE	Did not latch, non-repeated, parallel path circuit
33	Sequoyah	2B	K615	A8L	18	8	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
34	Sequoyah	2B	K620	A8	18	8	10/19/87	U	U/TE	Did not actuate, non-repeated
35	Sequoyah	2B	K622	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
37	Sequoyah	2B	K622	A8L	18	3	10/19/87	L	U	Did not latch, non-repeated
38	Sequoyah	2B	K622	A8L	18	1	Replaced 6/19/88	L	U	Did not latch
39	Sequoyah	1A	K606				4/6/90	U	U	Did not actuate, non-repeated

Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.

TABLE 9-9 - CROSS REFERENCE BETWEEN WCAP SECTIONS AND TABLES 9-7 AND 9-8

Event ID#	WCAP-13877 Section #	Table #	Relay ID #	Plant Name	Unit/Train
1	9.3.3 (Reference 1, paragraph 1)	9-8	K601	Beaver Valley	1B
2	*	9-7	K603	Beaver Valley	1B
3	*	9-7	K610	Beaver Valley	1B
4	9.3.3 (Reference 1, paragraph 1)	9-8	K620	Beaver Valley	1B
5	9.3.3 (Reference 1, paragraph 2)	9-8	K632	Beaver Valley	1B
6	9.3.3 (Reference 1, paragraph 3)	9-8	K641	Beaver Valley	1B
7	9.3.3 (Reference 1, paragraph 3)	9-8	K641	Beaver Valley	1B
8	9.3.3 (Reference 1, paragraph 3)	9-8	K641	Beaver Valley	1B
9	*	9-7	K602	Braidwood	1B
10	*	9-7	K648	Braidwood	2A
11	*	9-7	K632	Byron	1B
12	*	9-7	K612	Catawba	1A
13	*	9-7	K616	Catawba	1A
14	*	9-7	K619	Catawba	1A
15	*	9-7	K636	Catawba	1A
16	*	9-7	K643	Catawba	1A
17	*	9-7	K602	D. C. Cook	1A
18	*	9-7	K629	D. C. Cook	2A
19	9.2.2	9-7	K620	Farley	2A
20	9.3.4 (Reference 1, paragraph 1)	9-8	K608	North Anna	2B
21	9.3.4 (Reference 1, paragraph 1)	9-8	K610	North Anna	2B
22	9.3.4 (Reference 1, paragraph 2)	9-7	K619	North Anna	2B
23	9.3.1.1	9-8	K603	Sequoyah	1A
24	9.3.1.1	9-8	K604	Sequoyah	1A
25	9.3.1.3	9-8	K647	Sequoyah	1A
26	9.2.1 (paragraph 3)	9-7	K615	Sequoyah	1B
27	9.3.1.9	9-8	K615	Sequoyah	1B
28	9.3.1.4	9-8	K610	Sequoyah	2A
29	9.3.1.2	9-8	K615	Sequoyah	2A
30	9.2.1 (paragraph 1)	9-7	K615	Sequoyah	2A
31	9.3.1.6	9-8	K622	Sequoyah	2A
32	9.3.1.11	9-8	K607	Sequoyah	2B
33	9.3.1.2	9-8	K615	Sequoyah	2B
34	9.3.1.7	9-8	K620	Sequoyah	2B
35	9.3.1.2	9-8	K622	Sequoyah	2B
36	9.2.1 (paragraph 2)	9-7	K622	Sequoyah	2B
37	9.3.1.5	9-8	K622	Sequoyah	2B
38	9.3.1.8	9-8	K622	Sequoyah	2B
39	9.3.1.10	9-8	K606	Sequoyah	1A

NOTES:
1) Reference 1: Letter from J. A. Scalice to the U.S. NRC, dated October 2, 1997
2) * Relay failure accepted -- not discussed in WCAP-13877

Figure 9-1 Distribution of Relay Actuations

AR Relays, All Test Intervals, All Failure Types

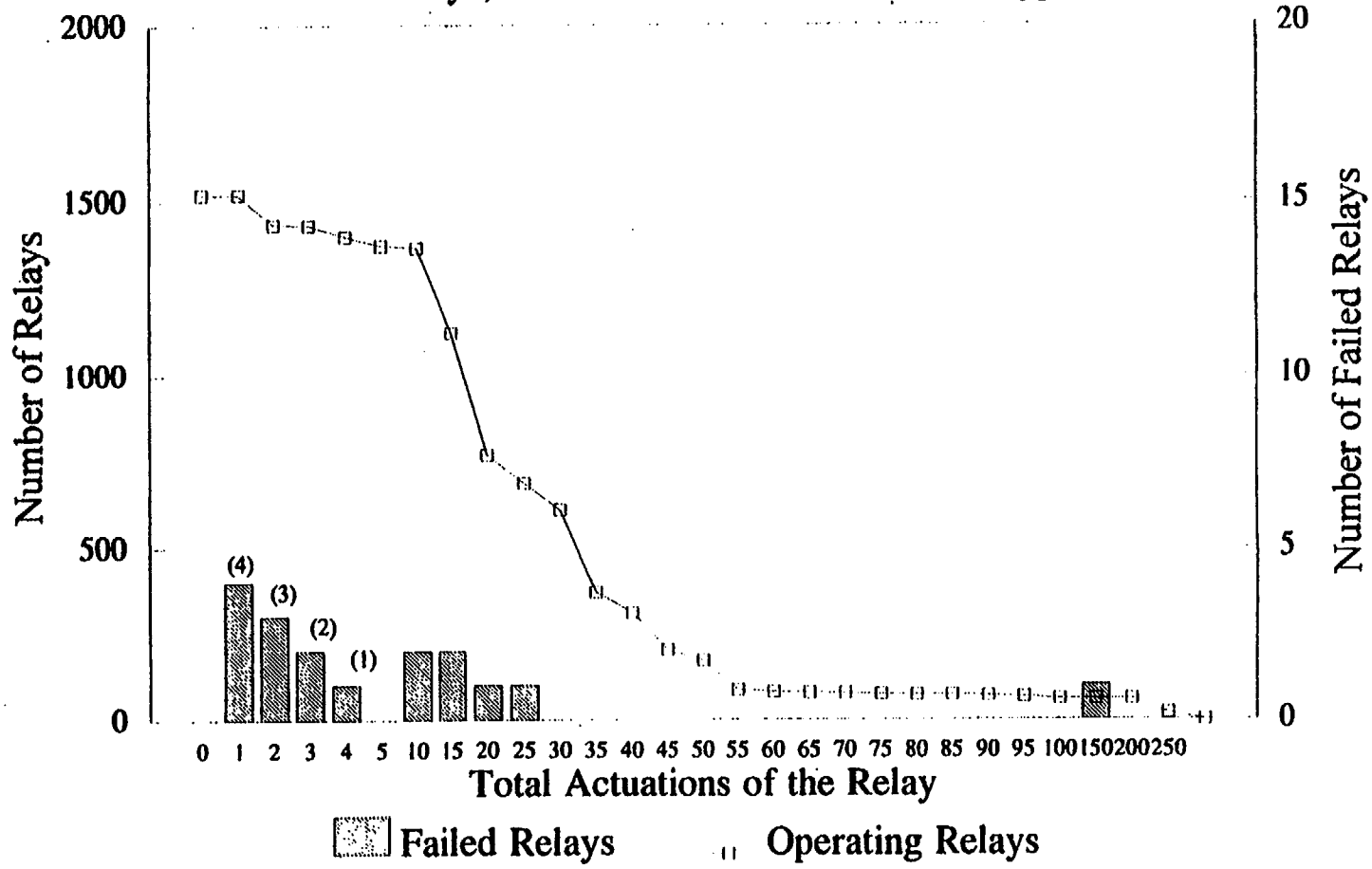


Figure 9-2 Distribution of Relay Actuations

AR Relays, All Test Intervals, Not Including Latch Failures

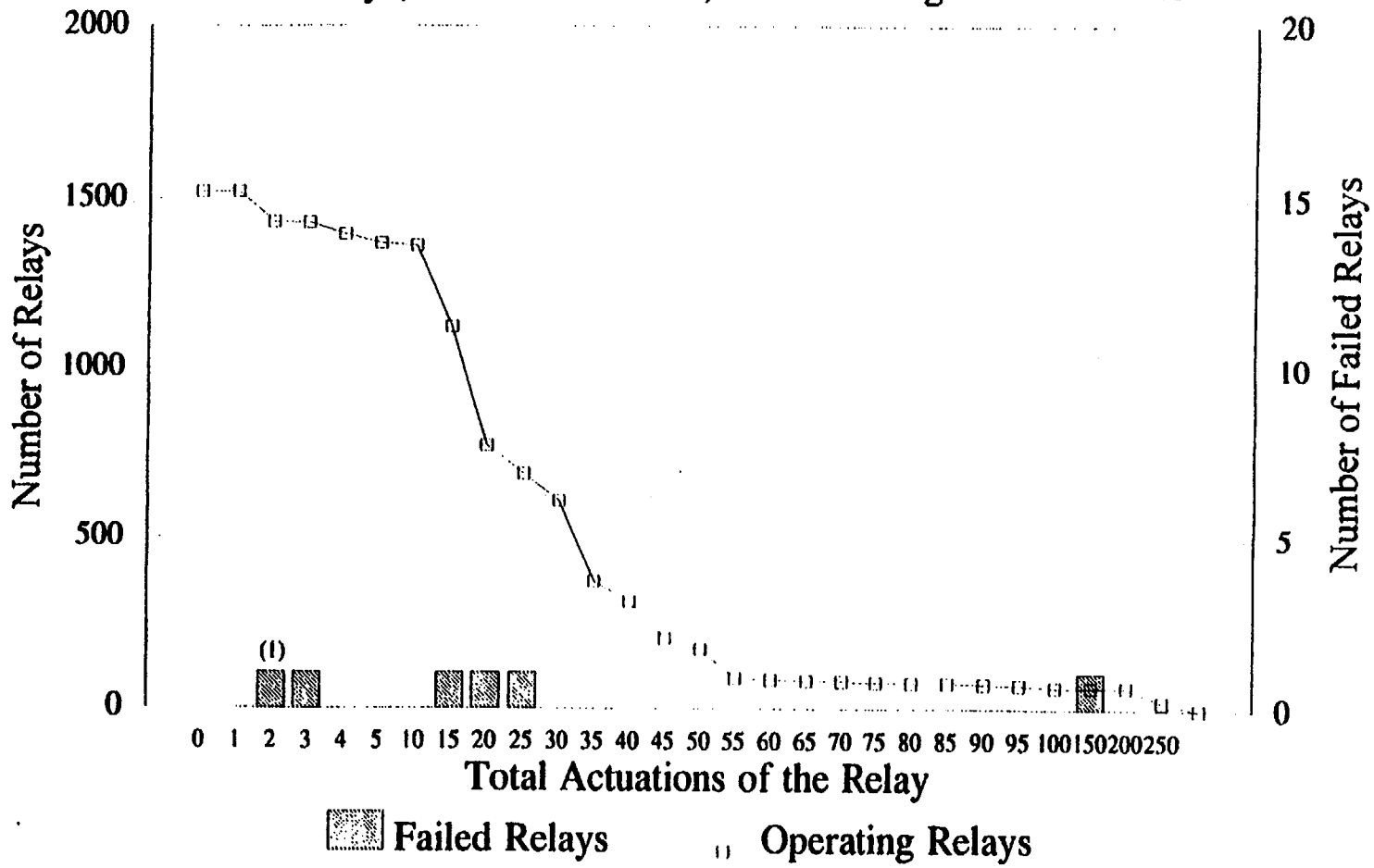


Figure 9-3 Distribution of Relay Actuations

AR Latching Relays, All Test Intervals

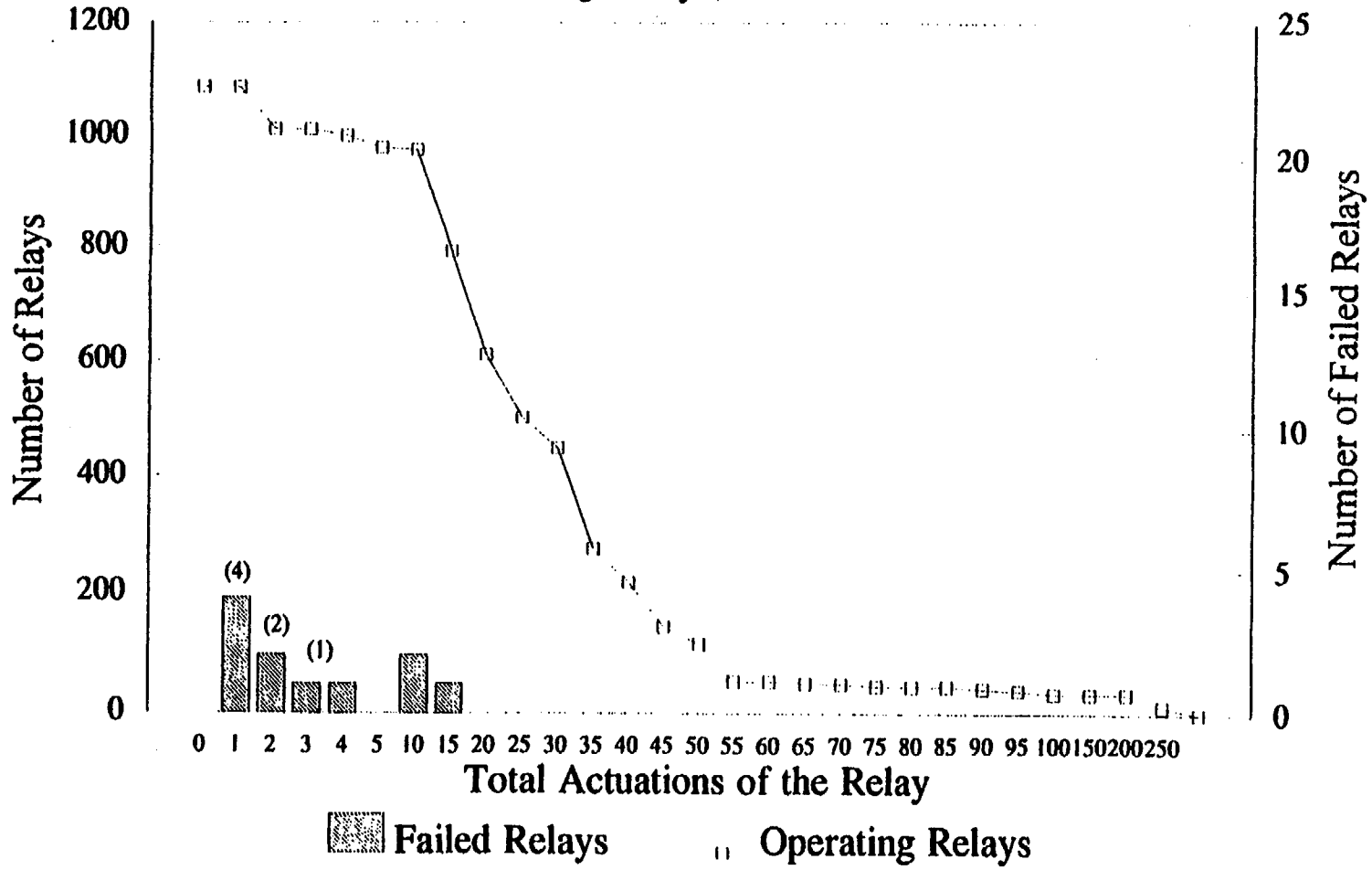


Figure 9-4 Distribution of Relay Service Times

AR Relays, All Test Intervals, All Failure Types

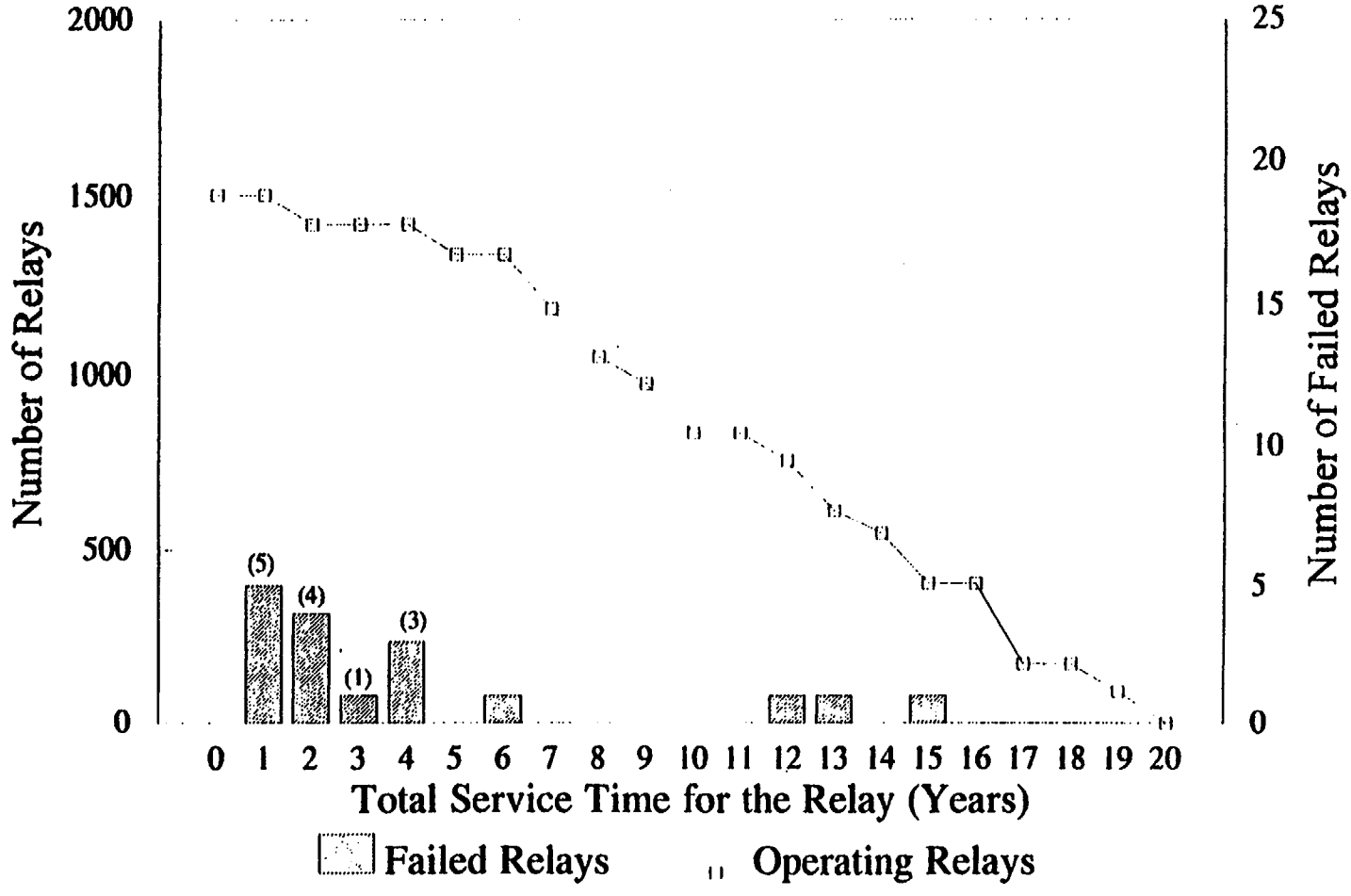


Figure 9-5 Distribution of Relay Service Times

AR Relays, All Test Intervals, Non-Latch Failures

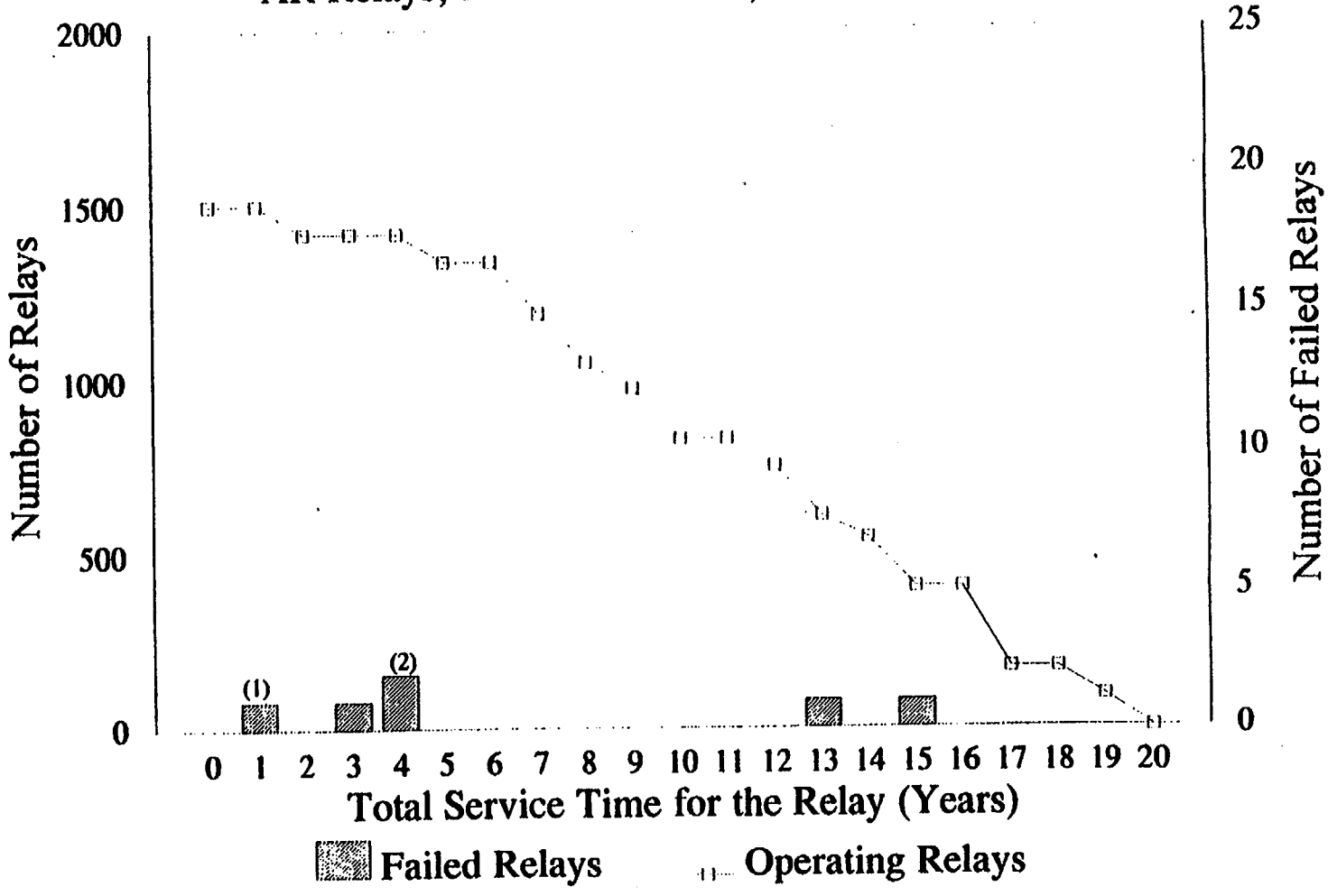
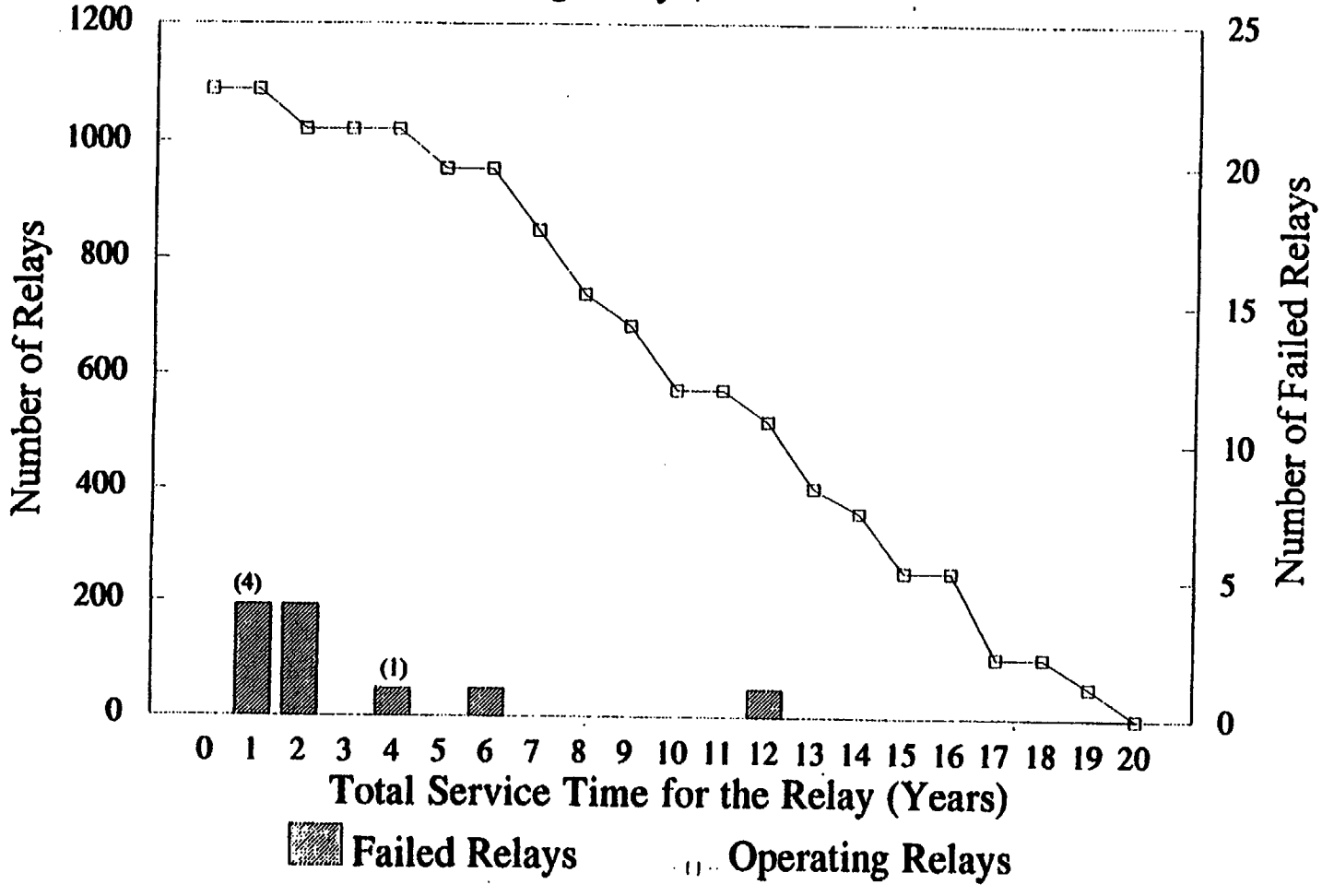


Figure 9-6 Distribution of Relay Service Times

AR Latching Relays, All Test Intervals



10.0 CONCLUSIONS OF FMEA

10.1 GENERAL CONCLUSIONS

Failure modes for normally de-energized (ND) and normally energized (NE) relays are fundamentally the same. However, effects of coil assembly failures differ significantly for the two operating modes (Section 10.3).

Failure mechanisms dependent on age/temperature effects can be accelerated by relay operating mode or duty cycle. Thus, the probability that a given age-related failure mechanism may occur differs for ND and NE relays. Even among ND relays, the duty cycle during refueling outages will affect the probability of age/temperature related failure mechanisms. However, representative calculations summarized in Section 8.0 support the conclusion that the difference is of little significance to SSPS slave relays over a 40-year plant life.

A replacement interval can be established to minimize or preclude the possibility of certain age/temperature-related failures. Based on representative calculations for FNP in Section 8.0, SSPS slave relays at FNP which are normally energized should be replaced every 19 years. For other plants, the assessment should be applied on a relay-specific basis to account for the actual ambient temperature environment, relay duty cycle, and relay self heating.

10.2 RELAY BINDING

The relay binding failure mode is of particular concern for the SSPS slave relays. This failure mode is defined generally as a mechanical condition which prevents the relay from changing state on demand. Relay binding is postulated to occur in Westinghouse AR and ARD relays due to the following failure mechanisms.

1. Fusing of the contacts,
2. Latch mechanism does not release on demand, or
3. Excessive friction between moving and stationary components.

Fusing of the contacts is a failure generic to all types of relays. Generally, the direct cause is excessively high instantaneous current. Root causes include contamination, corrosion, misapplication of the relay, or excessive currents which should otherwise have been prevented by other protective devices (e.g., fuses and suppression resistors) in the circuit. The potential for contact fusion can be reduced or eliminated by the following:

1. Minimize exposure to dust and contaminants,
2. Minimize exposure to high relative humidity, and
3. Good design practice in over current protection.

For ND SSPS slave relays, primary concern is for fused normally closed (NC) contacts which would prevent the relay from changing state. Contact fusing is further discussed with other contact failures in Section 10.5.

Failure of the latch mechanism to release on demand will also appear as binding of the relay. This failure mode is further discussed in Section 10.6.

Excessive friction between stationary and moving relay components results from several potential root causes. Increased friction between components may be caused by normal wear, age-related degradation of component materials, or dirt or debris entering the relay. Routine wear is not postulated to result in excessive friction or binding of Westinghouse type AR relays. Given the low cycle life demands for SSPS slave relays, relay wear degradation is minimal. This is because of the very low number of relay operating cycles expected over the plant life (e.g., 1000) versus the designed and test-demonstrated capability of the relay (i.e., 10,000,000).

Two cases of temperature/age-related end-of-life failures are postulated for AR relays. These failure modes/mechanisms affect the organic material components of the coil assembly (coil bobbin interface with the plunger or armature) and the contact block assembly (cover interface with the crossbar). Both are assessed based on the Arrhenius time/temperature relationship. The two failure types are discussed in Sections 10.3 and 10.4, respectively. These failure modes are of particular concern for the SSPS slave relays if an extended test interval is adopted because of the time/temperature related nature of the degradation/failure mechanisms. It is concluded that these postulated failure modes/mechanisms are improbable in ND SSPS slave relays over the plant life. However, degradation mechanism(s) are accelerated

by the coil temperature rise such that they are probable in NE SSPS slave relays within plant life. As such, replacement may be necessary to assure operability and reliability (See Section 8.0).

10.3 RELAY COIL ASSEMBLIES

Failure modes for AC and DC coils are fundamentally the same. Differences in coil assembly configuration and relay duty cycle effect the probability of the postulated failures. The dominant failure mode for the relay coil assembly is binding caused by the degradation of the coil bobbin (Section 10.3.1). Binding of the coil assembly is expected to occur substantially in advance of coil wire degradation sufficient to cause coil failure. Recommended replacement of the AR relays is based on the conservative aging calculations for the degradation of the coil bobbin material. Incidents of coil wire insulation failure will more likely appear as infant mortalities or random events.

10.3.1 Coil Bobbin

The failure postulated for the coil bobbin is age/temperature-related. The impact of coil bobbin material degradation is accelerated by coil temperature rise. The coil bobbin material, a Nylon, will lose dimensional stability with prolonged exposure to high temperatures. At end-of-life the coil bobbin will expand, change shape, or creep when exposed to high temperatures. The binding of the coil bobbin and plunger (moving part in DC coil assembly) is most likely in NE relays with DC coil assemblies (See Section 8.0).

This failure mechanism is considered more probable to occur in DC coils because

- the clearance between coil bobbin and plunger is less than that in an AC coil assembly, and
- DC coils generally have greater heat rise than AC coils (of the same wattage) when normally energized.

Smaller coil assemble clearances make the DC coil assembly more vulnerable to change in shape or size of the bobbin. Greater heat rise increases the probability that coil assembly binding will occur. The temperature induced degradation of the Nylon coil bobbin makes the DC coil more susceptible to the effects of dirt/debris that might enter the relay. An excess of dust or debris can be prevented. However, the adverse

effects of high temperature can only be remedied by limiting the duty cycle or by periodic replacement of NE or high duty cycle relays. A replacement interval can be estimated on the basis of the aging assessment (Section 8.0). It is also prudent to monitor conditions within the cabinet to refine aging calculations and, possibly, further extend the estimated service life.

Coil assembly binding is also postulated for type AR relays with AC coils, but, it is considered to be much less likely. The coil bobbin failure is considered most improbable for normally de-energized and low duty cycle relays with AC coil assemblies. Section 8.0 concludes that no coil bobbin failures will occur in normally de-energized relays and low duty cycle relays over the 40-year plant life.

There exists the possibility that AC relay coil bobbin failures can occur for normally energized or high duty cycle applications. However, several factors of service and design features minimize coil bobbin age/temperature effects.

- The AC coil assembly has a much greater gap between the coil bobbin and armature than the DC coil assembly.

- AC coil heat rise is generally lower than that for DC coils (heat rises used in Section 8.0 are for relays with DC coils).

- The movement of the upper half armature is restricted such that it does not make contact with the AC coil bobbin.

- The AC coil bobbin has a square cross-section (rather than the cylindrical cross-section of the DC coil bobbin) and, consequentially, a minor structural inhibition to swelling/ or creep of the bobbin material.

Sample calculations in Section 8.3 should be used as the basis for determining plant-specific, application-specific relay replacement intervals for normally energized relays. Based on engineering judgement, the AC relay service life should be longer than the DC relay service life. Based on engineering judgement, binding in NE type AR relays with AC coils is less likely or would require a greater period of high-temperature exposure than relays with DC coils. As such, it would be prudent to consider replacement of all NE and high

duty cycle type AR relays at the calculated interval. However, lacking actual occurrence of an end-of-life failure in AC coil relays, it would be conservative to base their replacement on data and calculations for the DC coil relay. Replacement schedules for AC and DC relays are not necessarily the same. Additional efforts to establish different replacement schedules for AC and DC relay could be successful, but are not likely to be cost beneficial.

The schedule for NE relay replacement is dependent upon coil type (AC or DC), duty cycle and age/temperature considerations discussed in Section 8.0. Recommendation for replacement is applicable to a small number of SSPS slave relays that perform control system functions. Typically, SSPS slave relays performing ESF actuation functions are normally de-energized.

10.3.2 Coil Wire Insulation

Short or open coil failure in a NE relay should immediately result in an equipment actuation. In ND relays, the short or open coil failure occurs concurrent with demand. This can be viewed as a hidden failure. However, monthly periodic testing continues to demonstrate that coil failures (shorting or opening due to coil wire insulation failure) within a 10 million operating cycle life is highly improbable. Given the relatively few operating cycles demanded of SSPS slave relays, the postulated coil wire failure at energization is considered to be incredible. To date, no such failure of an AR relay coil has occurred.

The much lower total temperature and temperature impact to ND relays makes the age-related form of this failure highly improbable. Based on representative calculations in Section 8.6, coil wire insulation failures due to temperature-induced aging-related degradation are highly improbable in both NE and ND SSPS slave relays.

Other causes of coil failure exist. Section 5.4.3 discusses a manufacturing change implemented to eliminate one known failure mechanism which occurs in some type AR relays in high-cycle demand applications. Such failures are not expected in SSPS slave relays.

10.4 CONTACT BLOCK ASSEMBLIES

Failure modes and effects for contact block assembly and the adder block assembly are fundamentally the same. However, failure modes attributable to contact travel are considered more likely in the adder block

due to tolerance stacking. Tolerance stacking may effect latch operation. This is addressed in Section 10.6.2.

It is postulated that prolonged exposure to high temperatures may result in a loss of mechanical strength or dimensional changes in the crossbar. The crossbar is made of a glass-filled phenolic and has outstanding resistance to both degradation mechanisms. It is more likely that the crossbar would break, due to fatigue, in applications where 10 millions operating demands are expected. Therefore, breakage of the crossbar (mechanical fatigue) is considered highly improbable for SSPS slave relays. Furthermore design development and monthly product testing demonstrate at least a 10 million cycle life for type AR relays. SSPS slave relays are estimated to accumulate 1000 cycles of operation over a forty-year plant life. The SSPS slave relays, whether NE or ND, are located in areas where temperatures are maintained in the range of 70°F to 90°F. Section 8.0 concludes that temperature/aging conditions for the SSPS cabinets do not result in sufficient degradation of the crossbar material (phenolic) to accelerate any postulated failure mechanism. It is unlikely that temperature-induced failures postulated for the crossbar would appear within a 40-year service life.

Excessive friction between cover and crossbar is postulated to result from age-related degradation of phenolic materials or dirt/debris entering the contact block assembly. However, both failures are considered improbable for SSPS slave relays. Routine wear is not a significant concern for type AR relays in light of their capability to perform 10 million cycles of operation. The cleanliness due to good housekeeping in nuclear plant control rooms and equipment periodic cleaning, inspection and preventative maintenance programs preclude concern for dirt/debris impact to SSPS slave relays (See Section 10.7.1). The age-related end-of-life failures postulated for contact block assembly (cover, crossbar, contact cartridges) require substantial time and temperature to occur.

Section 8.0 provides an aging assessment which quantifies the time to failure based on conditions in the SSPS cabinet and the material characteristics of the components. These calculations conclude that age-related failures of the contact block assembly are not credible for SSPS slave relays because of the durability of phenolic materials, relatively low ambient temperatures, and, in most cases, the absence of significant cabinet/component temperature rise. It is unlikely that temperature-induced failures that delay relay actuation/de-actuation would appear in ND SSPS slave relays within a 40-year plant life. Recommended replacement intervals for NE SSPS slave relays will similarly preclude these postulated failures over the plant life.

10.5 CONTACTS

Failure modes and effects postulated for the relay contacts are generic to all relay types. Those reflected in Table 7-3 (see "Contacts") are not unique to the type AR relay. Most relay contact failures are a result of misapplication of the relay and not due to the relay design.

The knife-edge contact design used in the type AR relay contacts is intended to reduce the likelihood of certain contact failures. The knife-edge assures good contact by reducing the potential effects of corrosion for contacts idled for substantial lengths of time. It also minimizes both the circumstances leading to and impact of contact pitting.

The fusing of relay contacts most commonly results from relay misapplication. This failure mechanism is the direct result of contacts experiencing currents in excess of their maximum rating (60 Amps making; 6 Amps breaking). Section 6.5, discusses specific cases of excessive contact loading in SSPS slave relays. For the purposes of this evaluation, it is assumed that previously existing cases of excessive contact loading have been resolved. Confidence is affirmed by:

- Very few contact failures have been reported;
- Factory acceptance testing and plant start-up testing have identified no significant design flaws; and
- Good housekeeping prevails at the SSPS cabinet locations.
- High relative humidity is not a concern due to plant heating, ventilation and air-conditioning (HVAC) systems.

Therefore, the probability of contact failure in Westinghouse type AR SSPS slave relays is significantly less than that for industrial applications of control relays.

10.6 LATCH ATTACHMENT

For SSPS slave relays equipped with a latch, latch operation is not critical to the initiation of the safety function performed by the relay. A failure to latch will not prevent successful automatic ESFAS actuation(s). The purpose of the latch on SSPS slave relays is to maintain the ESFAS function until reset by the operator. The actuation circuitry is configured to provide continuous energization of the slave relays so long as a valid actuation signal exists. No failure of the ARLA latch attachment will prevent ESFAS actuation.

Failure of the latch to make may have consequence only in a loss of power event. That is, a loss of the ESFAS actuation signal will immediately reset the slave relay with a failed or "un-made" latch. However, once power is restored, if a trip or actuation condition is warranted the relay would be re-energized and the ESFAS functions restored. Even if the latch were to bind in the "reset" position the automatic trip and ESFAS functions would be provided on demand. This failure scenario will not differ from IPE evaluations for the loss of off-site power events.

Another consideration would be the automatic reset of ESFAS functions when the trip condition is reset, and prior to operator actions to reset individual functions (e.g., SI). In most cases, the signal is sealed-in by other circuit components. For these, the postulate latch failure may not be of consequence. Where the latching slave relay is the sole seal in, inadvertent reset may result in an increase in accident consequences.

A failure of an SSPS slave relay to unlatch is not a failure to perform its automatic safety function. A failure to unlatch on demand is readily detectable. For example, safety-injection (SI) reset is performed manually by the operator as directed by the Emergency Response Procedures (ERP). The ERPs also direct the operator to verify that SI reset has occurred. If a given SI relay fails to reset, other measures can be taken, with a small penalty in time.

10.6.1 Latch Coils

Latch coils are normally de-energized and have the same insulation material as the relay coil. Furthermore, latch coil energizations are exclusively of momentary duration precluding the possibility that self-heating is a factor in latch coil life or reliability. It is concluded that these postulated failure modes/mechanisms for the ALRA latch coils used on SSPS slave relays are highly improbable over the estimated plant life.

10.6.2 Tolerance Stacking

Section 5.3 discusses tolerance stacking which may effect the relay crossbar, contact block assembly, and latch mechanism. In the extreme case where the relay crossbar(s) and latch mechanism components are at their maximum tolerances, travel may be insufficient to permit consistent latch making. The tolerance stacking of the components is considered to be an infant mortality type failure which can be corrected, preferably by the manufacturer. Cases of the tolerance mismatch are demonstrated in the WOG survey responses.

The tolerance stacking related failure mode/mechanism will not appear as a result of temperature/aging-related degradation of the relay. Early detection will preclude any impact to SSPS slave relay reliability. Following any replacement of a latching relay, or replacement of either the latch mechanism or the relay on which it is installed, a multiple of test actuations should be performed. Ten cycles of operation should be sufficient to reveal any intermittence in latch making. If a failure to latch does occur, it should be concluded that the particular relay and latch combination are incompatible. It should not be conclude that either the latch or the relay has failed. The manufacturer should be consulted if additional instructions are needed.

10.7 OTHER FACTORS

The following subsections address environmental factors postulated to cause certain relay failures or accelerate failure mechanisms which are time/temperature-dependent. Conditions in typical industrial areas are discussed and compared to conditions in nuclear plant areas where the SSPS is installed. Extreme or damaging forms of these environs exist in many industries, but are virtually absent from the normal operating conditions of most nuclear plant "mild" environment areas. The exception is high temperature, a particular concern for normally-energized relays because of the resistive heating in the relay coil. It is concluded that time and temperature play little or no role in the reliability of the SSPS slave relays. The exception for the few cases of normally energized slave relays used for control/interlock functions should be addressed by on plant specific calculations of service life per Sections 8.3.3 and 8.3.4.

10.7.1 Dirt, Debris and Contamination

Among the challenges to reliability of industrial control relays are adverse effects of dirt, debris and contamination. In typical industrial applications these factors may, at times, represent the greatest challenge to relay operability. Ultimately, adverse effects of dirt, debris, and contamination (e.g., mining applications) will lead to some of the failure modes described in Section 7.0.

10.7.1.1 Large accumulations of dust may foul contacts or increase friction between moving parts of the relay. Contact fouling may contribute directly and indirectly to high contact resistance. Dust "flashing" on contact closure/energization will leave carbon residue. The effect can be additive with successive operations. Extreme cases of flashing will "pit" the contact surface. Pitting, alone, will degrade contact performance reducing the effective contact surface and or increasing contact resistance. Pitting can also increase the potential for contact corrosion. In particularly dirty environments, contact fusing will eventually result from increasing contact resistance and abrasive degradation of the contact surface.

10.7.1.2 Debris (e.g., foreign material chips, loose screws) may become lodged in the relay, preventing mechanical movement.

10.7.1.3 Chemical contamination (e.g., oil, corrosive chemistry) may be the result of inadvertent spray from adjacently mounted equipment or processes. The degradation process is similar to that described in Section 10.7.1.1. Again, the leading concern is for degradation of the relay contacts, though in general, other relay components and materials may be equally vulnerable.

Typical industrial environments provide significant opportunity for the above mechanisms to occur in extreme. This is not the case in nuclear power plants. Housekeeping conditions in nuclear plant control rooms are exceptional by comparison to most primary industry or mining operations. The SSPS is located in or adjacent to the main control rooms where environmental conditions generally are milder than the shipping/storage conditions specified by the vendors. While these nuclear plant areas are not "dust-free", there are no large accumulations of dust or dirt as might be expected near lathes or on mining equipment. Periodic inspection of the SSPS cabinets typically include housekeeping checks, with cleaning performed as needed.

The SSPS cabinets are normally required to be closed at all times, except during authorized surveillance. This requirement arises from seismic qualification requirements and concern for "missile" damage by flying debris during a seismic event. Even during plant surveillance, access to the cabinets is subject to procedural control. Furthermore there are no sources of missiles or inadvertent chemical/oil spray (as might result from rupture of a hydraulic cylinder or hose) in nuclear plant control rooms.

The SSPS cabinets have good defense to sources of dust, debris and contamination. The SSPS is located in plant areas where dust is minimal and where debris and contamination are non-existent. Random, non-time dependent failure modes associated with dirt, debris and contamination are considered to have a very low probability. For this reason, the SSPS slave relays are expected to perform with above average reliability.

10.7.2 High Ambient Temperature

High ambient temperatures will accelerate thermal/age-related degradation of relay component materials. High ambient temperatures may accelerate wear-aging of lubricated components in the ARLA latch attachment. This is postulated to be the result of decreased lubricant viscosity. For these reasons, high ambient temperatures can become a factor of reliability within the service life of type AR relays.

Temperature-induced aging degradation of materials is minimized by temperature controls in the SSPS cabinet locations. Furthermore plants provide climate control (i.e., heating, ventilation, and air-conditioning; HVAC) with Class 1E powered redundant systems. Table 8-1 lists the ambient temperature ranges for plants which responded to the WOG survey. Westinghouse recommends a 40 year shelf life for type AR relays when stored at or below 120°F. Normal ambient temperatures in SSPS cabinet areas are well within the specified shelf life conditions. This is demonstrated in the calculations summarized in Sections 8.3.3 and 8.3.4 for the expected end-of-life failure of type AR relays.

Extensive temperature monitoring efforts for the Farley Nuclear Plant (FNP) spanning (date 1992 to date 1993) are summarized in Table 8-2. These data are considered to be typical of domestic nuclear plants. As such, the FNP data is used in the aging assessment calculations.

10.7.3 High Relative Humidity

High relative humidity will accelerate corrosion of relay contacts, especially in applications where there are few and infrequent operations of normally open relay contacts. Room heating and air-conditioning in the SSPS cabinet locations minimizes relative humidity. In general, nuclear plant environmental controls maintain the relative humidity in the main control room and adjacent equipment rooms at non-condensing levels. Thus, it is expected that corrosion of SSPS slave relay contacts should be at a minimum throughout their service life. This is demonstrated by the few reported cases of contact replacements cited for the SSPS slave relays.

11.0 BASIS FOR ASSESSING SLAVE RELAY RELIABILITY

Standard sources of relay reliability typically base the reliability of relays on numbers of failures per accumulated cycles of operation. For industrial control relays, reliability is assessed on the number of failures expected per 10,000, 100,000, or 1 million relay operations, as recommended in the National Relay Manufacturers Association (NRMA) Handbook (Reference 14-3). These bases are derived from expectations that industrial control relays will accumulate 10,000 to over a million cycles of operation over their service life, and that failure, when it ultimately occurs, will be the result of wear. Furthermore, some applications of industrial control relays may demand 10,000 to a million cycles of operation in a single year.

Based on the WOG survey data (Section 9.0), the type AR relays have a relatively low failure-per-hour rate when used as the SSPS slave relays in domestic nuclear plants. For the 10 plants contributing data, the time-based failure rate is 4.4E-08 failures per hour of service collectively for 2, 3 and 18 month test intervals for the type AR slave relays. This is two orders of magnitude less than the 3.1E-06 best estimate for failures per hour of service for 120 to 199 volt AC control relays recommended in IEEE-500-1984 (Reference 14-2). Statistically, this is a favorable comparison since there are far fewer AR relays and service hours for AR relays, documented in this report, than relays in general, documented in IEEE-500-1984. Considering the relatively low temperature, low duty cycles and absence of other conditions which challenge relay operability, it is anticipated that the type AR relay hourly failure rate would be significantly less if more AR relay data were available. Supporting this expectation is the observation that most of the type AR failures reported occur early in plant life, and that plants with the longest operating history indicate few real problems with type AR slave relays in service.

While the Westinghouse type AR relay is an industrial control type relay, service in the SSPS slave relay application is not typical of industrial control relay applications. [

]^{g} However, SSPS slave relays are estimated to perform approximately 1000 operations within a 40-year service life in nuclear power plant. It can be concluded that the standard references for industrial control relay reliability have little relevance to the SSPS slave relay application. That is, it is very unlikely that the SSPS slave relays will be degraded by factors of wear or frequent operational stress. It is more likely that the SSPS slave relays will experience component degradation due to the effects of temperature and age, and that failures will occur as isolated random events over the majority of their service life.

Thus, it is proposed that the reliability of SSPS slave relays should be assessed on the basis of their resistance to temperature-induced and aging-related degradation. The aging assessment, Section 8.0, demonstrates that the degradation of SSPS slave relays requires substantial time, given the mild temperature environments which prevail in the typical SSPS location, and the absence of other environmental challenges to relay operation and reliability. Furthermore, the rate of degradation is sufficiently slow that testing at a three-month interval is no more likely to detect significant changes in the SSPS slave relays than testing at an 18 to 24 month interval.

12.0 ANALYSIS SUMMARY

In the absence of high ambient temperatures, significant accumulations of dirt and debris, and sources of contamination, no failure modes have been identified that would be accelerated or catalyzed in the normally de-energized type AR relays. Of the valid failures reported for type AR relays, few constitute a concern for a failure of an SSPS slave relay to perform its primary safety related function. A majority of the failures reported occur in the ARLA latch attachment. The two failure modes of the type ARLA latch mechanism (i.e., failure to latch, failure to unlatch) will not delay or prevent automatic initiation of ESFAS functions.

The FMEA (Section 7.0) cites failure mechanisms which are postulated due to the degradation of the type AR relay materials. However, conditions in the SSPS output relay cabinet are sufficiently mild that the time dependent failure modes are not likely to occur within the 40-year plant life. Furthermore, the very slow rate of degradation in material properties is equally insignificant at the three-month or refueling (18 - 24 month) intervals. The aging assessment (Section 8.0) concludes that ND relays may be suitable for use throughout the life of the nuclear plant with minimal need for testing and surveillance.

Relatively few SSPS slave relays in each train are normally energized (NE). The resultant heat rise of a NE relay coil accelerates the aging of type AR relays such that operability will be compromised within the 40-year nuclear plant life. Adverse impact to operability and reliability can be avoided by replacement at an appropriate interval. The estimated life of NE type AR relays should be based on example calculations presented in Section 8.3.4 and should rely on temperature data specific to the SSPS location in each plant. Conservatism in these results is assured for the AC version of the type AR relay used in the SSPS slave relay application because the end-of-life condition is based on the DC version of the type AR relay (See Section 8.0).

With replacement at a conservative interval, NE type AR relays will exhibit the same reliability as normally de-energized (ND) type AR relays. As such, it is also concluded that testing of NE type AR SSPS slave relays is equally effective at the three month interval as at the refueling based interval.

13.0 CONCLUSIONS

Based on the reliability assessment of the type AR SSPS slave relay, the assumed initial quarterly test interval supported by WCAP-10271-P-A Supplement 2 Rev 1 is overly conservative. Slave relay testing may be extended to a refueling basis without impact or consequence to relay reliability.

It is recommended that a replacement interval be determined for the few normally energized SSPS slave relays. With replacement of normally energized relays at an appropriate interval, the reliability of both normally energized and normally de-energized SSPS type AR slave relays would be the same.

14.0 REFERENCES

14-1 IEEE Standard 352-1987, "IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Stations Safety Systems"

14-2 IEEE Standard 500-1984, "Guide to the Collection and Presentation of Electrical, Electronic, and Sensing Component Reliability Data for Nuclear-Power Generating Stations"

14-3 National Relay Manufacturer's Association Handbook, fourth edition, 1991.

14-4 NUREG-4715, "An Aging assessment of Relays and Circuit Breakers and System Interactions", June 1987.

14-5 NUREG-1366, "Improvements to Technical Specification Surveillance Requirements", December 1992.

14-6 INPO Bulletin Board Item: MI 11291 Q ROBERTS (VAP) 23-JUL-93 14:05 EDT, Subject: "REQUEST FOR INFORMATION ON WESTINGHOUSE ARD RELAY FAILURES", (Included as Appendix I)

14-7 Westinghouse STC Document No. 93-7TC-MATEV-L1, "Materials Properties Assessment of type AR Relays".

14-8 Smith et al., Journal of Polymer Science, vol. 18, pp. 3543-3554, 1974.

14-9 IEEE Standard 98-1984, "IEEE Standard for Preparation of Test Procedures for Thermal Evaluation of Solid Electrical Insulating Materials"

14-10 NUREG/CR-3156, "Survey of State-of-the-Art in Aging of Electronics with Application to Nuclear Power Plant Instrumentation"

14-11 EPRI NP-1558, "A Review of Equipment Aging Theory and Technology"

14.1 GENERIC COMMUNICATIONS ON RELAYS

14.1-1 RO Bulletin 74-12, "Incorrect Coils in Westinghouse Type SG Relays at Trojan", 10/21/74

14.1-2 I&E Bulletin 76-02, "Relay Coil Failures - GE Type HFA, HGA, HKA, HMA Relays", 3/12/76

14.1-3 I&E Bulletin 76-03, "Relay Malfunctions - GE Type STD Relays", 3/15/76

14.1-4 I&E Bulletin 76-05, "Relay Failures - Westinghouse BFD Relays", (Not Dated)

14.1-5 I&E Bulletin 77-02, "Potential Failure Mechanism in Certain Westinghouse AR Relays with Latch Attachments", 9/12/77

14.1-6 I&E Bulletin 78-01, "Flammable Contact-Arm Retainers in GE CR120A Relays", 1/16/78

14.1-7 I&E Bulletin 78-06, "Defective Cuttlerhammer, Type M Relays with DC Coils", 5/31/78

14.1-8 I&E Bulletin 79-25, "Failures of Westinghouse BFD Relays in Safety-Related Systems", 11/2/79; includes excepts from Westinghouse letter TS-E-412, December 6, 1978.

14.1-9 I&E Bulletin 80-19 Revision 1, "Failures of Mercury-Wetted Matrix Relay in Reactor Protective Systems of Operating Nuclear Power Plants Designed by Combustion Engineering", 8/13/80

14.1-10 I&E Bulletin 84-02, "Failures of General Electric Type HFA Relays in use in Class 1E Safety Systems", 3/12/84

14.1-11 I&E Bulletin 88-03, "Inadequate Latch Engagement in HFA Type Latching Relays Manufactured By General Electric (GE) Company", 3/10/88

14.1-12 I&E Circular 76-02, "Relay Failures Westinghouse BF (ac) and BFD (dc) Relays", 8/18/76

14.1-13 I&E Circular 79-20, "Failure of GTE Sylvania Relay, Type PM Bulletin 7305, Catalog 5U12-11-AC with 1 120V AC Coil", 9/24/79

14.1-14 I&E Circular 80-01, "Service Advice for General Electric Induction Disc Relays", 1/17/8

14.1-15 I&E Notice 81-01, "Possible Failure of General Electric Type HFA Relays", 1/16/81

14.1-16 I&E Notice 82-02, "Westinghouse NBFD Relay Failures in Reactor Protection Systems at Certain Nuclear Power Plants", 1/27/82

14.1-17 I&E Notice 82-04, "Potential Deficiency of Certain Agastat E-7000 Series Time-Delay Relays", 3/10/82

14.1-18 I&E Notice 82-13, "Failures of General Electric Type HFA Relays", 5/10/82

14.1-19 I&E Notice 82-48, "Failures of Agastat CR 0095 Relay Sockets", 12/3/82

14.1-20 I&E Notice 82-50, "Modification of Solid State AS Undervoltage Relays Type ITE-27", 12/20/82

14.1-21 I&E Notice 82-54, "Westinghouse NBFD Relays Failures in Reactor Protection Systems, 12/27/82

14.1-22 I&E Notice 82-55, "Seismic Qualification of Westinghouse AR Relay With Latch Attachments Used In Westinghouse Solid State Protection System", 12/28/82

14.1-23 I&E Notice 83-19, "General Electric Type HFA Contact Gap and Wipe Setting Adjustments", 3/5/83

14.1-24 I&E Notice 83-38, "Defective Heat Sink Adhesive and Seismically Induced Chatter in relays Within Printed Circuit Cards", 6/13/83

14.1-25 I&E Notice 83-63, "Potential Failures of Westinghouse Electric Corporation Type SA-1 Differential Relays", 9/26/83

14.1-26 I&E Notice 83-63 Supplement 1, "Potential Failures of Westinghouse Electric Corporation Type SA-1 Differential Relays", 2/15/84

14.1-27 I&E Notice 84-20, "Service Life of Relays in Safety-Related Systems", 3/21/84

14.1-28 I&E Notice 85-49, "Relay Calibration Problem", 7/1/85

14.1-29 I&E Notice 85-82, "Diesel Generator Differential Protection Relay Not Seismically Qualified", 10/18/85

14.1-30 NRC Information Notice 87-66, "Inappropriate Application of Commercial Grade Components", 12/31/87

14.1-31 NRC Information Notice 88-14, "Potential Problems With Electrical Relays", 4/18/88

14.1-32 NRC Information Notice 88-45, "Problems in Protective Relay and Circuit Breaker Coordination", 7/7/88

14.1-33 NRC Information Notice 88-58, "Potential Problems With ASEA Brown Boveri ITE-51L Time-Over Current Relays", 8/8/88

14.1-34 NRC Information Notice 88-69, "Movable Contact Finger Binding in HFA Relays Manufactured by General Electric (GE)", 8/19/88

14.1-35 NRC Information Notice 88-69 Supplement 1, "Movable Contact Finger Binding in HFA Relays Manufactured by General Electric (GE)", 9/29/88

14.1-36 NRC Information Notice 88-83, "Inadequate Testing of Relay Contacts in Safety-Related Logic Systems", 10/19/88

14.1-37 NRC Information Notice 88-88, "Degradation of Westinghouse ARD Relays", 11/16/88

14.1-38 NRC Information Notice 88-88 Supplement 1, "Degradation of Westinghouse ARD Relays", 5/31/89

14.1-39 NRC Information Notice 88-98, "Electrical Relay Degradation Caused by Oxidation of Contact Surfaces", 12/19/88

14.1-40 NRC Information Notice 90-57, "Substandard, Refurbished Potter & Brumfield Relays Misrepresented as New", 9/5/90

14.1-41 NRC Information Notice 90-57, Supplement 1, "Substandard, Refurbished Potter & Brumfield Relays Misrepresented as New", 11/27/91

14.1-42 NRC Information Notice 91-45, "Possible Malfunction of Westinghouse ARD, BFD, and NBFD Relays, and A200 DC and DPC 250 Magnetic Contactors", 7/5/91

14.1-43 NRC Information Notice 92-04, "Potter & Brumfield Model MDR Rotary Relay Failures", 1/6/92

14.1-44 NRC Information Notice 92-05, "Potential Coil Insulation Breakdown in ABB RXMH2 Relays", 1/8/92

14.1-45 NRC Information Notice 92-19, "Misapplication of Potter & Brumfield MDR Rotary Relays", 3/2/92

14.1-46 NRC Information Notice 92-24, "Distributor Modification to Certain Commercial-Grade Agastat Electrical Relays", 3/30/92

14.1-47 NRC Information Notice 92-27, "Thermally Induced Accelerated Aging and Failure of ITE/Gould AC Relays Used in Safety-Related Applications", 4/3/92

14.1-48 NRC Information Notice 92-45, "Incorrect Relay Used in Emergency Diesel Generator Output Breaker Control Circuitry", 6/22/92

14.1-49 NRC Information Notice 92-77, "Questionable Selection and Review to Determine Suitability of Electropneumatic Relays for Certain Applications", 11/17/92

14.2 GENERIC COMMUNICATIONS RELATED TO ESFAS SYSTEMS

14.2-1 I&E Bulletin 77-03, "On-Line Testing of Westinghouse Solid State Protection System (SSPS)", 9/12/77 (Cites Westinghouse Technical Bulletin NSD-TB-77-11.)

14.2-2 (Intentionally blank)

14.2-3 I&E Bulletin 80-06, "Engineered Safety Feature (ESF) Reset Controls", 3/13/80

14.2-4 I&E Notice 79-04, "Degradation of Engineered Safety Features"

14.2-5 I&E Notice 81-10, "Inadvertent Containment Spray Due to Personnel Error", 3/25/81

14.2-6 I&E Notice 81-15, "Degradation of Automatic ECCS Actuation Capability by Isolation of Instrument Lines"

14.2-7 I&E Notice 82-10, "Following Up Symptomatic Repairs to Assure Resolution of the Problem", 3/31/82

14.2-8 I&E Notice 82-19, "Loss of High Head Safety Injection Emergency Boration and Reactor Coolant Makeup Capability", 6/18/82

14.2-9 I&E Notice 84-37, "Use of Lifted Leads and Jumpers During Maintenance or Surveillance Testing", 5/10/84

14.2-10 I&E Notice 84-39, "Inadvertent Isolation of Containment Spray Systems", 5/25/84

14.2-11 I&E Notice 85-18, "Failures of Undervoltage Output Circuit Boards in the Westinghouse Designed Solid State Protection System", 3/7/85

14.2-12 I&E Notice 85-18 Supplement 1, "Failures of Undervoltage Output Circuit Boards in the Westinghouse Designed Solid State Protection System", 9/10/91

14.2-13 I&E Notice 85-23, "Inadequate Surveillance and Postmaintenance and Postmodification System Testing", 3/22/85

14.2-14 I&E Notice 85-51, "Inadvertent Loss or Improper Actuation of Safety-Related Equipment, 7/10/85

14.2-15 I&E Notice 87-01, "RHR Valve Misalignment Causes Degradation of ECCS in PWRs", 1/6/87

14.3 WESTINGHOUSE TECHNICAL BULLETINS

14.3-1 NSD-TB-76-2, February 18, 1976, "BFD Relays", System(s): Reactor Protection System.

14.3-2 NSD-TB-76-16, November 22, 1976, "BFD & NBFD Relays", System(s): Relay Reactor Protection Systems, Relay Engineered Safeguards Systems.

14.3-3 NSD-TB-77-10, July 21, 1977, "AR Relays with Latch Attachments", System(s): Solid State Protection System (SSPS) and Auxiliary Safeguards Cabinets (ASG).

14.3-4 NSD-TB-79-05, August 14, 1979, "NBFD Relays", System(s): Relay Reactor Protection System, and Relay Engineered Safeguards Systems.

14.3-5 NSD-TB-81-14, December 7, 1981, "BFD (NBFD) Relays", System(s): Reactor Protection and Safeguard Systems.

14.3-6 NSD-TB-81-14, Rev. 1, January 15, 1982, "BFD (NBFD) Relays", System(s): Reactor Protection and Safeguard Systems.

14.3-7 NSD-TB-82-03, June 24, 1982, "AR Relays with Latch Attachments", System(s): Solid State Protection System and Auxiliary Safeguards Cabinets.

14.3-8 NSD-TB-82-03, Rev. 1, December 14, 1982, "AR Relays with Latch Attachments", System(s): Solid State Protection System and Auxiliary Safeguards Cabinets.

14.3-9 NSID-TB-85-16, July 31, 1985, "SSPS Undervoltage Output Driver Card", System(s): Solid State Protection System (SSPS).

14.3-10 NSD-TB-92-02, Rev. 0, January 24, 1992, "Misapplied Relay Contacts", System(s): Solid State Protection System (SSPS).

14.4 WESTINGHOUSE DRAWINGS

14.4-1 [

14.4-2

14.4-3

14.4-4

14.4-5

14.4-6

14.4-7

]a,b,c

14.4-8 [

14.4-9]a,b,c

14.5 MAINTENANCE WORK REQUESTS (MWR)

14.5-1 TVA MWR A-100268, "Unit 2 SSPS RELAY K615", 10/4/83

14.5-2 TVA MWR A-101100, "U/2 SSPS K622", 10/4/83

14.5-3 TVA MWR 124244, "SSPS SLAVE RELAY K615 TRAIN B", 6/10/86

14.5-4 TVA MWR A-560179, "SAFETY INJECTION LATCH RELAY K-647", 8/27/85

14.5-5 TVA MWR B-281387, "SSPS SLAVE RELAY K615 TRAIN B", 11/6/89

14.5-6 TVA MWR B216541, "SSPS TRAIN A SLAVE RELAY K610", 10/1/87

14.5-7 TVA MWR A-085758, "SLAVE RELAY K615", 12/15/82

14.5-8 TVA MWR A-085759, "SALVE RELAY K615 AND K622", 12/15/82

14.5-9 TVA MWR B276508, "TRAIN B SSPS RELAY K622", 11/2/87

14.5-10 TVA MWR C073607, "SLAVE RELAY K607 B TRAIN", 4/15/92

14.5-11 TVA MWR B-276504, "K620 RELAY TRAIN B (SI-26 DNH)", 10/19/87

14.5-12 TVA MWR B276503, "K622 RELAY TRAIN B", 10/19/87

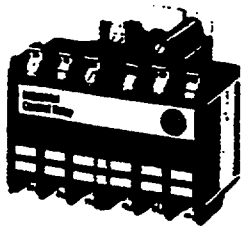
14.5-13 TVA MWR 62023, "TRAIN A SSPS SLAVE RELAY", 9/15/81

14.5-14 TVA MWR B758792, "PRT TO GAS ANALYZER VALVE", 4/6/90

APPENDIX A - TYPE AR RELAY DATA SHEETS

376 INDUSTRIAL CONTROL RELAYS
Types AR 600 Volt Ac, ARD 600 Volt Dc, Convertible Contacts

AR 4 Pole



AR 6 Pole

Application
AR/ARD relays are designed for use on machine tools, process lines, conveyors, and similar automatic and semi-automatic equipment.

AR/ARD relays are electro-mechanical convertible contact relays. AR relays are Ac devices, and the ARD is for Dc applications.

Description
Available in either 4 or 6-pole configurations, AR relays are easily converted to 8 or 10 poles simply by adding a 4-pole deck. In addition, mechanical latch and pneumatic or solid state timer attachments are available for use with 4 and 6-pole relays.

Contacts are convertible from either NO to NC to provide any combination desired, up to a maximum of 10, except that for the ARD, the number of NC poles cannot exceed four in any pole configuration. Wide spacing of contacts simplifies installation, contact testing, and maintenance. Contacts are electrically and mechanically isolated from each other. Overlap contacts are also available in one or two sets. These contacts should be mounted in the center pole positions. Ac and Dc contact cartridges should not be used in the same relay.

AR/ARD Relays

Number of Pole Spaces	Contacts NO	Contacts NC	Contacts Blank Cavities	AR 600 Volt Ac Relays 120 60, 110 50 Ac Coil Catalog Number	List Price	ARD 600 Volt Dc Relays 120 Volt Dc Coil Catalog Number	List Price
4	0	0	4	AR4A	$ 48	ARD4S	$108
	2	0	2	AR420A	72	ARD420S	132
	4	0	0	AR440A	96	ARD440S	156
6	0	0	6	AR6A	48	ARD6S	108
	4	0	2	AR640A	96	ARD640S	156
	6	0	0	AR660A	120	ARD660S	180
8 [1]	6	0	2	AR860A	120	ARD860S	180
	8	0	0	AR880A	144	ARD880S	204
10 [1]	10	0	0	AR10100A	168	ARD10100S	228

Contact Cartridges

Type Terminal	Standard Contact Cartridges Catalog Number	List Price [1]	Overlap Contact Cartridges Catalog Number [2]	List Price [2]
600 Volt Ac Cartridges				
With Clamp Terminals	ARC	$12	AROC	$24
With Screw Terminals	ARCR	12	AROCR	24
600 Volt Dc Cartridges				
With Clamp Terminals	ARDC	12	ARDOC	24
With Screw Terminals	ARDCR	12	ARDOCR	24

Standard cartridges are sold in cartons of 4 cartridges. Catalog number and list price are for single cartridge.
[2] Overlap contact cartridges are sold in sets of 2 cartridges. Catalog number and list price are for sets of 2.
[3] Will not accept top mounted latch or timers.

FURTHER INFORMATION

Discount C10-S12
UL File No. E19223
CSA File No. LR39402-6, LR54517, and LR54520

Contact Ratings

600 Volt Ac Cartridges NEMA A600

Volts	Cont. Current	Max. Current Make	Max. Current Break	Max. VA Make	Max. VA Break
120	10	60	6	7200	720
240	10	30	3	7200	720
480	10	15	1.5	7200	720
600	10	12	1.2	7200	720

Dc Cartridges NEMA P600

Volts	Cont. Current	Max. Current Make or Break	Max. VA Make or Break
125	5	1.1	138
250	5	.55	138
600	5	.20	138

Resistive Load
125V Dc: 3.0 amps
250V Dc: 1.5 amps

Coil Power Requirements
Ac: 96 VA open, 14 VA close
Dc: 14 watts open, 250 volts max.

- Order by catalog number. AR relays listed have 120/110 volt, 60/50 Hz coils, and ARD relays have 120 volt Dc coils.
- If a different coil voltage is required, select the catalog letter from the **Coil Voltage Table** below and substitute it for the SHADED letter in the catalog number.
- AR and ARD relays listed are supplied with NO contacts which are easily converted to NC. If both NO and NC poles are required, order by catalog number. **Example:** 4 pole relay with 1 NO and 3 NC contacts, order **AR413A. Add $12 list** per relay.
- **SCREW Terminals** – For ring-type connectors, add Suffix R to the catalog number. Example: **AR420AR**. No additional charge.
- **OVERLAP Contacts** – Overlap contacts for AR and ARD relays are designed so that a normally open contact closes before the corresponding normally closed contact opens. Overlap contacts come in NO-NC sets of two cartridges. Add catalog letter Suffix S to the catalog number. **Example:** AR420AS. Specify the number of sets required: S for one set and S2 for two sets. **Add $12 list per relay.**

Coil Voltage Table

AR Coils Volts Ac	Hz	Catalog Suffix	ARD Coils Volts Dc	Catalog Suffix
12	60	F	12	D
24	60	I	24	L
48	60	G	48	M
110	60	V	95	B
208	60	B	130	U
240 220	60-50	W	240	T
277	60	C		
440 380	60-50	H		
480 440	60-50	X		
550	60	D		
600 550	60-50	E		

Electrical Components Division
September, 1989

o:\4320w.wmf-1h/081202

INDUSTRIAL CONTROL RELAYS

Types AR 600 Volt Ac, ARD 600 Volt Dc Convertible Contacts

ACCESSORIES

Four Pole Top Deck Adder

- Increases contact capacity from four/six poles to eight/ten poles.
- Mounts on top of basic relay using three screws.
- Will not interfere with wiring, testing or converting cartridges.
- Screw terminals for ring connectors available: to order add Suffix R to catalog number of adder.

List Prices

No. of Pole Spaces	Contacts N.O	Contacts N.C.	Blank Cavities	Catalog Number	List Price
With 600 Volt Ac Cartridges					
4	2	0	2	ARA20	$24
	4	0	0	ARA40	48
With 600 Volt Dc Cartridges					
4	2	0	2	ARDA20	24
	4	0	0	ARDA40	48

ARPT Pneumatic Timer

For AR Relays

- Includes 1 N.O. and 1 N.C. non-convertible timed contacts
- Mounts on basic four or six pole AR Relay. Not for use on Dc.
- Field convertible between On Delay and Off Delay.
- Repeatability accuracy: ±15%

List Prices

Timing Range, Seconds	Catalog Number	List Price
.2-20	ARPT-20	$166
4-60	ARPT-60	166
20-200	ARPT-200	166

ART Solid State Timer

- Mounts on basic four or six pole relay using two screws
- Has one N.O. Solid State Contact.
- On Delay or Off Delay applications
- Will switch 120 volt Ac and Dc coils
- ARTD is field convertible to 24 or 48 volts Dc

List Prices

Voltage	Time Delay, Seconds	Catalog Numbers On Delay	Catalog Numbers Off Delay	List Price
Ac	1-30	ART-ON	ART-OF	$288
Ac	30-60	ART-ONB	ART-OFB	288
Dc	1-30	ARTD-ON	ARTD-OF	288

Electrical Ratings

Input: 120 Volts Ac, ±10%, 50/60 Hz; 120, 48, 24 Volts Dc, ±10%
Power Required: Ac, Dc: 2 VA max.
Contact Ratings: Ac, .2 amps inductive (1.3 amps max. inrush.)
Dc, will switch 4, 8, and 10 pole ARD relays:
48 Volts Dc, .25 amp.
24 Volts Dc, .5 amp.
Repeatability: Ac ±2% with 10% voltage variation, ±7.5% with 15°C temperature variation;
Dc, ±1% with 10% voltage variation, and 15°C temperature variation
Ambient Temp. Range: −20°C to −70°C
Duty Cycle: Ac, Dc: 150 Operations/minute max.
Reset Time: ART and ARTD
On Delay: ART, 50 ms Max; ARTD, 100 ms independent of time setting and duty cycle.
Off Delay: Instantaneous

Contact Ratings: NEMA A600

Ac Volts	Normal Load Break (Amps.)	Inrush and Interrupting Capacity (Amps.)
120	6.0	60
240	3.0	30
480	1.5	15
600	1.2	12

ARML Permanent Magnet Latch

For AR/ARD Relays

By energizing the relay coil, the latch attachment "sets" (when the base relay's armature/crossbar assembly has closed) holding the relay "On", even after the relay coil has been de-energized. The clearing coil on the latch is energized to release the armature/crossbar assembly.

- Field mountable to four and six pole.
- Latch plunger is adjustable.
- Latch coil continuously rated.
- Unlatching power requirement:
  Open Gap: 24 VA
  Closed Gap: 7 VA
  Burden: 4 Watts Ac, 6 Watts Dc

List Prices – Permanent Magnet Latch

For Ac Control Circuits

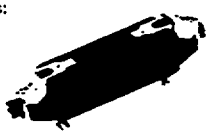
Operating Volts	Coil Hz	Catalog Number	List Price
24	60	ARMLJ	$84
48	60	ARMLG	84
120	60/50	ARMLA	84
240	60/50	ARMLW	84
220	50	ARMLB	84

For Dc Control Circuits

Coil Volts	Catalog Number	List Price
24	ARMLL	$111
48	ARMLM	111
120	ARMLS	111
240	ARMLT	111

ARSS Surge Suppressor

For AR Relays:



- Mounts in contact cavity of AR relays.
- Limits high transient voltages resulting from de-energizing relay coil or other electro-mechanical devices.
- Protects sensitive instruments and solid state devices.
- 120 Volts Ac max. Not for use on Dc.
- For noise suppression, see Cat. No. SS-56 starter-mounted surge suppressor, p. 313.

Catalog Number: ARSS; List Price: $24

Mounting Strip for AR/ARD

No. of Relays 4 Pole	No. of Relays 6 Pole	Catalog Number	List Price
4	2	ARMS4	$12.80

IL 14510, IL 14485: ART, ARTD
IL 14846: ARPT
Renewal Parts, Page 545
Enclosures, Page 375
UL File No. E19223
CSA File No. LR39402-6, LR54517, and LR54520

Electrical Components Division
September, 1989

APPENDIX B - WOG SURVEY DATA SHEETS

APPENDIX B - WOG SURVEY DATA SHEETS

You are requested to complete this data sheet and the attached table in support of a WOG sponsored program. The program objective is to develop a generic technical basis for requesting relaxation of SSPS Slave Relay Test Frequency. The data sheet and the attached table seek to gather any existing data which is indicative of SSPS Slave Relay reliability. The data sheet seeks information applicable to slave relays in both trains. The data table is intended to focus on specific slave relays (See further instructions attached to the data table). Please respond as completely as plant records permit. The data should reflect the operating experience after receipt of the plant operating licensing. (It is assumed that pre-operational testing will have successfully identified/resolved most "infant mortalities".)

Experience data is also requested for Westinghouse type AR and Potter-Brumfield Type MDR relays in other relay applications where operating conditions and demands are similar to those for the SSPS Slave Relays. Use the data table attached. Such data will be meaningful if the following criteria are met.

1. Relays should be normally de-energized.

2. Operating demands are infrequent; once a month or less often (specify).

3. Ambient environment at the relay location is similar to that where the SSPS cabinets are installed (similar temperature and relative humidity).

4. "Housekeeping" in the area where the relays are located should be similar to conditions for the SSPS cabinets. The area should be free from sources of contamination or excessive dust and moisture.

Rev. 1, 5-7-93

SLAVE RELAY TEST DATA SHEET

Should you have any questions or require further clarification of the intent of the data sheet or table, please contact:

B. J. (Bern) Metro (412) 374-5598

G. R. (Jerry) Andre (412) 374-4723

* ** ***** ** *

1. Plant Name: _____

2.1 Date SSPS installed (month/year), if known: _____

2.2 Date of reactor initial criticality (month/year): __

Rev. 1, 5-7-93

SLAVE RELAY TEST DATA SHEET

3.1 Number of SSPS Slave Relays in-service: ____

3.2 All SSPS Slave Relays of same type? Yes _ No _

AR _

MDR _

Other _, Specify _____

3.3 If there was a general replacement of AR relays, supplied as original equipment, with MDR relays, state date of change-out: ____

It is desired that the test experience for both types of relays be reported. Please take care to clearly distinguish AR relay data and MDR relay data in the data table.

4.1 List tests which impact the SSPS slave relays. The list should include all procedures which cause actuation of SSPS slave relays or collect data indicative of the relay condition or environment. The test period should be on a per-relay basis (enter "NO" if not periodic). Test Duration is the time the SSPS is out of service for the test. Describe impact to slave relays (e.g., relay actuates, coil energized but no actuation, contacts continuity verified).

Item No.	Plant Procedure No.	Test Period	Test Duration	Description
__	_____	____	____	_____
__	_____	____	____	_____
__	_____	____	____	_____
__	_____	____	____	_____
__	_____	____	____	_____

Rev. 1, 5-7-93

SLAVE RELAY TEST DATA SHEET

4.2 All SSPS Slave Relays tested with same period? Yes _ No _

In "No", explain. Cite Item number(s) above.

4.3 Routine maintenance/surveillance programs inspect for:

Relay condition or appearance? Yes _ No _

In-Cabinet "housekeeping"? Yes _ No _

If "Yes" to either, please add to list in question 4.1.

4.4 "Failures" of the SSPS slave relays have been observed? Yes _ No _

Complete the table attached, listing all slave relays (include Aux. Safeguards Cabinet, if applicable).

5.1 Is temperature controlled in the area of the SSPS (e.g., via Class 1E HVAC)? Yes _ No _

Range: ___ to ___

5.2 Is the local area temperature monitored and recorded? Yes _ No _

Peak value recorded ___

Rev. 1, 5-7-93

SLAVE RELAY TEST DATA SHEET

5.3 Is the SSPS in-cabinet temperature monitored? Yes _ No _

Range: ___ to ___

Peak value recorded ___

6. Please attach a descriptive summary of any incidents where components in the Safeguards Test Cabinet (STC) have caused inadvertent actuations or plant trips during testing. Include reference to applicable plant documents or LERs

7. Please identify person(s) to be contacted if clarification is necessary.

Name: _____ Phone No.: _____

Name: _____ Phone No.: _____

Mail to:

Bill Schivley (ECE MS 4-01)

P.O. Box 355

Pittsburgh, PA 15230-0355

Fax to: (412) 374-5139

Rev. 1, 5-7-93

SLAVE RELAY TEST DATA SHEET

SLAVE RELAY DATA TABLE sheet _ of _

Plant/Utility Name: _____ Contact: _____

RELAY ID (1)	RELAY TYPE (2)	RELAY COIL (3)	INSTALLED/REPAIRED/ REPLACED (4)	TEST PERIOD (5)	TEST TYPE (6)	TOTAL ACTUA-TIONS (7)	FAILURES (8)	ROOT CAUSE (9)	NOTES (10)	REFS (11)

Mail to: , P.O. Box 355, Pittsburgh, PA 15230-0355 - Fax to:

SLAVE RELAY TEST DATA SHEET

INSTRUCTIONS FOR DATA TABLE

Ideal data would be specific to each of the SSPS slave relay by Tag/ID numbers (See SSPS Technical Manual). Answer as completely as possible. Please identify any data "estimated" by circling. If relay replacements have occurred, such should be identified in Column (4); see instruction (4) below.

Questions or requests for clarification on the data sheet or table, please contact:

(1) Preferred response consists of Relay ID Number (refer to Tech Manual schematic) and Train A or B; i.e., K624-A.

At minimum, enter the quantity of relays for which all other items of the line apply identically.

(2) Enter: "A" for AR relays: "A4" for AR440 or "A8" for AR880; add "L" for latching relays (e.g., A4L = AR440 relay with latch). "M" for MDR rotary relays; "ML" for MDRs with latch; specify 4 or 8 contact types (e.g., M4L = a 4-contact MDR with latch). Any others, please specify. SSPS MDRs are the "small" variety, outside the SSPS MDRs may be the "medium" with up to 16 contacts. Use Notes, as necessary.

(3) Please specify the relay coil type and state (during normal plant operation), as follows (e.g., AC-NE = an AC coil relay normally energized during plant operation).

Enter: "AC" for AC current coils
"DC" for DC current coils

Enter: "ND" for normally de-energized coils
"NE" for normally energized
"NX" for normally de-energized; but energized during plant shutdown. (Please specify cumulative outage time relay energized in NOTES.

(4) Enter "X" for relays that are original equipment. If relay was replaced, enter date (month/year) on following line and respond in any columns that apply since the new relay was installed. State whether the relay or a part was repaired or replaced. Recall that the objective is to gather data after issuance of the plant operating license. Use Notes to provide details.

SLAVE RELAY TEST DATA SHEET

INSTRUCTIONS FOR DATA TABLE (cont.)

(5) Enter number of months between periodic tests (e.g., "4"). Enter "R" if relay(s) are tested only during plant/refueling outage.

(6) Enter: "G" for "Go" testing, or
"B" for "Block" testing.

Also add notes identifying equipment actuated via the slave relay.

(7) Total actions should include all experienced since issuance of operating license to date or until failure/replacement. This is to include any actuations which have involved other system tests which result in slave relay actuations and any due to plant trips.

(8) Failures should be characterized as one of the following:
"A" Did not actuate on demand.
"L" Did not latch when actuated.
"UL" Did not unlatch when reset.
"CO" Contact(s) did not make.
"CI" Contact(s) intermittence.
"N" None apply; add Notes (9) to describe.

(9) Root causes should be characterized as one of the following:
"U" if unknown or not determined.
"X" Failure was not in relay, but due to other circuit problem. Specify in Notes.
"B" Binding of the relay; "BD" if caused by dirt or debris;
"BM" Binding of an MDR relay due to coil outgassing/corrosion product accumulation (See NRC IN 92-04)
"O" Relay coil failed open or short.
"CA" Contact alignment
"CW" Contact wear; note if corroded (CWC), pitted (CWP), or high resistance (CWR)
"CF" Contacts fused or welded; "CFL" if due to excessive loading of contacts.
"LA" Latch alignment (poor or needed)
"LR" Latch reset coil open or shorted
"M" Latch magnet would not "hold" (AR-type relays)
"S" Return spring broken or misaligned
"N" None apply; add Notes (9) to describe.

SLAVE RELAY TEST DATA SHEET

INSTRUCTIONS FOR DATA TABLE (cont.)

(10) Compile notes on separate sheet and attach. Make reference to all LERs or other documents which provide details.

(11) Enter applicable reference numbers. Compile list of references and attach.

APPENDIX C - Type ARD Failure at North Anna

MI 11291 Q ROBERTS (VAP) 23-JUL-93 14:05 EDT

Subject: "REQUEST FOR INFORMATION ON WESTINGHOUSE ARD RELAY FAILURES"

North Anna Power Station recently experienced a failure of two normally energized Westinghouse ARD relays, model number ARD440V. This failure has occurred once at North Anna. This failure seems to be different from ARD relay failures previously reported in NRC IEIN IN 88-88-S1, Westinghouse VRA 91-094 and VRA 92-003 for sand-based and epoxy-based potting compounds.

The following was observed in the field and repeated during a benchtest. After maintenance, the relays were re-energized. However, the travel of the metal plug that inserts into the coil when the relay is energized was impeded. Therefore, little or no movement of the armature/cross bar assembly occurred and the relay contacts were not made. These two failed relays were original equipment with the plant. Therefore, they were energized for the majority of the time since the plant came on line 15 years ago.

A possible failure mechanism which could cause this event is the coil being plastically deformed over a long time by heat and gravity to an out of circular shape. After an ARD relay is de-energized, for a long time, the coil insulation material cools down to room temperature and contracts. Because plastic deformation has taken place, the coil inner shape is now oval. Hence, when the relay is re-energized, the plug is blocked from going into the coil.

Please review this event to determine if any similar events have occurred at your plant. Thank you in advance.

Information Contact: R.C. SIMPSON, STA, (703) 894-2628 OR FAX -2830

APPENDIX D - Arrhenius Equation for Aging at One or More Temperatures

Assuming that the accelerated thermal aging process expressed by the Arrhenius Model correctly simulates the change in properties due to aging at a different temperature than the accelerated aging temperature, then:

$$t_s \exp(-E/KT_s) = t_o \exp(-E/KT_o) \qquad \text{(E1)}$$

where:

t_s	=	total service life at temperature T_s
exp	=	base of natural log (2.71828)
t_o	=	time at temperature T_o (accelerated aging temperature)
T_s	=	material temperature at total service life conditions (°K)
T_o	=	material temperature at accelerated aging conditions (°K)
E	=	material activation energy (eV) for property of interest
K	=	Boltzmann's Constant (8.62E-05)

The total service life (t_s) may be split into two time periods at different temperatures:

$$f_{s1}\, t_s \exp(-E/KT_{s1}) + f_{s2}\, t_s \exp(-E/KT_{s2}) = t_o \exp(-E/KT_o) \qquad \text{(E2)}$$

where:

f_s	=	fraction of total service life (t_s) at defined temperature

The above equation E2 is useful in calculating the total service life (t_s) based on known accelerated aging test parameters and a defined duty cycle, e.g., energized fraction f_{s1} and deenergized fraction f_{s2}. Solving for t_s:

$$t_s = t_o/(f_{s1} \exp((-E/K)(1/T_{s1} - 1/T_o)) + f_{s2} \exp((-E/K)(1/T_{s2} - 1/T_o))) \qquad \text{(E3)}$$

The above equation E3 may be expanded to include multiple fractions of the service life or used to determine the required aging time (t_o) for a test when other parameters are known or defined, e.g., t_s could be defined.

APPENDIX E - CORRESPONDENCE

Westinghouse Electric Company LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

August 15, 2000

AW-00-1413

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

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", WCAP-13877, Rev. 2-P-A, (Proprietary) August 2000

Dear Mr. Collins:

The application for withholding is submitted by Westinghouse Electric Company LLC, pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.790, Affidavit AW-00-1413 accompanies this application for withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-00-1413 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosure

cc: S. Bloom, NRR/OWFN/DRPW/PDIV2 (Rockville, MD) 1L, 1A

AW-00-1413

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC, and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 21st day
of August, 2000

Lorraine M. Piplica

Notary Public

Notarial Seal
Lorraine M. Piplica, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Dec. 14, 2003
Member, Pennsylvania Association of Notaries

0531s.doc

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Business Unit of the Westinghouse Electric Company LLC and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Nuclear Services Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Nuclear Services Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(g) The information is not the property of Westinghouse but must be treated as proprietary by Westinghouse according to agreements with the Owner.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", WCAP-13877, Rev. 2-P-A, August 2000 being transmitted by Westinghouse Letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention Mr. Samuel J. Collins. The proprietary information as submitted by Westinghouse is expected to be applicable in licensee submittals in response to certain NRC requirements.

This information is part of that which will enable Westinghouse to:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar calculation, evaluation and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing tests.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (g) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(g) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

COPYRIGHT NOTICE

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Westinghouse Electric Company LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

November 9, 1999

AW-99-1369

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

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

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

Dear Mr. Collins:

The application for withholding is submitted by Westinghouse Electric Company LLC, pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.790, Affidavit AW-99-1369 accompanies this application for withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-99-1369 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosure

cc: T. Carter/NRC (5E7)

0348s.doc

AW-99-1369

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC, and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 10th day
of November, 1999

Notarial Seal
Janet A. Schwab, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires May 22, 2000
Member, Pennsylvania Association of Notaries

Notary Public

JANET A. SCHWAB
COMMONWEALTH OF PENNSYLVANIA
NOTARY PUBLIC

0348s.doc

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Business Unit of the Westinghouse Electric Company LLC and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Nuclear Services Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Nuclear Services Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(g) The information is not the property of Westinghouse but must be treated as proprietary by Westinghouse according to agreements with the Owner.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", WCAP-13877, Rev. 2-P, October 1999 being transmitted by Westinghouse Letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention Mr. Samuel J. Collins. The proprietary information as submitted by Westinghouse is expected to be applicable in licensee submittals in response to certain NRC requirements.

This information is part of that which will enable Westinghouse to:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar calculation, evaluation and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing tests.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (g) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(g) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

COPYRIGHT NOTICE

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Westinghouse Electric Company,
a division of CBS Corporation

Box 355
Pittsburgh Pennsylvania 15230-0355

February 2, 1999

CAW-99-1319

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

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", WCAP-13877, Rev. 1-P-A, January 1999

Dear Mr. Collins:

The application for withholding is submitted by Westinghouse Electric Company, a division of CBS Corporation ("Westinghouse"), pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10 CFR Section 2.790, Affidavit CAW-99-1319 accompanies this application for withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference CAW-99-1319 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosure

cc: T. Carter/NRC (5E7)

CAW-99-1319

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company, a division of CBS Corporation ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 2nd day
of February, 1999

Notary Public

Notarial Seal
Janet A. Schwab, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires May 22, 2000
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Division, of the Westinghouse Electric Company, a division of CBS Corporation ("Westinghouse"), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures

a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(g) The information is not the property of Westinghouse but must be treated as proprietary by W according to agreements with the Owner.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", WCAP-13877, Rev. 1-P-A, January 1999 for Watts Bar Units 1 and 2, being transmitted by Tennessee Valley Authority letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention Mr. Samuel J. Collins. The proprietary information as submitted for use by Tennessee Valley Authority for Watts Bar Units 1 and 2 is expected to be applicable in other licensee submittals in response to certain NRC requirements.

This information is part of that which will enable Westinghouse to:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar calculation, evaluation and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing tests.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (g) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(g) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

COPYRIGHT NOTICE

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 30, 1998

RECEIVED
Site Licensing
JAN 7 1999
2591
Watts Bar Nuclear Plant

Mr. J. A. Scalice
Chief Nuclear Officer and
Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: ISSUANCE OF AMENDMENT ON SLAVE RELAY SURVEILLANCE INTERVAL (TAC NO. M94425)

Dear Mr. Scalice:

The Commission has issued the enclosed Amendment No. 17 to Facility Operating License No. NPF-90 for Watts Bar Nuclear Plant, Unit 1. This amendment is in response to your application dated February 28, 1996, as supplemented October 2 and December 12, 1997, March 30 and December 11, 1998. The February 28, 1996 letter proposed to extend the surveillance interval for Westinghouse type AR relays with alternating current and direct current coils from quarterly to an 18 month interval. The letter of December 11, 1998 revised the scope of the application such that it now applies only to Westinghouse type AR relays which use alternating current coils. Accordingly, this amendment approves the extension of the surveillance interval only for Westinghouse type AR relays which use alternating current coils.

A copy of the safety evaluation is also enclosed. Notice of issuance will be included in the Commission's biweekly Federal Register notice.

Sincerely,

Robert Martin

Robert E. Martin, Senior Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosures: 1. Amendment No. 17 to NPF-90
2. Safety Evaluation

cc w/enclosures: See next page

Mr. J. A. Scalice
Tennessee Valley Authority

cc:
Senior Vice President
Nuclear Operations
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Jack A. Bailey, Vice President
Engineering & Technical
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Richard T. Purcell, Site Vice President
Watts Bar Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Spring City, TN 37381

General Counsel
Tennessee Valley Authority
ET 10H
400 West Summit Hill Drive
Knoxville, TN 37902

Mr. Raul R. Baron, General Manager
Nuclear Assurance
Tennessee Valley Authority
5M Lookout Place
1101 Market Street
Chattanooga, TN 37402-2801

Mr. Mark J. Burzynski, Manager
Nuclear Licensing
Tennessee Valley Authority
4X Blue Ridge
1101 Market Street
Chattanooga, TN 37402-2801

WATTS BAR NUCLEAR PLANT

Mr. Paul L. Pace, Manager
Licensing
Watts Bar Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Spring City, TN 37381

Mr. William R. Lagergren, Plant Manager
Watts Bar Nuclear Plant
Tennessee Valley Authority
P.O. Box 2000
Spring City, TN 37381

Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
61 Forsyth Street, SW., Suite 23T85
Atlanta, GA 30303-3415

Senior Resident Inspector
Watts Bar Nuclear Plant
U.S. Nuclear Regulatory Commission
1260 Nuclear Plant Road
Spring City, TN 37381

County Executive
Rhea County Courthouse
Dayton, TN 37321

County Executive
Meigs County Courthouse
Decatur, TN 37322

Mr. Michael H. Mobley, Director
TN Dept. of Environment & Conservation
Division of Radiological Health
3rd Floor, L and C Annex
401 Church Street
Nashville, TN 37243-1532

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

TENNESSEE VALLEY AUTHORITY

DOCKET NO. 50-390

WATTS BAR NUCLEAR PLANT, UNIT 1

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No. 17
License No. NPF-90

1. The Nuclear Regulator Commission (the Commission) has found that:

   A. The application for amendment by Tennessee Valley Authority (the licensee) dated February 28, 1996, as supplemented October 2 and December 12, 1997, March 30 and December 11, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Facility Operating License No. NPF-90 is hereby amended to read as follows:

(2) Technical Specifications and Environmental Protection Plan

The Technical Specifications contained in Appendix A, as revised through Amendment No. 17 , and the Environmental Protection Plan contained in Appendix B, both of which are attached hereto, are hereby incorporated into this license. TVA shall operate the facility in accordance with the Technical Specifications and the Environmental Protection Plan.

3. This license amendment is effective as of the date of its issuance, to be implemented prior to startup following the second refueling outage. The licensee shall perform, as discussed in the licensee's submittal dated October 2,1997, a plant specific aging assessment for all normally energized and periodically energized Type AR slave relays to determine a service life which satisfies the recommendations and guidance set forth in the topical report, WCAP-13877, prior to completion of the second refueling outage. The licensee shall revise, as discussed in the licensee's submittal dated March 30, 1998, the Watts Bar Nuclear Plant Technical Instruction TI-119, "Maintenance Rule Performance Indicator Monitoring, Trending, and Reporting," Attachment 30, Reactor Protection System (099), to require that the surveillance interval be evaluated and reduced, when needed, if two or more Westinghouse Type AR relays fail within a 12-month interval, prior to completion of the second refueling outage.

FOR THE NUCLEAR REGULATORY COMMISSION

Frederick J. Hebdon

Frederick J. Hebdon, Director
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Technical
Specifications

Date of Issuance: December 30, 1998

ATTACHMENT TO AMENDMENT NO. 17

FACILITY OPERATING LICENSE NO. NPF-90

DOCKET NO. 50-390

Revise the Appendix A Technical Specifications by removing the pages identified below and inserting the enclosed pages. The revised pages are identified by the captioned amendment number and contain marginal lines indicating the area of change.

Remove Pages	Insert Pages
3.3-32	3.3-32
3.3-55	3.3-55
B 3.3-116	B 3.3-116
B 3.3-120	B 3.3-120
B 3.3 162	B 3.3-162

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.3.2.5	----------NOTE---------- Slave relays tested by SR 3.3.2.7 are excluded from this surveillance. ---------- Perform SLAVE RELAY TEST.	92 days OR 18 months for Westinghouse type AR relays
SR 3.3.2.6	----------NOTE---------- Verification of relay setpoints not required. ---------- Perform TADOT.	92 days
SR 3.3.2.7	Perform SLAVE RELAY TEST on slave relays K603A, K603B, K604A, K604B, K607A, K607B, K609A, K609B, K612A, K625A, and K625B.	18 months
SR 3.3.2.8	----------NOTE---------- Verification of setpoint not required. ---------- Perform TADOT.	18 months
SR 3.3.2.9	----------NOTE---------- This Surveillance shall include verification that the time constants are adjusted to the prescribed values. ---------- Perform CHANNEL CALIBRATION.	18 months

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.2.4 (continued)

The Frequency of 92 days is justified in Reference 7, except for Function 7. The Frequency for Function 7 is justified in Reference 10.

SR 3.3.2.5

SR 3.3.2.5 is the performance of a SLAVE RELAY TEST. The SLAVE RELAY TEST is the energizing of the slave relays. Contact operation is verified in one of two ways. Actuation equipment that may be operated in the design mitigation MODE is either allowed to function, or is placed in a condition where the relay contact operation can be verified without operation of the equipment. Actuation equipment that may not be operated in the design mitigation MODE is prevented from operation by the SLAVE RELAY TEST circuit. For this latter case, contact operation is verified by a continuity check of the circuit containing the slave relay. This test is performed every 92 days. The Frequency is adequate, based on industry operating experience, considering instrument reliability and operating history data.

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays with AC coils. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 13.

This SR is modified by a Note, which states that performance of this test is not required for those relays tested by SR 3.3.2.7.

SR 3.3.2.6

SR 3.3.2.6 is the performance of a TADOT every 92 days. This test is a check of the Loss of Offsite Power (Function 6.d), AFW Pump Suction Transfer on Suction Pressure-Low for motor driven and turbine driven pumps (Functions 6.f and 6.g respectively), and Turbine Trip and Feedwater Isolation - Main Steam Valve Vault Rooms Water Level - High (Function 5.d).

The SR is modified by a Note that excludes verification of setpoints for relays. Relay setpoints require elaborate bench calibration and are verified during CHANNEL CALIBRATION. The Frequency is adequate. It is based on industry operating experience, considering instrument reliability and operating history data.

(continued)

BASES

REFERENCES (continued)

6. WCAP-12096. Rev. 7. "Westinghouse Setpoint Methodology for Protection System. Watts Bar 1 and 2." March 1997.

7. WCAP-10271-P-A. Supplement 1 and Supplement 2. Rev. 1. "Evaluation of Surveillance Frequencies and Out of Service Times for the Reactor Protection Instrumentation System." and "Evaluation of Surveillance Frequencies and Out of Service Times for the Engineered Safety Features Actuation System." May 1986 and June 1990.

8. Watts Bar Technical Requirements Manual. Section 3.3.2. "Engineered Safety Feature Response Times."

9. TVA Letter to NRC. November 9. 1984. "Request for Exemption of Quarterly Slave Relay Testing. (L44 841109 808)."

10. Evaluation of the applicability of WCAP-10271-P-A. Supplement 1. and Supplement 2. Revision 1. to Watts Bar.

11. Westinghouse letter to TVA (WAT-D-8347). September 25. 1990. "Charging/Letdown Isolation Transients" (T33 911231 810).

12. Design Change Notice W-38238 associated documentation.

13. WCAP-13877. Rev. 1. "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays." August 1998.

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.6-1 to determine which SRs apply for each Containment Vent Isolation Function.

SURVEILLANCE		FREQUENCY
SR 3.3.6.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.6.2	Perform ACTUATION LOGIC TEST.	31 days on a STAGGERED TEST BASIS
SR 3.3.6.3	Perform MASTER RELAY TEST.	31 days on a STAGGERED TEST BASIS
SR 3.3.6.4	Perform COT.	92 days
SR 3.3.6.5	Perform SLAVE RELAY TEST.	92 days OR 18 months for Westinghouse type AR relays
SR 3.3.6.6	----------NOTE---------- Verification of setpoint is not required. ---------- Perform TADOT.	18 months
SR 3.3.6.7	Perform CHANNEL CALIBRATION.	18 months

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.6.5 (continued)

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in Reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays with AC coils. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 3.

SR 3.3.6.6

SR 3.3.6.6 is the performance of a TADOT. This test is a check of the Manual Actuation Functions and is performed every 18 months. Each Manual Actuation Function is tested up to, and including, the master relay coils. In some instances, the test includes actuation of the end device (i.e., pump starts, valve cycles, etc.).

For these tests, the relay trip setpoints are verified and adjusted as necessary. The Frequency is based on the known reliability of the Function and the redundancy available, and has been shown to be acceptable through operating experience.

The SR is modified by a Note that excludes verification of setpoints during the TADOT. The Functions tested have no setpoints associated with them.

SR 3.3.6.7

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy.

The Frequency is based on operating experience and is consistent with the typical industry refueling cycle.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."

2. NUREG-1366, "Improvement to Technical Specification Surveillance Requirements," December 1992.

3. WCAP-13877, Rev. 1, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," August 1998.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 17 TO FACILITY OPERATING LICENSE NO. NPF-90

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

1.0 INTRODUCTION

By letter dated February 28, 1996, as supplemented October 2 and December 12, 1997, March 30 and December 11, 1998, the Tennessee Valley Authority (TVA or the licensee) submitted a request for changes to the Watts Bar Nuclear Plant (WBN), Unit 1, Technical Specifications (TSs). The February 28, 1996 letter proposed to extend the surveillance interval for Westinghouse type AR relays with alternating current (ac) and direct current (dc) coils from quarterly to an 18 month interval. The letter of December 11, 1998 revised the scope of the application such that it now applies only to Westinghouse type AR relays which use ac coils. Accordingly, this amendment approves the extension of the surveillance interval only for Westinghouse type AR relays which use ac coils. The October 2 and December 12, 1997, March 30 and December 11, 1998, letters provided clarifying information that did not change the initial proposed no significant hazards consideration determination.

2.0 BACKGROUND

TVA's letter of February 28, 1996, submitted proposed TS changes for WBN, Unit 1, as a lead plant, based on generic Westinghouse Owners Group (WOG) topical reports, as discussed below. The proposal, as modified by TVA's letter of December 11, 1998 would allow a test interval extension for Westinghouse Type AR relays used as slave relays which use ac coils. Currently at WBN and other Westinghouse plants, slave relays for the Engineered Safety Features Actuation System (ESFAS) are tested quarterly with the exception of some relays which were previously approved by the U.S. Nuclear Regulatory Commission (NRC or Commission) to be tested every 18 months. The proposed changes to the TSs would extend the test interval for all Westinghouse Type AR slave relays in WBN's ESFAS to 18 months. In order to justify these changes, TVA provided generic

ENCLOSURE

Westinghouse Topical Report WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays," dated June 1994. In addition to this Topical Report the WOG submitted Westinghouse Topical Report WCAP-13900, "Extension of Slave Relay Surveillance Test Interval," dated April 1994.

Following review of the above topical reports, the NRC staff, by letter dated September 3, 1996 requested additional information and TVA responded by letters dated October 2, 1997 and December 12, 1997. A further request for additional information (RAI) was submitted to TVA by letter dated January 27, 1998, and TVA responded by letter dated March 30, 1998, which included revised pages to WCAP-13877. The WOG by letter dated September 1, 1998, submitted Rev. 1 to WCAP-13877 incorporating these revisions. The staff, by letter dated October 26, 1998, accepted and issued a Safety Evaluation (SE) to the WOG finding the above topical reports acceptable with the requirement that each licensee address the following plant specific items:

1. Confirm the applicability of the WCAP-13877, analyses to their plant.

2. Ensure that the contact loading analysis for the Type AR relays has been performed to determine the acceptability of these relays.

3. Determine the qualified life for the Type AR relays based on plant specific environmental conditions.

4. Establish a program to evaluate the adequacy of the proposed test interval if two or more AR relays fail in a 12-month period.

3.0 EVALUATION

The licensee, in submittals dated October 2, 1997, December 12, 1997, and March 30, 1998, addressed each of the above plant specific items and the staff evaluation is discussed below:

1. TVA, in the letter dated October 2, 1997, confirmed the applicability of the topical report to WBN for the Type AR relays with ac coils and further proposed to extend the applicability of the topical report to Type AR relays with dc coils, used as interposing relays at WBN. The staff, in a telephone conference with TVA and Westinghouse on November 7, 1998, identified that additional information would be necessary in order to determine applicability of the topical report to relays with dc coils. Subsequently, by letter dated December 11, 1998, TVA revised the scope of its proposed license amendment request such that it is only applicable to Westinghouse type AR relays which use ac coils. Based on this, the staff considers that the licensee submittal has adequately addressed the applicability of the topical report to WBN.

2. TVA's letter dated December 12, 1997 provided the results of contact loading analysis which concluded that the ESFAS slave relay contacts are adequate for their applications and will not be subjected to long term degradation. Based on this, the staff finds that TVA has adequately addressed the staff's concern regarding contact loading of AR relays.

3. TVA's letter dated October 2,1997, committed, in response to question 11, to perform a plant specific aging assessment for all normally energized and periodically energized Type AR slave relays to determine a service life which satisfies the recommendations and guidance set forth in the topical report, WCAP-13877. TVA has committed to complete this assessment prior to completion of the second refueling outage. The staff considers TVA's commitment acceptable based on the fact that the generic service life in the topical report for these relays has been established as 19 years and all relays should be replaced if any relay fails after 14 years.

4. TVA's letter dated March 30, 1998, committed, in its response to RAI question 4, to revise the WBN Technical Instruction TI-119, "Maintenance Rule Performance Indicator Monitoring, Trending, and Reporting," Attachment 30, Reactor Protection System (099), prior to implementation of the approved TS changes, to require that the surveillance interval be evaluated and reduced, when needed, if two or more Westinghouse Type AR relays fail within a 12-month interval. As discussed with TVA representatives on December 15 and 16, 1998, this implementation date will be consistent with the implementation of the license amendment, which is prior to completion of the second refueling outage. The staff finds TVA's commitment acceptable.

Summary

Based on the review of the WCAP-13877, Rev. 1, WCAP-13900, Rev. 0, and the licensee's submittals referencing these topical reports, the staff concludes that the proposed test interval extension to 18 months for Westinghouse Type AR relays with ac coils used in ESFAS slave relays applications is justified for WBN. This test interval extension does not apply to Westinghouse Type AR relays with dc coil relays. Therefore, the licensee's TS changes are acceptable for Westinghouse Type AR relays with ac coil.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Tennessee State official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes surveillance requirements. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (61 FR 15998 dated April 10, 1996). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: H. Garg

Date: December 30, 1998

T04 981211 625

DEC 11 1998

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

Gentlemen:

In the Matter of)
Tennessee Valley Authority)

Docket No. 50-390

WATTS BAR NUCLEAR PLANT (WBN) - UNIT 1 - SCOPE REVISION PERTAINING TO THE PROPOSED LICENSE AMENDMENT FOR SLAVE RELAY TEST FREQUENCY (TAC MA4425)

The purpose of this letter is to revise the scope of TVA's proposed license amendment request such that the proposed change to the WBN Technical Specifications is only applicable to Westinghouse type AR relays which use alternating current (AC) coils.

TVA's original amendment request dated February 28, 1996, proposed an extension of the surveillance frequency for Westinghouse type AR relays used as SSPS slave relays or auxiliary (interposing) relays from quarterly to a refueling outage frequency. The proposed change was based on Westinghouse topical report WCAP-13877, "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays." Subsequently, on September 3, 1996, the NRC issued a Request for Additional Information for the proposed amendment requesting, in part, that TVA demonstrate the applicability of WCAP-13877 to WBN. TVA's reply dated October 2, 1997, stated the WCAP can be applied to all Westinghouse type AR relays used in the SSPS slave relay application and can also be applied to certain other models in the type AR product line, including a majority of ARD relays (DC coils) which are not used in the SSPS

cabinets, but are used in interposing relay applications. As stated in WCAP-13877, the type ARD relay is a member of the type AR relay family and the analysis can be applied to all type AR relays, with exceptions noted.

During a November 1998 telecon with NRC and Westinghouse, NRC Staff noted that additional failure information and plant-specific data were needed in order to complete their review of the ARD relays if used in the proposed amendment request for the surveillance extension. Although WBN plant-specific ARD relay application data is readily available, TVA has determined that the balance of information needed for the Staff's review will require collection and analysis of additional survey data from WOG utilities. Should TVA decide to pursue this with the other utilities, a separate licensing action will be initiated.

Therefore, TVA requests that the NRC withdraw the ARD relay from consideration in the proposed amendment request. TVA's proposed amendment request will continue to apply to Westinghouse type AR relays with AC coils used in both SSPS slave relay and interposing relay applications, but will not include any DC relay applications at this time. This revised scope has been reflected in markups of the original proposed text for Technical Specification Bases Surveillance Requirements (SR) 3.3.2.5 and SR 3.3.6.5, which also reflect the current revision level of WCAP-13877 (Revision 1, August 1998). These markups are provided in Enclosure 1. Enclosure 2 forwards the revised TS Bases pages which incorporate the marked-up information.

If you have any questions concerning this matter, please call me at (423) 365-1824.

Sincerely,

P. L. Pace
Site Licensing and Industry Affairs

Enclosure

DEC 1 1 1998

PLP:CWT
cc (Enclosure):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. Robert E. Martin, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

J. S. Adams, BR 3H-C
J. A. Bailey, LP 6A-C
R. R. Baron, LP 5M-C
M. J. Burzynski, BR 4X-C
E. S. Christenbury, ET 10A-K
C. C. Cross, LP 3B-C
W. R. Lagergren, MOB 2R-WBN
J. E. Maddox, EQB 1A-WBN
NSRB Support, LP 5M-C
L. V. Parscale, ADM 1B-WBN
J. A. Scalice, LP 6A-C
S. W. Spencer, EQB 2V-WBN
Sequoyah Licensing Files, OPS 4C-SQN
R. J. Vander Grift, EQB 2W-WBN
T. L. Huskey, ADM 1B-WBN
EDMS, WT 3B-K

S:\lrouse\submit\SLAVE RELAY LETTER.CWT

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

REVISED PROPOSED TECHNICAL SPECIFICATION BASES
MARKED-UP PAGES

I. AFFECTED PAGE LIST

B 3.3-116
B 3.3-120
B 3.3-162

II. MARKED-UP PAGES

ATTACHED

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.2.4 (continued)

The Frequency of 92 days is justified in Reference 7, except for Function 7. The Frequency for Function 7 is justified in Reference 10.

SR 3.3.2.5

SR 3.3.2.5 is the performance of a SLAVE RELAY TEST. The SLAVE RELAY TEST is the energizing of the slave relays. Contact operation is verified in one of two ways. Actuation equipment that may be operated in the design mitigation MODE is either allowed to function, or is placed in a condition where the relay contact operation can be verified without operation of the equipment. Actuation equipment that may not be operated in the design mitigation MODE is prevented from operation by the SLAVE RELAY TEST circuit. For this latter case, contact operation is verified by a continuity check of the circuit containing the slave relay. This test is performed every 92 days. The Frequency is adequate, based on industry operating experience, considering instrument reliability and operating history data.

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays with AC coils may require periodic replacement in accordance with the guidance given in Reference 13.

This SR is modified by a Note, which states that performance of this test is not required for those relays tested by SR 3.3.2.7.

SR 3.3.2.6

SR 3.3.2.6 is the performance of a TADOT every 92 days. This test is a check of the Loss of Offsite Power (Function 6.d), AFW Pump Suction Transfer on Suction Pressure—Low for motor driven and turbine driven pumps (Functions 6.f and 6.g respectively), and Turbine Trip and Feedwater Isolation - Main Steam Valve Vault Rooms Water Level - High (Function 5.d).

(continued)

BASES

REFERENCES (continued)

6. WCAP-12096, Rev. 6, "Westinghouse Setpoint Methodology for Protection System, Watts Bar 1 and 2," May 1994.

7. WCAP-10271-P-A, Supplement 1 and Supplement 2, Rev. 1, "Evaluation of Surveillance Frequencies and Out of Service Times for the Reactor Protection Instrumentation System," and "Evaluation of Surveillance Frequencies and Out of Service Times for the Engineered Safety Features Actuation System." May 1986 and June 1990.

8. Watts Bar Technical Requirements Manual, Section 3.3.2, "Engineered Safety Feature Response Times."

9. TVA Letter to NRC, November 9, 1984, "Request for Exemption of Quarterly Slave Relay Testing, (L44 841109 808)."

10. Evaluation of the applicability of WCAP-10271-P-A, Supplement 1, and Supplement 2, Revision 1, to Watts Bar.

11. Westinghouse letter to TVA (WAT-D-8347), September 25, 1990, "Charging/Letdown Isolation Transients" (T33 911231 810).

12. Design Change Notice W-38238 associated documentation.

13. WCAP-13877, Rev. ~~0~~ 1, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," ~~January 1994.~~ August 1998.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.6.5 (continued)

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays with AC coils may require periodic replacement in accordance with the guidance given in Reference 3.

SR 3.3.6.6

SR 3.3.6.6 is the performance of a TADOT. This test is a check of the Manual Actuation Functions and is performed every 18 months. Each Manual Actuation Function is tested up to, and including, the master relay coils. In some instances, the test includes actuation of the end device (i.e., pump starts, valve cycles, etc.).

For these tests, the relay trip setpoints are verified and adjusted as necessary. The Frequency is based on the known reliability of the Function and the redundancy available, and has been shown to be acceptable through operating experience.

The SR is modified by a Note that excludes verification of setpoints during the TADOT. The Functions tested have no setpoints associated with them.

SR 3.3.6.7

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy.

The Frequency is based on operating experience and is consistent with the typical industry refueling cycle.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."

2. NUREG-1366, "Improvement to Technical Specification Surveillance Requirements," December 1992.

3. WCAP-13877, Rev. ~~0~~ 1, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," ~~January 1994~~ August 1998.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

REVISED PROPOSED TECHNICAL SPECIFICATION BASES
REVISED PAGES

I. AFFECTED PAGE LIST

B 3.3-116
B 3.3-120
B 3.3-162

II. REVISED PAGES

ATTACHED

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.2.4 (continued)

The Frequency of 92 days is justified in Reference 7, except for Function 7. The Frequency for Function 7 is justified in Reference 10.

SR 3.3.2.5

SR 3.3.2.5 is the performance of a SLAVE RELAY TEST. The SLAVE RELAY TEST is the energizing of the slave relays. Contact operation is verified in one of two ways. Actuation equipment that may be operated in the design mitigation MODE is either allowed to function, or is placed in a condition where the relay contact operation can be verified without operation of the equipment. Actuation equipment that may not be operated in the design mitigation MODE is prevented from operation by the SLAVE RELAY TEST circuit. For this latter case, contact operation is verified by a continuity check of the circuit containing the slave relay. This test is performed every 92 days. The Frequency is adequate, based on industry operating experience, considering instrument reliability and operating history data.

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays with AC coils. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 13.

This SR is modified by a Note, which states that performance of this test is not required for those relays tested by SR 3.3.2.7.

SR 3.3.2.6

SR 3.3.2.6 is the performance of a TADOT every 92 days. This test is a check of the Loss of Offsite Power (Function 6.d), AFW Pump Suction Transfer on Suction Pressure-Low for motor driven and turbine driven pumps (Functions 6.f and 6.g respectively), and Turbine Trip and Feedwater Isolation - Main Steam Valve Vault Rooms Water Level - High (Function 5.d).

The SR is modified by a Note that excludes verification of setpoints for relays. Relay setpoints require elaborate bench calibration and are verified during CHANNEL CALIBRATION. The Frequency is adequate. It is based on industry operating experience, considering instrument reliability and operating history data.

(continued)

BASES

REFERENCES (continued)

6. WCAP-12096, Rev. 7, "Westinghouse Setpoint Methodology for Protection System, Watts Bar 1 and 2," March 1997.

7. WCAP-10271-P-A, Supplement 1 and Supplement 2, Rev. 1, "Evaluation of Surveillance Frequencies and Out of Service Times for the Reactor Protection Instrumentation System," and "Evaluation of Surveillance Frequencies and Out of Service Times for the Engineered Safety Features Actuation System," May 1986 and June 1990.

8. Watts Bar Technical Requirements Manual, Section 3.3.2, "Engineered Safety Feature Response Times."

9. TVA Letter to NRC, November 9, 1984, "Request for Exemption of Quarterly Slave Relay Testing, (L44 841109 808)."

10. Evaluation of the applicability of WCAP-10271-P-A, Supplement 1, and Supplement 2, Revision 1, to Watts Bar.

11. Westinghouse letter to TVA (WAT-D-8347), September 25, 1990, "Charging/Letdown Isolation Transients" (T33 911231 810).

12. Design Change Notice W-38238 associated documentation.

13. WCAP-13877, Rev. 1, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," August 1998.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.6.5 (continued)

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in Reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays with AC coils. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 3.

SR 3.3.6.6

SR 3.3.6.6 is the performance of a TADOT. This test is a check of the Manual Actuation Functions and is performed every 18 months. Each Manual Actuation Function is tested up to, and including, the master relay coils. In some instances, the test includes actuation of the end device (i.e., pump starts, valve cycles, etc.).

For these tests, the relay trip setpoints are verified and adjusted as necessary. The Frequency is based on the known reliability of the Function and the redundancy available, and has been shown to be acceptable through operating experience.

The SR is modified by a Note that excludes verification of setpoints during the TADOT. The Functions tested have no setpoints associated with them.

SR 3.3.6.7

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy.

The Frequency is based on operating experience and is consistent with the typical industry refueling cycle.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."

2. NUREG-1366, "Improvement to Technical Specification Surveillance Requirements," December 1992.

3. WCAP-13877, Rev. 1, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," August 1998.

SLAVE RELAY TEST

Westinghouse Owners Group *Subgroup*

WOG-SRT-98-005

Project Number 694
WCAP-13877, Rev. 1-P
WCAP-14129, Rev. 1-NP

September 1, 1998

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Attn: Chief, Information Management Branch
Division of Inspection and Support Programs

Subject: Westinghouse Owners Group
SRT AR Licensing Support Subgroup
Submittal of WCAP-13877, Rev. 1, (Proprietary) and WCAP-14129, Rev. 1, (Non Proprietary) "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays, WOG Program MUHP-3040", August 1998
(MUHP7042)

References:

1) D.V. Kehoe, TVA "Watts Bar Nuclear Plant (WBN) -Proposed License Amendment, Slave Relay Test Frequency (TAC No. 94425)", dated February 28, 1996, to USNRC Document Control Desk.

2) Robert E. Martin, NRC to Oliver D. Kingsley, Jr., TVA "Request for Additional Information Regarding Slave Relay Test Frequency, Watts Bar Unit 1 (TAC No. M94425)", dated September 3, 1996.

3) J.A. Scalice, TVA, "Watts Bar Nuclear Plant (WBN) - Unit 1 - Request for Additional Information Pertaining to the Proposed Slave Relay Test Frequency Amendment (TAC No. M94425)", dated October 2, 1997, to USNRC Document Control Desk.

4) J.A. Scalice, TVA, "Watts Bar Nuclear Plant (WBN) - Unit 1 - Proposed Slave Relay Test Frequency Amendment (TAC No. M94425)", dated December 12, 1997, to USNRC Document Control Desk.

5) R.E. Martin, NRC to O.J. Zeringue, TVA, "Request for Additional Information on Slave Relay Test Frequency Extension (TAC No. M94425)", dated January 27, 1998.

6) R.T. Purcell, TVA, "Watts Bar Nuclear Plant (WBN) Unit 1 - Request for Additional Information on Slave Relay Test Frequency Extension (TAC No. M94425)", dated March 30, 1998, to USNRC Document Control Desk.

7) N.J. Liparulo, W to W.T. Russell, NRC, "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays, WOG Program MUHP-3040",CAW-95-816, dated May 1, 1995.

This letter transmits 15 copies of WCAP-13877, Rev. 1, (Proprietary) and 12 copies of WCAP-14129, Rev. 1 (Non Proprietary) "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays, WOG Program MUHP-3040", August 1998. This revision of the subject reports incorporates the comments generated during the staff's review, References 2), 3), 4), 5), and 6).

Watts Bar is the lead plant for the Westinghouse Owners Group for relaxation of the slave relay test frequency for the Westinghouse type AR relays, whose license amendment request was provided by Reference 1), which included the original submittal of these reports.

Reference 1) transmitted the following documents to the Document Control Desk, which are also applicable to revision 1 of the subject reports:

1. One (1) copy of the Application of Withholding Proprietary Information from Public Disclosure. CAW-95-816 (Non-proprietary).
2. One (1) copy of Affidavit CAW-95-816 (Non-proprietary).
3. One (1) copy of the Copyright Notice.
4. One (1) copy of the Proprietary Information Notice.

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Correspondence with respect to the proprietary aspects of the Application for Withholding or the supporting Westinghouse affidavits should reference CAW-95-816 as appropriate and should be addressed to Mr. H.A. Sepp, Manager, Regulatory and Licensing Engineering, Westinghouse Electric Company, P.O. Box 355, Pittsburgh, PA, 15230-0355.

Very truly yours,

Charlie W. Touchstone

Charlie W. Touchstone, Chairman
Slave Relay Test (SRT) AR Licensing Support Subgroup
Westinghouse Owners Group

enclosure

cc: SRT AR Licensing Support Subgroup (1L)
N. J. Stringfellow, Chairman, Licensing Subcommittee (1L)
Westinghouse Owners Group Steering Committee (1L)
A. P. Drake, Westinghouse, ECE 5-16 (1L)
M. M. DeWitt, Westinghouse, ECE 5-43 (1L)
H. A. Sepp, Westinghouse, ECE 4-7A (1L)
P. Wen, USNRC (1L)
H. Garg, USNRC (1L)

T04 980330 556

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

Richard T. Purcell
Site Vice President, Watts Bar Nuclear Plant

MAR 3 0 1998

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

Gentlemen:

In the Matter of) Docket No. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - REQUEST FOR ADDITIONAL INFORMATION ON SLAVE RELAY TEST FREQUENCY EXTENSION (TAC. NO. M94425)

The purpose of this letter is to reply to the NRC request for additional information (RAI) dated January 27, 1998, concerning slave relay test frequency extension in support of NRC review of the subject proposed license amendment. The NRC RAI questions 1 through 3 are restated with responses provided by Westinghouse in Enclosure 1. The response to question 4 prepared by TVA is also included in this enclosure. Enclosures 2 and 3 provide information discussed in Enclosure 1.

Please note that the revised WCAP 13877 pages in Enclosure 2, although marked as proprietary information, do not contain proprietary information. This was confirmed through a telephone call with Westinghouse on March 25, 1998, and by a comparison of the original WCAP 13877 information and its non-proprietary WCAP 14129 version which revealed that both versions contained the same information. Enclosure 4 contains the commitment made in this letter.

MAR 3 0 1998

If you should have any questions, please contact P. L. Pace at (423) 365-1824.

Sincerely,

R. T. Purcell

Enclosures
cc: See page 3

PLP:RAS
cc (Enclosures):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. Robert E. Martin, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

J. S. Adams, BR 3H-C
R. J. Akers, ADM 1V-WBN
J. A. Bailey, LP 6A-C
R. R. Baron, BR 4J-C
M. J. Burzynski, BR 4J-C
E. S. Christenbury, ET 10A-K
R. D. Greer, EQB 2V-WBN
K. N. Harris, LP 3B-C
D. V. Kehoe, EQB 2V-WBN
W. R. Lagergren, MOB 2R-WBN
J. E. Maddox, EQB 1A-WBN
NSRB Support BR 4J-C
L. V. Parscale, ADM 1B-WBN
J. A. Scalice, LP 6A-C
R. J. Vander Grift, EQB 2W-WBN
O. J. Zeringue, LP 6A-C
Sequoyah Licensing Files, OPS 4C-SQN
EDMS, WT 3B-K

S:\site_lic\shared\lmaster\submit\12798 RAI RESPONSE.RAS.DOC

ENCLOSURE 1

Response to NRC Request for Additional Information
License Amendment Request - Slave Relay Test

References:

1. Letter from J. A. Scalice to the U.S. NRC, "Watts Bar Nuclear Plant (WBN) - Unit 1 -Request for Additional Information Pertaining to the Proposed Slave Relay Test Frequency Extension (TAC NO. M94425), dated October 2, 1997

2. "Evaluation of Surveillance Frequencies and Out of Service Times for the Engineered Safety Features Actuation System", WCAP-10271-P-A, Supplement 2, Revision 1, May 1989.

3. "Probabilistic Risk Analysis of the RPS and ESFAS Test Times and Completion Times", WCAP-14333-P, May 1995.

The following questions are from Robert E. Martin (NRC) letter to O. J. Zennque (TVA), "Request for Additional Information on Slave Relay Test Frequency Extension" (TAC NO. M94425), dated January 27, 1998. The questions (reproduced for reviewer convenience) and answers are provided below.

Question 1

In response to Question No 12, it was stated that the failure identified as number 7 should appear in Table 9-7 only. However, this failure does not appear in Table 9-7, it appears in Table 9-8. Clarify this discrepancy.

Response 1

In the October 2, 1997 letter from J. A. Scalice to the U.S. NRC (Reference 1), Section 9.3.3 (paragraph 3) discusses that event ID number 7 was due to contact overloading. Contact overloading is not a relay reliability issue. Therefore, ID number 7 should not have been included in Reference 1 response to question 12 (paragraph 3) as being only in Table 9-7. This relay non-failure for ID number 7 is correctly included in Table 9-8 as provided in Reference 1.

While addressing the above question, it was noted that the discussions about Tables 9-6, 9-7 and 9-8 in Reference 1 were not complete in regards to event ID numbers 20, 21, 22, 23 and 24. The following clarifications are provided in regard to event ID numbers 20, 21, 22, 23 and 24.

a. Event ID numbers 20 and 21 appear in Table 9-6 in WCAP-13877 but do not appear in either Table 9-7 or Table 9-8 in WCAP-13877. ID numbers 20 and 21 are included in Reference 1 Table 9-8 as discussed in Section 9.3.4 (paragraph # 1) of Reference 1.

b. Event ID number 22 is included in both Table 9-7 and 9-8 in WCAP-13877. ID number 22 is eliminated from Table 9-8 and remains in Reference 1 Table 9-7 as discussed in Section 9.3.4 (paragraph # 2) of Reference 1.

c. Event ID numbers 23 and 24 do not appear in WCAP-13877 Table 9-6, 9-7 or 9-8. ID numbers 23 and 24 are included in Reference 1 Tables 9-6 and 9-8 as discussed in WCAP-13877 Section 9.3.1.1.

The clarifications provided in the above items (a, b and c) do not require any changes to the discussions or Tables 9-6, 9-7 or 9-8 provided in Reference 1.

Question 2

The New Table 9-8 does not clearly address the basis for why some of the failures such as those identified as numbers 25, 29 through 35 and 38, which resulted in repair/replacement are considered non-failures of the relay. Provide this information.

Response 2

Responses for the above event Identification Numbers are provided below:

Event ID Number 25 (Sequoyah Unit 1, Relay K647-A)

Technician error is suspected because the reported relay anomaly could not be repeated. The relay was not repaired, it was disassembled, cleaned then returned to service. (Reference: WCAP-13877 Section 9.3.1.3). Deleted "Repaired" from Event/Date column in Tables 9-6 and 9-8 in Enclosure 2.

Event ID Number 29 (Sequoyah Unit 2, Relay K615-A)

This is a not an accepted failure because it is suspected that technician error may have contributed to the event. The reported anomaly could not be repeated. (Reference: WCAP-13877 Section 9.3.1.2) Added "replaced latch" to Notes column in Tables 9-6 and 9-8 in Enclosure 2.

Event ID Number 30 (Sequoyah Unit 2, Relay K615-A)

Event ID Number 30 is included in Table 9-7 as a valid failure.

Event ID Number 31 (Sequoyah Unit 2, Relay K622-A)

The reported anomaly is not a relay failure. The anomaly is an assembly error. A screw was tightened, the relay reinstalled and proper operation of the relay was verified. (Reference: WCAP-13877 Section 9.3.1.6) This event remains in Table 9-8 as shown in Enclosure 2.

Event ID Number 32 (Sequoyah Unit 2, Relay K607-B)

Technician error is suspected because a parallel path circuit may have caused the anomaly. Subsequent testing could not repeat the reported anomaly. The relay was not replaced. (Reference: WCAP-13877 Section 9.3.1.11) Deleted "Repaired" from Event/Date column, changed "A/L" to "U" in the Failure column and added "parallel path circuit" to the Notes column in Tables 9-6 and 9-8 in Enclosure 2.

Event ID Number 33 (Sequoyah Unit 2, Relay K615-B)

This is not an accepted failure because it is suspected that technician error may have contributed to the event. The reported anomaly could not be repeated. (Reference: WCAP-13877 Section 9.3.1.2) Changed "Repaired" to "Replaced" in Event/Date column in Tables 9-6 and 9-8 in Enclosure 2. Also corrected typographical error from "replace" to "replaced" in Table 9-8 in Enclosure 2.

Event ID Number 34 (Sequoyah Unit 2, Relay K620-B)

Technician error is suspected because the reported anomaly could not be repeated. The relay was verified to energize and returned to service. (WCAP-13877 Section 9.3.1.7) Deleted "Repaired" from Event/Date column,

changed "A/L" to "U" in Failure column and corrected typographical error from "U/OE" to "U/TE" in Tables 9-6 and 9-8 in Enclosure 2.

Event ID Number 35 (Sequoyah Unit 2, Relay K622-B)

This is a not an accepted failure because it is suspected that technician error may have contributed to the anomaly. The reported anomaly could not be repeated. (Reference: WCAP-13877 Section 9.3.1.2) Corrected typographical error from "replace" to "replaced" in Notes column in Table 9-8 in Enclosure 2.

Event ID Number 38 (Sequoyah Unit 2, Relay K-622B)

This is not an accepted failure because the failure mechanism suspected is an infant mortality due to the apparent tolerance incompatibility between the relay and the latch mechanism. Testing of the assembled relay and latch mechanism will detect this failure mode. (Reference: WCAP-13877 Section 9.3.1.8)

Question 3

If more failures are added to Table 9-7 as a result of responses to Question 1 and 2 above, then revise Tables 9-1, 9-2 and 9-5. Also discuss the specific reliability of AR relays with respect to the reliability value of the slave relays used in calculation core damage frequency in other topical reports.

Response 3

There are no additional failures, therefore, no additional items are added to Reference 1 New Tables 9-1, 9-2, 9-5 or 9-7 as a result of responding to Questions 1 and 2 above.

Core Damage Frequency

The reliability of the slave relays is used in WOG topical reports (References 2 and 3) related to evaluating extensions to allowed outage times for components of the reactor protection system (RPS). This includes signals that are generated in the RPS to produce a reactor trip and actuate engineered safety features, such as safety injection and auxiliary feedwater. Components modeled in these systems include the analog channels, logic cabinets, master relays, slave relays, and reactor trip breakers.

In Reference reports 2 and 3, the slave relay failure rate is developed from several potential failure modes that will cause the slave relay to fail to actuate equipment when required. The analyses in both of these reports use the same slave relay failure rate. The identified failure modes and the failure rates for each mode are listed in Reference 2 as follows:

Failure Mode	Failure Rate
Mechanically bound	4.0E-07/hr
Contact short	1.9E-08/hr*
Shorted coil	1.0E-07/hr
Open coil	1.0E-08/hr
Total	5.3E-07/hr

* Converted to an hourly failure rate by assuming 20 demands per year.
8.5E-06/d x 20 d/yr x 1 yr/8760 hr = 1.9E-08/hr

WCAP-13877 calculates an AR relay failure rate of 4.40E-08/hr and an AR latch relay failure rate of 1.10E-07/hr based on plant experience. This failure rate is based on all the slave relay data collected during the program to assess the reliability of type AR relays and includes failure data for plants with slave relay surveillance test intervals of 1 month, 3 months, and 18 months.

A comparison of the relay failure rate used in the topical reports (5.3E-07/hr) to the failure rate based on plant experience (4.40E-08/hr for AR relays and 1.10E-07/hr for AR latch relays) leads to the conclusion that the analysis results presented in the topical reports are conservative. The following paragraphs explain this conclusion.

The analyses discussed in References 2 and 3 use detailed fault trees of the reactor trip and engineered safety features (ESF) actuation signals to determine the impact of allowed outage time changes on signal unavailability. The ESF actuation signal unavailabilities are then used in the accident sequence quantification to determine the frequency of core damage related to ESF actuation signal unavailability.

Component unavailability in these fault trees includes contributions from random and common cause failures, and test and maintenance activities. Increases to the allowed outage times impact the time available for testing and maintenance activities; the longer the allowed outage time, the more time available to perform test and maintenance activities during power operation. The slave relay failure rate is used to determine the slave relay unavailability (or failure probability) related to random and common cause failures. Lower slave relay failure rates result in lower ESF actuation signal unavailabilities and a more reliable system. Since the ESF actuation system is more reliable, with more reliable slave relays, when one ESF actuation signal train is unavailable for a test or maintenance activity, the operable train is more reliable than originally assumed so the impact on core damage frequency will be reduced. Therefore, the Reference 2 and 3 analyses are conservative and remain applicable.

Miscellaneous Corrections Not Related to Questions 1, 2 and 3 Above

1. Because of an accounting error in WCAP-13877 Table 9-7, relay failures are reapportioned in Table 9-1. The Beaver Valley 1&2 relay failure is decreased from 1 to 0 and the D.C. Cook 1&2 relay failure is increased from 1 to 2 in Table 9-1. This reapportionment does not change the total number of relay failures. The failure rate for the 18 month test period is changed by an insignificant amount (i.e., from 2.71E-04 to 4.06E-04). Enclosure 2 includes corrected pages of WCAP-13877 Table 9-1.

   As a result of the above change in WCAP-13877 Table 9-1, WCAP-13877 Table 9-5 is also changed. The relay failures per demand for the 1 month Surveillance Test Interval (STI) is changed from 1 to 0 and the failures/demand is changed to N/A. In addition, the relay failures per hour for the 1 month STI is changed from 1 to 0 and the failures/hr is changed to N/A. The relay failures per demand for the 18 month STI is changed from 2 to 3 and the failures/demand is changed by an insignificant amount (i.e., from 2.71E-04 to 4.06E-04). In addition, the relay failures per hour for the 18 month STI is changed from 2 to 3 and the failures/hr is changed by an insignificant amount (i.e., from 2.80E-08 to 4.13E-08). Enclosure 2 includes corrected pages of WCAP-13877 Table 9-5.

2. In WCAP-13877 Section 9.3.1.10, Sequoyah Unit 1 Relay K606-A is discussed. However, this relay does not appear in either WCAP-13877 Table 9-6, 9-7 or 9-8 nor in Tables 9-6, 9-7 or 9-8 in Reference 1.

   Enclosure 2 includes corrected pages of Tables 9-6 and 9-8 that incorporates relay K606-A as ID number 39. The relay was found to be fully operational. Other circuit components were then examined. Adding an item to Table 9-8 does not increase the number of failures nor does it require that any new relay failure calculations be performed.

3. Event ID Number 4: Corrected typographical error from "A4" to "A4L" in Relay Type column in Tables 9-6 and 9-8 in Enclosure 2.

4. Event ID Number 15: Corrected typographical error from "A41-8" to "A4L-8" in Relay Type column in Tables 9-6 and 9-7 in Enclosure 2.

5. Event ID Number 22: Corrected typographical error from "A8" to "A8L" in Relay Type column in Tables 9-6 and 9-7 in Enclosure 2.

6. Event ID Number 36: Corrected "repaired" to "replaced" in Event/Date column in Tables 9-6 and 9-7 in Enclosure 2. Corrected typographical error from "replace" to "replaced" in Relay Type column in Table 9-7 in Enclosure 2. These corrections make Tables 9-6 and 9-7 consistent.

TVA RESPONSE TO QUESTION 4

RAI QUESTION NO. 4:

Your response to Question No. 18 states that the Maintenance Rule Program cover slave relays. Confirm that this program meets the concern identified in Question 18.

RESPONSE:

Question 18 and TVA's response from letter dated October 2, 1997, are provided below:

"18. **QUESTION---RAI#1**

When two or more AR relays fail in a 12-month period, the staff requires licensees to re-evaluate the adequacy of the proposed extended surveillance interval and if it is determined that the interval is inadequate for detecting single relay failures, the surveillance interval should be decreased. The revised surveillance interval should be such that the licensee can detect an ESFAS subgroup relay failure prior to the occurrence of a second failure. Provide a commitment to implement this requirement.

18. **RESPONSE---RAI#1**

The WBN Maintenance Rule program implements the requirements of 10CFR50.65 and provides instructions for initiation, analysis, retrieval, trending, and periodic reporting of data relative to performance indicators of plant systems and components. The program includes guidance for trending and reporting of repetitive preventable failures of functions which are within the scope of the Maintenance Rule. It also includes performance of cause determinations for failures to meet performance criteria and for repetitive failures. The program assigns plant system engineers responsibility for identifying when performance criteria are not met and increased monitoring under paragraph (a)(1) of the Maintenance Rule is required, along with the corrective actions necessary to restore acceptable performance. The functions performed by the slave relays are in the scope of the program."

WBN Technical Instruction TI-119, Maintenance Rule Performance Indicator Monitoring, Trending, And Reporting, Attachment 30, REACTOR PROTECTION SYSTEM (099) will be revised prior to implementation of the approved TS change. This procedure change will require that the surveillance interval be evaluated and reduced, when needed, if two or more Westinghouse AR ESFAS subgroup relays fail within a 12-month interval.

ENCLOSURE 2
WATTS BAR NUCLEAR PLANT
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
DATED JANUARY 27, 1998

CORRECTED PAGES FOR BOTH WCAP 13877 AND OCTOBER 2, 1997 LETTER

Figures 9-1 through 9-6 show no evidence of end-of-life failures that would be represented by a clustering of failures at some large number of actuations or some long service life value. This is particularly significant since all of the latch mechanisms were manufactured at least nineteen years ago. While some relays of more recent vintage may be included in the sample population, only a handful are of lesser age than the latch attachments. The relays were designed to undergo millions of actuations over their service life. In comparison, the SSPS slave relays making up the sample populations have accumulated orders of magnitude fewer actuations. The latch attachment, even with consideration of the cycle life estimate based on high-demand applications in high-ambient temperature are actuated several orders of magnitude less than their ultimate capability during the 40-year plant life.

In conclusion, though there are too few failures to draw any solid statistical conclusions, the minimal number of failures indicate a random scattering of failures representative of a constant low failure rate, and a minor infant mortality failure rate that can be readily detected and avoided with adequate post-installation testing.

9.2 REPORTS OF SSPS SLAVE RELAY FAILURES

Plant-specific data on reported type AR relay events is found in Table 9-6, and valid failures found in Table 9-7.

9.2.1 Failures at Sequoyah

At Sequoyah Unit 2, October 4, 1983, Relay K615-A (880 configuration with latch) was replaced (relay and latch) in response to a reported test anomaly (Reference 14.5-1). The event is considered a valid failure due to the previous replacement of this relay latch attachment (See Section 9.3.1.2). This was the second test operation of the relay since the previous maintenance. It is suspected that the root cause was the tolerance incompatibility failure mechanism. Post-maintenance testing requirements in effect at the time of the December 1982 replacement did not require multiple actuations of the relay to verify operability (See Section 9.3.1.2).

At Sequoyah Unit 2, October 4, 1983, the latch attachment on relay K622-B (880 configuration with latch) was replaced when it failed to latch on demand (Reference 14.5-2). The event is considered a valid failure due to the previous replacement of this latch relay attachment (See Section 9.3.1.2). This was the second test operation of the relay since the previous maintenance. It is suspected that the root cause was the tolerance incompatibility failure mechanism. This event could be considered an infant mortality. Post-maintenance testing requirements in effect at the time of the December 1982 replacement did not require multiple actuations of the relay to verify operability.

At Sequoyah Unit 1, June 10, 1986, Relay K615-B (880 configuration with latch) was replaced after periodic testing when it did not unlatch on demand (Reference 14.5-3). The event is considered a valid failure because maintenance reports indicate that the failure was due to a spring misalignment in the ARLA latch mechanism. This report is questionable, however, because there is no adjustable spring in the ARLA latch attachment.

9.2.2 Failures at Farley

At Farley Unit 2, April 9, 1984, SSPS relay K620 (Train A) was replaced because it would not reset following removal of the actuation signal. The failure was discovered during on-line surveillance testing. During subsequent inspection of the failed relay a small piece of BAKLITE material was removed from the contact block assembly. Subsequently the relay performed upon demand. The root cause was binding caused by debris. Further investigation could not confirm the source of the foreign material. It was concluded that the BAKLITE piece had been in the relay since manufacture, equipment assembly, or construction.

9.3 NON-VERIFIABLE REPORTS OF SSPS SLAVE RELAY FAILURES

Plant-specific data on reported type AR relay events is found in Table 9-6 and non-verifiable events are found in Table 9-8.

TABLE 9-1 AR SLAVE RELAY ACTUATION DATA

Plant/Units (Footnote)	Test Period	Number of Relays	Actuations	Failures	Failure Rate
Byron 1 & 2	2 3 18	14 115 14	768 4251 82	0 1 0	
Braidwood 1 & 2	3 18	130 4	4356 96	2 0	
Beaver Valley 1 & 2	1	166	5636	0	
Comanche Peak	3	166	1193	0	
Catawba 1 & 2	3	149	4095	0	
McGuire 1 & 2	3	160	6864	0	
Sequoyah 1 & 2 (1)	18	129	1088	0	
North Anna 1 & 2 (1)	18	152	2356	0	
D. C. Cook 1 & 2 (1)	18	184	3120	2	
Farley 1 & 2	1 18	40 88	8640 649	0 1	
	1 2 or 3 18	206 734 571	14276 21527 7391	0 3 3 Total=6	N/A 1.39E-04 4.06E-04

(1) Actuations estimated by Westinghouse.
(2) Actuation data is from initial criticality of the plant. Factory acceptance testing and pre-operability testing records were not reviewed.

TABLE 9-5 FAILURE RATE SUMMARY - AR RELAYS	
Failures per Demand	
1 Month STI	(0 Failures)/(14276 Actuations) = N/A Failures/Demand
3 Month STI	(3 Failures)/(21527 Actuations) = 1.39E-04 Failures/Demand
18 Month STI	(3 Failures)/(7391 Actuations) = 4.06E-04 Failures/Demand
All STI's	(6 Failures)/(43194 Actuations) = 1.39E-04 Failures/Demand
Failures per Hour	
1 Month STI	(0 Failures)/(2.19E+07 Relay Hours) = N/A Failures/Hr
3 Month STI	(3 Failures)/(4.34E+07 Relay Hours) = 6.91E-08 Failures/Hr
18 Month STI	(3 Failures)/(7.26E+07 Relay Hours) = 4.13 E-08 Failures/Hr
All STI's	(6 Failures)/(1.38E+08 Relay Hours) = 4.40E-08 Failures/Hr

FAILURE RATE SUMMARY - AR RELAY LATCHES	
Failures per Demand	
1 Month STI	(2 Failures)/(8103 Actuations) = 2.47E-04 Failures/Demand
3 Month STI	(5 Failures)/(15241 Actuations) = 3.28E-04 Failures/Demand
18 Month STI	(4 Failures)/(4734 Actuations) = 8.45E-04 Failures/Demand
All STI's	(11 Failures)/(28078 Actuations) = 3.92E-04 Failures/Demand
Failures per Hour	
1 Month STI	(2 Failures)/(1.34E+07 Relay Hours) = 1.49E-07 Failures/Hr
3 Month STI	(5 Failures)/(3.32E+07 Relay Hours) = 1.51E-07 Failures/Hr
18 Month STI	(4 Failures)/(4.95E+07 Relay Hours) = 8.10E-08 Failures/Hr
All STI's	(11 Failures)/(9.61E+07 Relay Hours) = 1.10E-07 Failures/Hr

TABLE 9-6 - RELAY EVENTS

ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
1	Beaver Valley	1B	K601	A4L	1	184	6/4/91	UL	TE	Improper Test Setup
2	Beaver Valley	1B	K603	A4L	1	9	1/3/78	UL	S	Would not reset, spring misaligned
3	Beaver Valley	1B	K610	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
4	Beaver Valley	1B	K620	A4L	1	184	6/4/91	UL	TE	Improper test setup
5	Beaver Valley	1B	K632	A4	1	9	6/13/88	CO	TE	Non-repeatable, suspect tech error
6	Beaver Valley	1B	K641	A4	1	184	10/28/85	CO	CF	Contacts failed to open after test, problem self-c
7	Beaver Valley	1B	K641	A4	1		Replaced 10/24/90	CO	CF	Contacts failed to open after test, contacts 3-4 r
8	Beaver Valley	1B	K641	A4	1		Replaced 4/5/91	CO	CF	Contacts failed to open after test, contacts 3-4 r
9	Braidwood	1B	K602	A8L	3	33	Replaced 7/27/90	CO	CA	Contacts did not make - misaligned
10	Braidwood	2A	K648	A4	3	26	Replaced 4/10/82	N	B	Relay took 3 sec to reset, not a latching relay
11	Byron	1B	K632	A4	3	21	Replaced 8/1/88	CO	CF	Contacts replaced
12	Catawba	1A	K612	A4L-8	3	30 X	Repaired 2/85	L	LA	
13	Catawba	1A	K616	A4L-8	3	30 X	Replaced 1/85	L	U	
14	Catawba	1A	K619	A4L-8	3	13 X	Repaired 5/87	L	O	
15	Catawba	1A	K636	A4L-8	3	30 X	Repaired 5/87	L	LA	Re-aligned

	TABLE 9-6 - RELAY EVENTS									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
16	Catawba	1A	K643	A4L-8	3	15 X	Replaced 10/6/8	L	LA	
17	D.C. Cook	1A	K602	A	18	19	Repaired 7/28/83		CWR	Replaced contacts
18	D.C. Cook	2A	K629	A	18	15	Repaired 1/20/91		CWC	Replaced contacts
19	Farley	2A	K620	A8	18	11	Replaced 4/9/84	A	BD	Binding due to debris
20	North Anna	2B	K608	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
21	North Anna	2B	K610	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
22	North Anna	2B	K619	A8L	18	14	2/29/92	UL	U	Did not unlatch
23	Sequoyah	1A	K603				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
24	Sequoyah	1A	K604				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
25	Sequoyah	1A	K647	A4L	18	9	8/27/85	UL	U/IE	Did not unlatch, non-repeatable
26	Sequoyah	1B	K615	A8L	18	4	Replaced 6/10/86	UL	S	Did not unlatch on reset, spring misaligned
27	Sequoyah	1B	K615	A8L	18	2	Replaced 11/6/89	N	N	Replace old non-class 1E relay
28	Sequoyah	2A	K610	A8L	18	8	10/1/87	UL	U/IE	Did not unlatch on reset, non-repeated

TABLE 9-6 - RELAY EVENTS										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
29	Sequoyah	2A	K615	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeatable, replaced latch
30	Sequoyah	2A	K615	A8L	18	1	Replaced 10/4/83	U	U	Probable failure to unlatch
31	Sequoyah	2A	K622	A8L	18	8	Repaired 11/2/87	L	AE	Loose Cross-bar Screw
32	Sequoyah	2B	K607	A8L	18	8	4/15/92	U	TE	Did not latch, non-repeated, parallel path circuit
33	Sequoyah	2B	K615	A8L	18	8	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
34	Sequoyah	2B	K620	A8	18	8	10/19/87	U	U/TE	Did not actuate, non-repeated
35	Sequoyah	2B	K622	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
36	Sequoyah	2B	K622	A8L	18	1	Replaced 10/4/83	L	U	Did not latch, replaced latch
37	Sequoyah	2B	K622	A8L	18	3	10/19/87	L	U	Did not latch, non-repeated
38	Sequoyah	2B	K622	A8L	18	1	Replaced 6/19/88	L	U	Did not latch
39	Sequoyah	1A	K606				4/6/90	U	U	Did not actuate, non-repeated
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

	TABLE 9-7 - RELAY FAILURES									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
2	Beaver Valley	1B	K603	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
3	Beaver Valley	1B	K610	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
9	Braidwood	1B	K602	A8L	3	33	Replaced 7/27/90	CO	CA	Contacts did not make - misaligned
10	Braidwood	2A	K648	A4	3	26	Replaced 4/10/82	N	B	Relay took 3 sec to reset, not a latching relay
11	Byron	1B	K632	A4	3	21	Replaced 8/1/88	CO	CF	Contacts replaced
12	Catawba	1A	K612	A4L-8	3	30 X	Repaired 2/85	L	LA	
13	Catawba	1A	K616	A4L-8	3	30 X	Replaced 1/85	L	U	
14	Catawba	1A	K619	A4L-8	3	13 X	Repaired 5/87	L	O	
15	Catawba	1A	K636	A4L-8	3	30 X	Repaired 5/87	L	LA	Re-aligned
16	Catawba	1A	K643	A4L-8	3	15 X	Replaced 10/6/8	L	LA	
17	D.C. Cook	1A	K602	A	18	19	Repaired 7/28/83		CWR	Replaced contacts
18	D.C. Cook	2A	K629	A	18	15	Repaired 1/20/91		CWC	Replaced contacts
19	Farley	2A	K620	A8	18	11	Replaced 4/9/84	A	BD	Binding due to debris
22	North Anna	2B	K619	A8L	18	14	2/29/92	UL	U	Did not unlatch

TABLE 9-7 - RELAY FAILURES										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
26	Sequoyah	1B	K615	A8L	18	4	Replaced 6/10/86	UL	S	Did not unlatch on reset, spring misaligned
30	Sequoyah	2A	K615	A8L	18	1	Replaced 10/4/83	U	U	Probable failure to unlatch
36	Sequoyah	2B	K622	A8L	18	1	Replaced 10/4/83	L	U	Did not latch, replaced latch
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

	TABLE 9-8 - RELAY NON-FAILURES									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
1	Beaver Valley	1B	K601	A4L	1	184	6/4/91	UL	TE	Improper test setup
4	Beaver Valley	1B	K620	A4L	1	184	6/4/91	UL	TE	Improper test setup
5	Beaver Valley	1B	K632	A4	1	9	6/13/88	CO	TE	Non-repeatable, suspect tech error
6	Beaver Valley	1B	K641	A4	1	184	10/28/85	CO	CF	Contacts Failed to open after test, problem self-c
7	Beaver Valley	1B	K641	A4	1		Replaced 10/24/90	CO	CF	Contacts failed to open after test, contacts 3-4 r
8	Beaver Valley	1B	K641	A4	1		Replaced 4/5/91	CO	CF	Contacts failed to open after test, contacts 3-4 r
20	North Anna	2B	K608	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
21	North Anna	2B	K610	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
23	Sequoyah	1A	K603				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
24	Sequoyah	1A	K604				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
25	Sequoyah	1A	K647	A4L	18	9	8/27/85	UL	U/TE	Did not unlatch, non-repeatable
27	Sequoyah	1B	K615	A8L	18	2	Replaced 11/6/89	N	N	Replaced old non-class 1E relay

TABLE 9-8 - RELAY NON-FAILURES										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
28	Sequoyah	2A	K610	A8L	18	8	10/1/87	UL	U/TE	Did not unlatch on reset, non-repeated
29	Sequoyah	2A	K615	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
31	Sequoyah	2A	K622	A8L	18	8	Repaired 11/2/87	L	AE	Loose cross-bar screw
32	Sequoyah	2B	K607	A8L	18	8	4/15/92	U	TE	Did not latch, non-repeated, parallel path circuit
33	Sequoyah	2B	K615	A8L	18	8	Replaced 2/15/82	UL	U/TE	Non-repeated, replaced latch
34	Sequoyah	2B	K620	A8	18	8	10/19/87	U	U/TE	Did not actuate, non-repeated
35	Sequoyah	2B	K622	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
37	Sequoyah	2B	K622	A8L	18	3	10/19/87	L	U	Did not latch, non-repeated
38	Sequoyah	2B	K622	A8L	18	1	Replaced 6/19/88	L	U	Did not latch
39	Sequoyah	1A	K606				4/6/90	U	U	Did not actuate, non-repeated
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

ENCLOSURE 3
WATTS BAR NUCLEAR PLANT
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
DATED JANUARY 27, 1998

CROSS REFERENCE GUIDE

The following table is provided as a guide for cross referencing between Event ID Numbers, WCAP 13877 Sections, and WCAP-13877 Tables 9-7 and 9-8. Relay ID Numbers, Plant Names and Unit /Train designations are also provided.

Event ID#	WCAP-13877 Section #	Table #	Relay ID #	Plant Name	Unit/Train
1	9.3.3 (Reference 1, paragraph 1)	9-8	K601	Beaver Valley	1B
2	*	9-7	K603	Beaver Valley	1B
3	*	9-7	K610	Beaver Valley	1B
4	9.3.3 (Reference 1, paragraph 1)	9-8	K620	Beaver Valley	1B
5	9.3.3 (Reference 1, paragraph 2)	9-8	K632	Beaver Valley	1B
6	9.3.3 (Reference 1, paragraph 3)	9-8	K641	Beaver Valley	1B
7	9.3.3 (Reference 1, paragraph 3)	9-8	K641	Beaver Valley	1B
8	9.3.3 (Reference 1, paragraph 3)	9-8	K641	Beaver Valley	1B
9	*	9-7	K602	Braidwood	1B
10	*	9-7	K648	Braidwood	2A
11	*	9-7	K632	Byron	1B
12	*	9-7	K612	Catawba	1A
13	*	9-7	K616	Catawba	1A
14	*	9-7	K619	Catawba	1A
15	*	9-7	K636	Catawba	1A
16	*	9-7	K643	Catawba	1A
17	*	9-7	K602	D. C. Cook	1A
18	*	9-7	K629	D. C. Cook	2A
19	9.2.2	9-7	K620	Farley	2A
20	9.3.4 (Reference 1, paragraph 1)	9-8	K608	North Anna	2B
21	9.3.4 (Reference 1, paragraph 1)	9-8	K610	North Anna	2B
22	9.3.4 (Reference 1, paragraph 2)	9-7	K619	North Anna	2B
23	9.3.1.1	9-8	K603	Sequoyah	1A
24	9.3.1.1	9-8	K604	Sequoyah	1A
25	9.3.1.3	9-8	K647	Sequoyah	1A
26	9.2.1 (paragraph 3)	9-7	K615	Sequoyah	1B
27	9.3.1.9	9-8	K615	Sequoyah	1B
28	9.3.1.4	9-8	K610	Sequoyah	2A
29	9.3.1.2	9-8	K615	Sequoyah	2A
30	9.2.1 (paragraph 1)	9-7	K615	Sequoyah	2A
31	9.3.1.6	9-8	K622	Sequoyah	2A
32	9.3.1.11	9-8	K607	Sequoyah	2B
33	9.3.1.2	9-8	K615	Sequoyah	2B
34	9.3.1.7	9-8	K620	Sequoyah	2B
35	9.3.1.2	9-8	K622	Sequoyah	2B
36	9.2.1 (paragraph 2)	9-7	K622	Sequoyah	2B
37	9.3.1.5	9-8	K622	Sequoyah	2B
38	9.3.1.8	9-8	K622	Sequoyah	2B
39	9.3.1.10	9-8	K606	Sequoyah	1A

NOTES:

1.) Reference 1: Letter from J. A. Scalice to the U.S. NRC, dated October 2, 1997

2.) * Relay failure accepted – not discussed in WCAP-13877.

ENCLOSURE 4

LIST OF COMMITMENTS

WBN Technical Instruction TI-119, Maintenance Rule Performance Indicator Monitoring, Trending, And Reporting, Attachment 30, REACTOR PROTECTION SYSTEM (099), will be revised prior to implementation of the approved TS change. This procedure change will require that the surveillance interval be evaluated and reduced, when needed, if two or more Westinghouse AR ESFAS subgroup relays fail within a 12-month interval.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 27, 1998

Mr. O. J. Zeringue
Chief Nuclear Officer
and Executive Vice President
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON SLAVE RELAY TEST FREQUENCY EXTENSION (TAC NO. M94425)

Dear Mr. Zeringue:

By letter dated October 2, 1997, the Tennessee Valley Authority submitted responses to the staff request for additional information on the Westinghouse Owner's Group topical report, WCAP-13877, for extending the surveillance interval for slave relay testing. The staff has reviewed those responses and has determined that additional information is needed. Please provide responses to the following questions.

1. In response to Question No. 12, it was stated that the failure identified as number 7 should appear in Table 9-7 only. However, this failure does not appear in Table 9-7, it appears in Table 9-8. Clarify this discrepancy.

2. The new Table 9-8 does not clearly address the basis for why some of the failures, such as those identified as numbers 25, 29 through 35, and 38, which resulted in repair/replacement, are considered non-failures of the relay. Provide this information.

3. If more failures are added to Table 9-7 as a result of responses to Questions 1 and 2 above, then revise Tables 9-1, 9-2 and 9-5. Also discuss the specific reliability of AR relays with respect to the reliability value of the slave relays used in calculating core damage frequency in other topical reports.

4. Your response to Question No. 18 states that the Maintenance Rule Program covers slave relays. Confirm that this program meets the concern identified in Question 18.

Sincerely,

Robert Martin

Robert E. Martin, Senior Project Manager
Project Directorate II-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-390

cc: See next page

T04 971212 517

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee

John A. Scalice
Site Vice President, Watts Bar Nuclear Plant

DEC 12 1997

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

Gentlemen:

In the Matter of) Docket No. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - PROPOSED SLAVE RELAY TEST FREQUENCY AMENDMENT (TAC NO. M94425)

The purpose of this letter is to provide NRC with additional information to aid in the review of the proposed slave relay test frequency amendment. TVA committed to provide a summary of the completed contact loading analysis for those relays used in the slave relay applications subject to Technical Specification 92-day slave relay surveillance testing in the October 2, 1997, Request for Additional Information response. The enclosure provides this information.

If you should have any questions, please contact P. L. Pace at (423) 365-1824.

Sincerely,

R. Purcell for

J. A. Scalice

Enclosure
cc: See page 2

PLP:RAS
cc (Enclosure):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. Robert E. Martin, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

J. S. Adams, BR 3H-C
R. J. Akers, ADM 1V-WBN
J. A. Bailey, LP 6A-C
R. R. Baron, BR 4J-C
M. J. Burzynski, BR 4J-C
E. S. Christenbury, ET 10A-K
R. D. Greer, EQB 2V-WBN
K. N. Harris, LP 3B-C
D. V. Kehoe, EQB 2V-WBN
J. E. Maddox, EQB 1A-WBN
NSRB Support, BR 4J-C
L. V. Parscale, ADM 1B-WBN
R. T. Purcell, MOB 2R-WBN
J. B. Roden, WTC-1G-WBN
R. J. Vander Grift, EQB 2W-WBN
O. J. Zeringue, LP 6A-C
Sequoyah Licensing Files, OPS 4C-SQN
B. S. Williams WTC-1K-WBN
RIMS, MDB 1A-WBN

S:\SITE_LIC\SHARED\LMASTER\SUBMIT\SLAVE RELAY AMENDMENT FOLLOWUP.DOC

ENCLOSURE

SUMMARY OF SLAVE RELAY CONTACT LOADING ANALYSIS

BACKGROUND

The purpose of this letter is to provide NRC with additional information to aid in the review of the proposed slave relay test frequency amendment submitted on February 28, 1996. In TVA's October 2, 1997 Request for Additional Information response, WBN committed to provide a summary of the completed contact loading analysis for those relays used in the slave relay applications subject to Technical Specification 92-day slave relay surveillance testing.

PURPOSE AND SCOPE OF THE ANALYSIS

The purpose of the analysis was to analyze Solid State Protection System slave relay contacts and their interposing relay contacts to verify that the contact ratings are adequate for the applied loads, thereby ensuring that they can perform their safeguards function. By demonstrating that the contacts are properly applied, it is reasonable to conclude that their operation will not be subject to failure modes that are indicative of misapplication or contact overloading. The analysis specifically applies to slave relay contacts in circuits which are subject to testing at 92-day intervals to satisfy Technical Specification Surveillance Requirements 3.3.2.5 and 3.3.6.5. Since Train A and Train B are very nearly identical both in the application of slave relay contacts and the types of load devices, the analysis addressed Train A circuits only. Given the similarity of Train A and Train B and considering that no misapplications of slave relay contacts were identified in Train A, it is reasonable to conclude that the results of the study are also applicable to Train B.

ANALYSIS DISCUSSION

The analysis consisted of the following general steps:

- Identifying the slave relays and associated contacts which perform a safeguards function, any interposing relays, and actuated equipment.
- Obtaining and documenting load data.
- Determining the function of each contact (e.g., make, break, inhibit/permissive).
- Evaluating each contact application (contact rating vs load).

The evaluation considered the following:

- The contacts are either normally open or normally closed and typically will be required to make or break the circuit when an Engineered Safety Feature Actuation System (ESFAS) signal is generated.
- In some applications, the contacts will only be required to pass the load current, either continuously or momentarily, or may provide an inhibit function (i.e., contact opens to prevent actuation of a load device).
- Contacts are used in both AC and DC applications.

- Contacts are rated for continuous and make/break applications and for AC and DC circuits.
- The actuated loads in this study are inductive (e.g., other relays, solenoid valves, switchgear operating coils).
- The most limiting application is breaking a DC circuit.
- A few contacts switch low level loads (milliamps).

CONCLUSION

The analysis concluded that the ESFAS slave relay contacts are adequate for the actual applications, including the most limiting operating requirements imposed by inductive DC loads, and thus the contacts will not be subject to long-term degradation and reduced service life which could result from contact overloading. Therefore, testing on a refueling frequency is adequate to confirm reliability and demonstrate continued operability of slave relays.

T04 971002 482

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

John A. Scalice
Site Vice President, Watts Bar Nuclear Plant

OCT 0 2 1997

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

Gentlemen:

In the Matter of) Docket No. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) - UNIT 1 - REQUEST FOR ADDITIONAL INFORMATION PERTAINING TO THE PROPOSED SLAVE RELAY TEST FREQUENCY AMENDMENT (TAC NO. M94425)

The purpose of this letter is to reply to the NRC request for additional information (RAI) dated September 3, 1996, in support of NRC review of the subject proposed license amendment. The NRC questions are restated with TVA responses in Enclosure 1. The information in the responses regarding activities at non-TVA plants was provided by Westinghouse, as TVA has no direct knowledge of that information. Enclosure 2 provides a summary of proposed changes to WCAP-13877. Enclosure 3 provides a list of commitments made in this letter.

If you should have any questions, please contact P. L. Pace at (423) 365-1824.

Sincerely,

J. A. Scalice

Enclosures
cc: See page 2

PLP:RMB:
cc (Enclosure):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. Robert E. Martin, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

J. S. Adams, BR 3H-C
J. A. Bailey, LP 6A-C
R. R. Baron, BR 4J-C
M. J. Burzynski, BR 4J-C
S. O. Casteel, EQB 2V-WBN
E. S. Christenbury, ET 10A-K
D. V. Kehoe, EQB 2V-WBN
K. N. Harris, LP 3B-C
J. E. Maddox, EQB 1A-WBN
T. J. McGrath, LP 3B-C
L. V. Parscale, ADM 1B-WBN
R. T. Purcell, MOB 2R-WBN
R. J. Vander Grift, EQB 2W-WBN
K. Whittenburg, BR 4F-C
O. J. Zeringue, LP 6A-C
Sequoyah Licensing Files, OPS 4C-SQN
RIMS, MDB 1A-WBN

S:_SUBMIT\RAI slave relay.RMB.DOC

ENCLOSURE 1

Response to NRC Request for Additional Information
License Amendment Request - Slave Relay Test

QUESTION 1

Applicability of topical report: Westinghouse topical report WCAP-13877 is applicable for certain types of AR relays. The submittal of February 28, 1996, did not demonstrate the applicability of the topical report for the Watts Bar Nuclear Plant (WBN). Provide this information.

RESPONSE

The reliability assessment documented in WCAP-13877 can be applied to all Westinghouse type AR relays used in the Solid State Protection System (SSPS) slave relay application and can also be applied to other models in the type AR product line. Specifically, the report covers all AR440 and AR880 relays, including any AR440 or AR880 that is also equipped with an ARLA latch assembly. In addition, the report is applicable to a variety of mechanical latch assemblies, all now obsolete, which are equivalent to the ARLA, but are not used in the SSPS or interposing relay applications. The report can also be applied to a majority of ARD relays (DC coils) which are not used in the SSPS cabinets, but are used in interposing relay applications.

The relays used in the Watts Bar SSPS slave relay application are AR440 and AR880 models, some of which are equipped with the qualified ARLA latch assembly. As noted in the license amendment request, some slave relays actuate interposing relays which in turn operate an Engineered Safety Feature (ESF) component. The reliability assessment documented in WCAP-13877 encompasses these interposing relays if they are Westinghouse type AR or ARD relays except as discussed below. Since interposing relays can affect the ultimate function of the slave relay to actuate the required equipment, interposing relay reliability must be comparable to that of the associated slave relay. This conclusion is consistent with the definition of "Slave Relay Test" in the Technical Specifications and the discussion of Surveillance Requirement (SR) 3.3.2.5 in the Technical Specifications Bases, which require that the test include actuation of the ESF device, or as a minimum, a continuity check of the device. In addition to the AR440 and AR880 models, WBN also uses the ARD440 and ARD880 models in some applications requiring interposing relays.

The report does not apply to the following:

a) The AR660 series. This relay type physically differs from the AR440 and AR880 and is not used at WBN. The AR660 relay was not specifically considered in the reliability analysis because it is not used in any nuclear safety-related application known to

Westinghouse. Though it has many similarities, and indeed some identical subcomponents, additional evaluation would be necessary to address the AR660 series. (See WCAP-13877, Section 2.1)

b) Any AR relay equipped with a magnetic latch assembly. The ARMLA latch assembly replaced the obsolete ARLA latch. However, the ARMLA did not perform to expectations in seismic qualification tests and, therefore, was not qualified by Westinghouse for use in safety-related applications. The ARMLA latch is not used in safety-related applications at WBN (see response to Question 2 for additional discussion). This subject matter is discussed in the following documents:

IE Notice 82-55, "Seismic Qualification of Westinghouse AR Relay With Latch Attachments Used In Westinghouse Solid State Protection System,"

Westinghouse Nuclear Service Division Technical Bulletin NSD-TB-82-03, June 24, 1982, "AR Relays with Latch Attachments," System(s): Solid State Protection System and Auxiliary Safeguards Cabinets, and

NSD-TB-82-03, Revision 1, December 14, 1982, "AR Relays with Latch Attachments," System(s): Solid State Protection System and Auxiliary Safeguards Cabinets.

c) Any ARD relays equipped with the sand-based potted coil assembly. This coil design was not used in Class 1E service in Westinghouse designed systems. However, its commercial dedication and use by third party vendors/suppliers drew NRC attention in NRC Information Notice 88-88, "Degradation of Westinghouse ARD Relays," and NRC Information Notice 88-88 Supplement 1, "Degradation of Westinghouse ARD Relays." As a result of these notices, WBN identified and replaced the subject relays which could have adversely impacted safe operation of the plant.

QUESTION 2

Section 3.3, page 3-2: Since the ARLA latch attachment is obsolete and has been replaced by the new latch attachment which is not covered by this topical report, how are plants that have replaced the old latch attachment with the new attachment covered by this topical report?

RESPONSE

As noted in the response to Question 1, the ARMLA magnetic latch assembly is not covered by WCAP-13877 and is not used in safety-related applications at WBN. If a latching relay should require replacement, WBN has spares available from the inactive unit 2. If these spares are ever exhausted, WBN could use one of the two

relay (offered by Westinghouse), i.e., the Potter & Brumfield MDR Series relay or the Cutler-Hammer D26M relay. Although the Cutler-Hammer relay has not yet been approved for a refueling-frequency surveillance test interval, it is anticipated that the required reliability analysis will be successfully completed and the relay will be available for this application before it is needed by WBN.

QUESTION 3

Section 4.2.2, page 4-3: How is the reliability of AR relays as stated in WCAP-13877 affected for plants which do not have AR relays with their armature pin bonded with epoxy to the crossbar?

RESPONSE

There is no quantifiable impact to AR relay reliability in the SSPS slave relay application if the armature pin is "unbonded." The Failure Mode and Effects Analysis (FMEA) for the AR Relay (WCAP-13877, Section 7.0) includes discussion of all known or postulated AR relay failure modes. The known failure mode associated with an unbonded armature pin will not occur in the SSPS slave relay application because the conditions required to cause the failure mode are absent.

The conditions which give rise to the failure mode are as follows:

a) The relay is mounted such that gravity acts on the armature pin (the relay is "panel mounted" on a horizontal surface and situated such that the contact termination points are to the right and left of the relay, rather than top and bottom).
b) The relay is used in a high duty cycle application and has been operated (coil is energized then de-energized; armature changes position) in excess of one million times.
c) The relay is located in an environment that includes a continuous source of vibration.

Contrary to the above, the SSPS output relays are as follows:

a) Panel-mounted and situated such that the contact termination points are top- and bottom-facing (as is recommended by the manufacturer/designer).
b) Very-low duty cycle applications, where the estimated total forty-year service life will not exceed 1000 operations (WCAP-13877, Section 5.1).
c) The SSPS cabinets are not subject to continuous in-service vibration (such as would be expected on machine-mounted relays in mining equipment where this failure mode has been observed).

The manufacturer/designer reports that the known failure mode related to the "unbonded" armature pin has not occurred during the monthly cycle life tests. The monthly cycle life tests, described in

Sections 5.1 and 5.3 of WCAP-13877, routinely subject a randomly selected sample of ten relays to 10 million operations under nominal electrical load conditions. (The operations of the test specimen relay provide a continuous vibration environment.)

QUESTION 4

Section 5.3, page 5-3, first full paragraph: The last sentence of this paragraph states "The contacts selected for the AR relays exhibited greater reliability." However, no reliability number or basis for this statement was provided. Please provide this basis.

RESPONSE

Numerical reliability numbers were not established or considered in the selection of the contacts. The manufacturer/designer conducted run-to-failure tests with contacts from competing manufacturers. Those contacts which survived the longest were selected for use in the manufacture of type AR relays.

QUESTION 5

Section 5.4.1, page 5-5, bracketed paragraphs: The second bracketed paragraph states that the original lubricant material would have attacked and consumed the polycarbonate carrier material and the AR relays would, therefore, not have survived. This lubricant material was replaced by other suitable material. Has the lubricant material been replaced in all Westinghouse plants? How was the new suitable material qualified?

RESPONSE

The replacement of the original lubricant was a design improvement implemented in 1972, substantially prior to the manufacture of any SSPS cabinets. The first Westinghouse SSPS was manufactured in 1976 for the D. C. Cook Plant. No SSPS was manufactured with relay latch attachments affected by the "predatory lubricant" issue.

WCAP-13877 reports the "predatory lubricant" issue because of the following:

a) It is significant to the design evolution of the AR relay latch attachment design, and
b) IE Circular 80-01, "Service Advice for General Electric Induction Disc Relays," raises the issue of failure modes related to lubricants.

QUESTION 6

Section 5.4.3, page 5-6: This section discusses a failure mode in certain applications of the AR relays and the modification that was implemented in 1984 to eliminate this failure mode. This failure mode occurred after several million relay operations. Were these relays normally energized? If not, is it possible for this failure mode to occur after a small number of cycles for those relays which are normally energized?

RESPONSE

The concern for aluminum armature sideplates creates no quantifiable impact to the reliability of AR relays used in the SSPS slave relay applications.

The aluminum sideplate cracking phenomenon has only occurred in relays that have accumulated more than three million mechanical operations. Furthermore, these failures were only observed during the manufacturer's monthly production tests. There is no report of this failure mode having occurred in service. The cause was determined to be the impacting of the upper and lower halves of the AC relay armature. The failure mode has no causal connection to relays used in the normally energized (NE) or normally de-energized (ND) modes of service. Both NE and ND modes of service are low-duty cycle demand modes of operation. The failure mode is not temperature dependent and would neither be caused nor accelerated by the temperature rise associated with NE relay operation.

The original and current design of the AR relay called for stainless steel (SST) armature sideplates. The use of the aluminum side plates was relatively short lived, ending in 1984. It is not known if any AR relays with aluminum sideplates are in service in an SSPS slave relay application, and it is considered unlikely that any were used in the manufacture of the Watts Bar SSPS cabinets. Regardless, the SSPS slave relay application is characterized by very-low duty cycle demands, having an estimated forty-year service life total of 1000 (or fewer) operations (WCAP-13877, Section 5.1). Thus, the sideplate cracking failure mode should not occur.

QUESTION 7

Section 5.4.2, page 5-6, second paragraph: A design change was incorporated for AR relays in January 1994 to improve their reliability. Has this change been implemented for all Westinghouse designed plants?

RESPONSE

The manufacturing change, the addition of the contact cartridge spring clip hold-down, is for forward fit manufacture. A backfit of the upgrade is not required nor is it physically possible.

The concern for overtightening of the contact cartridge screws was first observed in the SSPS manufacturer's shop and reported according to the prevailing practices in the nuclear industry. This resulted in the issuance of NSD-TB-77-10, July 21, 1977, "AR Relays with Latch Attachments," System(s): Solid State Protection System (SSPS) and Auxiliary Safeguards Cabinets (ASG). This issue is resolved at WBN by a vendor-recommended torque specification provided on SSPS drawings. Additionally, operational testing following any maintenance or change verifies that no problem has been induced by potential overtightening of the contact cartridge screws.

QUESTION 8

Table 5-1 lists the expected temperature rise for non-metallic materials. However, no basis is provided for this temperature rise. It appears that the temperature rise for the normally energized relays must be higher than listed in the table. Explain this apparent discrepancy.

RESPONSE

The temperature rises reported in Table 5-1 of WCAP-13877 for the various AR relay components was provided by the relay manufacturer/designer. These numbers are conservative and apply to the ARD coils as well.

As per discussion during the telephone conversation among TVA, NRC, and Westinghouse on April 1, 1997, the temperature rise for AR relays should not be compared with that of the MDR series relays. Temperature rises vary with coil dimensions and parameters and can be influenced by external factors. The conservative upper bounding temperature rise stated in WCAP-13878 for MDR relays is based on data provided by the manufacturer for a medium size relay equipped with a DC coil and the maximum number of contact decks. This temperature rise is estimated to be 65°C, though the actual measured values are less than or equal to 58°C. It is also noteworthy that only small MDR series relays are used in the SSPS slave relay application. WCAP-13878 reports the results of temperature rise measurements of 25°C and 33°C for small MDR relays. The 33°C (58°F) temperature rise is conservative and is generally applicable to a typical 120 VAC relay used in the SSPS slave relay application.

Relay temperature rise is determined most directly by the coil resistance and the applied voltage. Coil resistance is determined by the size, type, hardness, and length of the coil magnet wire. The length of the magnet wire is nominally determined to meet the

manufacturer's power requirements, based on number of ampere turns, as well as other parameters. The power requirements are the result of relay operating mode, spring constants, component mass, and contact switching-load requirements. Note that, although the temperature rise data used in calculations of service life estimates for the small MDR and the AR relays used in the SSPS slave relay application (both with 120 VAC coils) are roughly the same, 33°C and 30°C, respectively. This is a coincidence.

Relay temperature rise is not necessarily equivalent between relays of different designs and types, even when used interchangeably in similar service.

QUESTION 9

Section 6.5, page 6-4: The reliability analysis in WCAP-13877 does not account for failures based on excess loading on relay contacts. Provide the contact loading analysis for WBN to justify excluding this failure mode at WBN.

RESPONSE

Section 6.5 of WCAP-13877 discusses industry reports of failures of Potter & Brumfield MDR relays due to excessive contact loading and notes that the concern also applies to Westinghouse type AR relays. The failures were characterized as misapplications due to consideration of only resistive loads and failure to consider inductive loads, specifically normally energized DC coil solenoid valves. As per discussion during the telephone conversation among TVA, NRC, and Westinghouse on April 1, 1997, WBN will perform a contact loading analysis of the relays used in the slave relay application which are subject to the Technical Specifications slave relay test surveillance requirement. A summary of the completed analysis will be provided to support approval of the license amendment request.

QUESTION 10

Section 8.2, page 8-2: Thermogravimetric Analysis (TGA) is used for aging. The staff has not accepted this methodology for aging. Provide the basis for the acceptability of TGA for this purpose.

RESPONSE

TGA is not used as the means for establishing an estimated service life. The service life estimates are based on the Arrhenius time-temperature relationship, and also consider physical/mechanical performance limits. The results of existing TGA were reviewed to determine if there existed, or if certain operating conditions could

create any secondary aging effects that could become a potential life-limiting failure mode.

In the case of Neoprene rubber, TGA results identify the generation of chlorine gas and chloride compounds as a by-product of the aging degradation process. This is an important factor in assessing the relay, its changes with time, and the impact of the changes on its ability to perform.

QUESTION 11

Sections 8.3.1 and 8.3.2, pages 8-6 and 8-7: The qualified life of normally energized AR relays based on the 8°C, 5°C, and 3°C cabinet temperature rise has been calculated as 5.3 years, 6.8 years, and 8.1 years, respectively. Also, the qualified life for periodically energized AR relays has been limited to 20 years. However, WBN has not provided any analysis to establish the life of these relays. Provide the appropriate analysis.

RESPONSE

TVA will determine a plant specific service life which satisfies the recommendations and guidance set forth in WCAP-13877. A plant-specific aging assessment will be performed for the normally energized and periodically energized slave relays. The results of the aging assessment will be used to establish such service life limits as are necessary to assure that age-related degradation should not become a factor which reduces the expected reliability of the slave relays or the performance of their safety-related function. The aging assessment is outlined as follows:

a) Temperature conditions in the relay cabinets will be determined.
b) Data will be compared with that provided in Section 8 of WCAP-13877.
c) As necessary, additional Arrhenius calculations will be performed.
d) Replacement intervals will be established on the basis of the aging assessment and will be enforced/enacted through the plant maintenance program.

The aging assessment will be completed and the results implemented prior to the completion of the second refueling outage.

QUESTION 12

Section 9.0, page 9-1, Table 9-8: Table 9-8 and Section 9.0 identify events which are considered non-failures of AR relays. However, no justification is provided for why these events are considered non-failures. Please provide the appropriate justification.

RESPONSE

It appears that final editing of Tables 9-6, 9-7, and 9-8 was not completed per the report author's instructions. Table 9-8 is affected by a number of errors, as is Table 9-7. There are also typographical errors on Table 9-6; however, these do not affect the technical content or purpose served by the table. Corrections of these errors will, in part, address and resolve the NRC reviewer's comments.

Revised copies of Tables 9-6, 9-7 and 9-8 are included in Enclosure 2. Note that a new column for identification number ("ID#") is added to each of the tables. On Table 9-6, a unique identification number is assigned to each "relay event" listed. The list has been verified to correctly reflect the failure experience for SSPS slave relays as derived from the Nuclear Plant Reliability Data System (NPRDS) database and supplemented by a WOG survey of Westinghouse-designed plants. The identification numbers are transcribed to Tables 9-7 and 9-8 as appropriate.

While addressing this comment, it was noted that events identified as identification Nos. 7, 9, 10, 11, 12, 13, 14, 15, 16, 18, and 19 were erroneously listed on both Tables 9-7 and 9-8; the errant implication being that the events were classified as both valid failures and non-valid failure reports. It was intended that the events identified as identification Nos. 7, 9, 10 through 16, 18, and 19 should have appeared only on Table 9-7, thus classifying them as valid failures. In most cases, errors occurred because no further evaluation or investigation was made to prove them otherwise. Also note that identification No. 17 did not appear on either Table 9-7 or 9-8. No. 17 should also have appeared on Table 9-7, indicating its acceptance as a valid failure in the absence of further evaluation or investigation.

Also, it was intended that only representative evaluation and investigation into the relay failure reports were to be included in the WCAP. In particular, the investigation performed by the author at TVA's Sequoyah Nuclear Plant, and the investigation performed by Southern Nuclear Company personnel at the Farley Nuclear Plant were included because they provided a detailed cross-section of the typical misdiagnoses, and because they provided clear examples of issues raised in the research of Generic Communications and FMEA, WCAP-13877 Sections 6.0 and 7.0, respectively.

It was the author's interpretation, relying on the detailed design description and FMEA provided in the report, that the brief notes in Tables 9-6, 9-7, and 9-8 clearly indicate that the non-valid failure reports were a product of test errors or misdiagnosis of the causes for test anomalies. Experience has shown that initial reports of "failure" should not be taken at face value. In fact, if additional/sufficient time and funding had been available, it is believed that the seventeen failures "accepted as valid" would be further reduced in number.

The bases for determining that event reports (Table 9-6) were "non-failures" is provided in Section 9.3 of the WCAP. Those events appropriately listed in Table 9-8, but not currently discussed in Section 9.3, are in Enclosure 2. The WCAP will be revised to include these new sections and the revised tables after the SER is available for inclusion in the report.

QUESTION 13

Section 9.2.1, page 9-4: The last sentence on this page states that the post-maintenance testing requirements did not require multiple actuation of the relay to verify operability. Do all Westinghouse designed plants use multiple actuation tests to identify this failure mode?

RESPONSE

It is not known if all Westinghouse designed plants use multiple actuation tests to confirm the correction or absence of the tolerance incompatibility failure mechanism (see WCAP-13877, Sections 5.4.1 and 6.6). However, the real issue is the practice of repairing AR relays and the scavenging of ARLA latch assemblies for use as replacement relays. The author of WCAP-13877 intended that multi-actuation tests would better serve the intent to demonstrate that repairs were made correctly, and that the tolerance compatibility problem was not in evidence where ARLA latches were transferred from one relay to another, presumably of different vintage.

In general, the practice of scavenging and interchanging relay parts is not recommended for equipment in safety-related applications, though, because of the limited availability of the obsolete ARLA latch assembly, it is not regarded as "strictly forbidden." Where scavenging or interchanging components is driven by a real need, it is recommended that "sufficient operations be made after assembly to assure that the assembly functions properly." Twenty relay operations would be reasonable in the case of Type AR relays given that they are capable of millions of such operations and are only required to perform an estimated 1000 times over their useful service life. All 20 operations must be successful. If the test results indicate that contact or travel was insufficient, the manufacturer should be consulted for guidance and instruction to assure tolerance compatibility of the relay and latch assembly.

WBN normally does not transfer an ARLA latch mechanism to another AR relay, but replaces the entire latch relay assembly. However, WBN will adhere to the recommendations above, as interpreted from WCAP-13877, if it should become necessary to transfer an ARLA latch mechanism to another AR relay.

QUESTION 14

Section 9.3, page 9-5: This section lists non-verifiable events of AR relay failures. Has Westinghouse approached the utilities for more information in order to determine the root cause of these events? From the discussion in Section 9.3.1, it appears that most of these failures are blamed on technician's error, which may not be the true cause of these failures. Provide additional information justifying the disposition of these non-failures.

RESPONSE

As part of the study which generated WCAP-13877, a detailed review of the maintenance records, such as could be performed, was conducted at Sequoyah Nuclear Plant by Westinghouse. At the request of Westinghouse, further investigations were performed by Southern Nuclear Company (SNC; Farley), Duquesne Light Company (DLC; Beaver Valley), and Virginia Power (North Anna). In most cases, test or technician errors were found to be the leading cause of non-failure events reported (also, see response to Question No. 12). This does not reflect that the technicians involved were careless, or unqualified, but rather that they acted responsibly in reporting conditions that did not meet expectations.

Experience has shown that initial reports of failure should not be taken at face value. In many cases, the initial report describes the event by its symptoms and in terms of what did not happen. In some cases, initial reports reflect a best guess of what might have been the cause of an undesired or unexpected result. In other cases, initial reports reflect the most tangible, visible evidence that the technician/author can recall to reflect his understanding of what happened, or more often, what failed to happen.

For example, it is common practice to assume that a relay has failed when it does not respond to what is believed to be a valid operating demand. The assumption implies, for example, that it is known that there was no possible reason to expect that the demand signal was not delivered to the relay coil. That is, it implies that the technician reporting the event knew the following:

a. The power supply, from which the demand current is drawn, was available, i.e., neither switched-off nor failed,

b. No fuses had blown and no circuit breakers had opened to isolate the demand circuit,

c. The initiator of the demand was functioning properly so that either: (1) the contacts of the test switch made when the button was pushed or the knob was turned, or (2) that the electronics which drive an upstream relay or contactor performed their function properly,

d. No leads had been lifted, nor were any broken, in the relay coil circuit, or

e. No terminations were loose or corroded that would have reduced the current supplied to the relay coil.

It is very likely that one or all of the above was not checked prior to the report of failure. Any one of the above reasons would explain why a relay would fail to change state, but none of them is a failure of the relay. However, in all cases, what the technician or any other observer is likely to report is that "the relay failed." "The relay failed" adequately describes what the technician was able to see or understood to have occurred in the absence of a sudden noise or flash of light. That is, without beginning an unauthorized probe of the system, the report states that "what I saw was that the relay just did not do its job."

In conclusion, when reading a trouble report, regardless of what is stated or supposed by the author, what should be interpreted is the "relay failed to change state on demand," not that "the relay has demonstrated a failure mode which indicates its useful service life has ended."

It is common that such "errors" are discovered when further investigation concludes the relay is functional and that there is another cause to be investigated (which is then the subject of another separate maintenance work request), or the conditions reported cannot be repeated. This is usually an indication that the original report was the product of technician/operator error either in the test setup or a failure of other equipment in the test set up.

QUESTION 15

Section 9.3.1.7, page 9-7, lists a failure of relay K620B at Sequoyah Unit 2 on November 19, 1987, while Table 9-6, page 9-16, lists the failure of the same relay at Sequoyah Unit 2 on October 19, 1987. Are these the same event?

RESPONSE

Yes, these are the same event. "November," in Section 9.3.1.7, will be changed to "October." A revised Section 9.3.1.7 is included in Enclosure 2.

QUESTION 16

Section 9.3.1.1, page 9-6, discusses failures of relays K603A and K604A at Sequoyah Unit 1 on September 15, 1981, but these failures have not been listed in Tables 9-6 through 9-8. Please resolve this discrepancy.

RESPONSE

The suspected failures of relays K603A and K604A will be added to Tables 9-6 and 9-8 in a future revision of WCAP-13877. Revised tables are provided in Enclosure 2.

QUESTION 17

All failures or non-failures of AR relays listed in Tables 9-7 and 9-8 are not discussed in Sections 9.2 and 9.3. Also, some of the failures discussed in Sections 9.2 and 9.3 are not listed in Tables 9-6 through 9-8. Please resolve this discrepancy.

RESPONSE

See Response to Question Nos. 12, 14, 15 and 16. Collectively, they address Question No. 17.

QUESTION 18

When two or more AR relays fail in a 12-month period, the staff requires licensees to re-evaluate the adequacy of the proposed extended surveillance interval and if it is determined that the interval is inadequate for detecting single relay failures, the surveillance interval should be decreased. The revised surveillance interval should be such that the licensee can detect an Engineered Safety Feature Actuation System (ESFAS) subgroup relay failure prior to the occurrence of a second failure. Provide a commitment to implement this requirement.

RESPONSE

As discussed in a telecon among representatives of the NRC, Westinghouse, and TVA on April 1, 1997, the WBN Maintenance Rule program implements the requirements of 10CFR50.65 and provides instructions for initiation, analysis, retrieval, trending, and periodic reporting of data relative to performance indicators of plant systems and components. The program includes guidance for trending and reporting of repetitive preventable failures of functions which are within the scope of the Maintenance Rule. It also includes performance of cause determinations for failures to meet performance criteria and for repetitive failures. The program assigns plant system engineers responsibility for identifying when performance criteria are not met and increased monitoring under paragraph (a)(1) of the Maintenance Rule is required, along with the corrective actions necessary to restore acceptable performance. Corrective actions are based on the identified causes, such as inadequate preventive maintenance and/or poor work-scheduling practices, and may include increased surveillance. The functions performed by the slave relays are in the scope of this program.

SUMMARY

Revisions to WCAP-13877 are necessary. It is noted that responses to comments Nos. 12, 14, 15 and 16 cite changes which are provided in Enclosure 2 and will be incorporated into a forthcoming revision of the WCAP.

ENCLOSURE 2

CHANGES TO WCAP-13877

The following new and revised sections and revised tables will be included in a revision to the WCAP-13877:

Section or Table	WCAP Page Nos.
Section 9.3.1.7	9-7
Section 9.3.3	9-8a
Section 9.3.4	9-8a
Section 9.3.5	9-8b
Table 9-6	9-14,15,16
Table 9-7	9-17,18
Table 9-8	9-19,20

(Proposed revised section)

Section 9.3.1.7

At Sequoyah Unit 2, October 19, 1987, after periodic testing of relay K620-B (880 configuration), it was reported that the relay did not actuate (Reference 14.5-11). Subsequent investigation could not repeat the anomaly. No other test anomaly has been reported for this relay. No failure mode or mechanism has been identified that caused intermittent operation of the relay coil. It is suspected that technician error was the root cause.

(Proposed new sections)

Section 9.3.3

Beaver Valley

Event ID Nos. 1 & 4 report that the ARLA latch mechanism of two relays did not unlatch on demand. It was later verified that both latches were operable. It was later determined that test set-up errors defeated the "unlatch demand" signal. No repair or replacement occurred. Both latches remain in service.

Event ID No. 5 reports that the relay contact(s) failed to make. This is interpreted to mean that a valid demand signal did not result in an indication that the relay contacts had closed completing the test actuation. Follow-up actions did not repeat the event. The relay was determined to be operable and remained in service. No repair or replacement occurred. Duquesne Light Company personnel concluded that the event was the result of technician error.

Event ID Nos. 6, 7, and 8 report the same contact failure occurring multiple times on relay K641 of the Unit 1 SSPS in Train B. ID Nos.

6 and 7 report the same symptom of the same cause on the same relay. Initially, ID No. 7 was determined to be a valid relay failure, and the relay was replaced. After replacement of the original relay, ID No. 8 reports the recurrence of the same contact problem. It was later determined that the relay contacts were overloaded. Contact overloading is not a failure of a relay. It is a design error/oversight and/or a misapplication of the relay. Thus, these events are not symptomatic of relay reliability; rather, they were signaling a problem that would have been detected by the contact loading study recommended to assure that relays are not "misapplied" (required to perform beyond their design limits). (Beaver Valley has performed a contact loading study and has made other "improvements" to preclude recurrence of contact overloading-related failures.)

Section 9.3.4

North Anna

Event ID Nos. 20 and 21 report that two different relays failed to unlatch on demand. Efforts to determine a cause could not repeat the anomaly observed during testing. The latches remain in service and have continued to function properly. There is no failure mode for the latch mechanism that would result in a failure to unlatch exactly once. No repair was made, and the relay latches remained in service. Virginia Power reports that the cause was "undetermined." However, the author of WCAP-13877 had concluded that the coincidence of two such "unlikely" events indicates that the root cause was most probably a test or test set-up error, or an intermittence in the test equipment which went unnoticed. Regardless of the cause, it is clear that the event is not a valid failure report.

Event ID No. 22 (See Table 9-7) reports an event with similar symptoms occurring as an isolated incident. No repair was made, and the relay latch remained in service. Virginia Power reports that the cause was "undetermined." Again, the most likely explanation of this event is test or test set-up error, or an intermittence in the test equipment which went unnoticed. However, event ID No. 22 was counted as a failure. This is viewed as a measure of conservatism.

Section 9.3.5

Summary

In a majority of cases, the raw event data (Table 9-6), as provided by members of the Westinghouse Owner's Group (WOG) Slave Relay Test (SRT), indicated that:

- Data provided was not screened; data from maintenance logs was provided without regard for the significance or content.
- Test anomalies, other than failures of the relay, were included in the data.

- Certain problems were recurring.

Respondents were contacted following preliminary evaluation of the data (time and funds permitting). The "failure" and "root cause" classifications coded in columns of Table 9-8, when not provided by the respondent, were established during follow-up review efforts by the author or the respondents.

Most of the cases identified as non-failures in Sections 9.3.1 through 9.3.4 and listed on Table 9-8 did not result in either repair or replacement of the relays. In fact, most of the relays discussed are still in service today. Among the items listed in Table 9-8 are cases of recurrent reports where the same "deficient condition" was reported to affect the same relay. These cases were the product of misdiagnosed causes or repeated instances of the same error. As discussed in Section 9.3.1 through 9.3.4, such cases were results of design or application errors that would have been identified by a contact loading study. They are not failures of the relays. Rather, the relay "problem" was symptomatic of another "failure".

Experience has shown that initial reports of "failure" should not be taken at face value. At least half of the Type AR relay "problem" reports identified in the survey were further investigated and found not to be relay failures. Note that failures reported by Braidwood, Byron, Catawba, and D.C. Cook, as listed in Tables 9-6 and 9-7, are questionable and have not been subject to further evaluation or investigation. It is believed that if detailed information were available, the seventeen failures "accepted as valid" would be further reduced in number.

(proposed WCAP-13877 table revisions)

TABLE 9-6 - RELAY EVENTS										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
1	Beaver Valley	1B	K601	A4L	1	184	6/4/91	UL	TE	Improper Test Setup
2	Beaver Valley	1B	K603	A4L	1	9	1/3/78	UL	S	Would not reset, spring misaligned
3	Beaver Valley	1B	K610	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
4	Beaver Valley	1B	K620	A4	1	184	6/4/91	UL	TE	Improper test setup
5	Beaver Valley	1B	K632	A4	1	9	6/13/88	CO	TE	Non-repeatable, suspect tech error
6	Beaver Valley	1B	K641	A4	1	184	10/28/85	CO	CF	Contacts failed to open after test, problem self-c
7	Beaver Valley	1B	K641	A4	1		Replaced 10/24/90	CO	CF	Contacts failed to open after test, contacts 3-4 r
8	Beaver Valley	1B	K641	A4	1		Replaced 4/5/91	CO	CF	Contacts failed to open after test, contacts 3-4 r
9	Braidwood	1B	K602	A8L	3	33	Replaced 7/27/90	CO	CA	Contacts did not make - misaligned
10	Braidwood	2A	K648	A4	3	26	Replaced 4/10/82	N	B	Relay took 3 sec to reset, not a latching relay
11	Byron	1B	K632	A4	3	21	Replaced 8/1/88	CO	CF	Contacts replaced
12	Catawba	1A	K612	A4L-8	3	30 X	Repaired 2/85	L	LA	
13	Catawba	1A	K616	A4L-8	3	30 X	Replaced 1/85	L	U	
14	Catawba	1A	K619	A4L-8	3	13 X	Repaired 5/87	L	O	
15	Catawba	1A	K636	A4l-8	3	30 X	Repaired 5/87	L	LA	Re-aligned

	TABLE 9-6 - RELAY EVENTS									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
16	Catawba	1A	K643	A4L-8	3	15 X	Replaced 10/6/8	L	LA	
17	D.C. Cook	1A	K602	A	18	19	Repaired 7/28/83		CWR	Replaced contacts
18	D.C. Cook	2A	K629	A	18	15	Repaired 1/20/91		CWC	Replaced contacts
19	Farley	2A	K620	A8	18	11	Replaced 4/9/84	A	BD	Binding due to debris
20	North Anna	2B	K608	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
21	North Anna	2B	K610	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
22	North Anna	2B	K619	A8	18	14	2/29/92	UL	U	Did not unlatch
23	Sequoyah	1A	K603				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
24	Sequoyah	1A	K604				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
25	Sequoyah	1A	K647	A4L	18	9	Repaired 8/27/85	UL	U/TE	Did not unlatch, non-repeatable
26	Sequoyah	1B	K615	A8L	18	4	Replaced 6/10/86	UL	S	Did not unlatch on reset, spring misaligned
27	Sequoyah	1B	K615	A8L	18	2	Replaced 11/6/89	N	N	Replace old non-class 1E relay
28	Sequoyah	2A	K610	A8L	18	8	10/1/87	UL	U/TE	Did not unlatch on reset, non-repeated

	TABLE 9-6 - RELAY EVENTS									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
29	Sequoyah	2A	K615	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeatable
30	Sequoyah	2A	K615	A8L	18	1	Replaced 10/4/83	U	U	Probable failure to unlatch
31	Sequoyah	2A	K622	A8L	18	8	Repaired 11/2/87	L	AE	Loose Cross-bar Screw
32	Sequoyah	2B	K607	A8L	18	8	Repaired 4/15/92	A/L	TE	Did not latch, non-repeated
33	Sequoyah	2B	K615	A8L	18	8	Repaired 12/15/82	UL	U/TE	Non-repeated, Replaced latch
34	Sequoyah	2B	K620	A8	18	8	Repaired 10/19/87	A/L	U/OE	Did not actuate, non-repeated
35	Sequoyah	2B	K622	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replaced latch
36	Sequoyah	2B	K622	A8L	18	1	Repaired 10/4/83	L	U	Did not latch, Replaced latch
37	Sequoyah	2B	K622	A8L	18	3	10/19/87	L	U	Did not latch, non-repeated
38	Sequoyah	2B	K622	A8L	18	1	Replaced 6/19/88	L	U	Did not latch
99	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

	TABLE 9-7 - RELAY FAILURES									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
2	Beaver Valley	1B	K603	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
3	Beaver Valley	1B	K610	A4L	1	9	1/3/78	UL	S	Would not reset, (latch) spring misaligned
9	Braidwood	1B	K602	A8L	3	33	Replaced 7/27/90	CO	CA	Contacts did not make - misaligned
10	Braidwood	2A	K648	A4	3	26	Replaced 4/10/82	N	B	Relay took 3 sec to reset, not a latching relay
11	Byron	1B	K632	A4	3	21	Replaced 8/1/88	CO	CF	Contacts replaced
12	Catawba	1A	K612	A4L-8	3	30 X	Repaired 2/85	L	LA	
13	Catawba	1A	K616	A4L-8	3	30 X	Replaced 1/85	L	U	
14	Catawba	1A	K619	A4L-8	3	13 X	Repaired 5/87	L	O	
15	Catawba	1A	K636	A4l-8	3	30 X	Repaired 5/87	L	LA	Re-aligned
16	Catawba	1A	K643	A4L-8	3	15 X	Replaced 10/6/8	L	LA	
17	D.C. Cook	1A	K602	A	18	19	Repaired 7/28/83		CWR	Replaced contacts
18	D.C. Cook	2A	K629	A	18	15	Repaired 1/20/91		CWC	Replaced contacts
19	Farley	2A	K620	A8	18	11	Replaced 4/9/84	A	BD	Binding due to debris
22	North Anna	2B	K619	A8	18	14	2/29/92	UL	U	Did not unlatch

	TABLE 9-7 - RELAY FAILURES									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
26	Sequoyah	1B	K615	A8L	18	4	Replaced 6/10/86	UL	S	Did not unlatch on reset, spring misaligned
30	Sequoyah	2A	K615	A8L	18	1	Replaced 10/4/83	U	U	Probable failure to unlatch
36	Sequoyah	2B	K622	A8L	18	1	Repaired 10/4/83	L	U	Did not latch, replace latch
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

	TABLE 9-8 - RELAY NON-FAILURES									
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
1	Beaver Valley	1B	K601	A4L	1	184	6/4/91	UL	TE	Improper test setup
4	Beaver Valley	1B	K620	A4	1	184	6/4/91	UL	TE	Improper test setup
5	Beaver Valley	1B	K632	A4	1	9	6/13/88	CO	TE	Non-repeatable, suspect tech error
6	Beaver Valley	1B	K641	A4	1	184	10/28/85	CO	CF	Contacts Failed to open after test, problem self-c
7	Beaver Valley	1B	K641	A4	1		Replaced. 10/24/90	CO	CF	Contacts failed to open after test, contacts 3-4 r
8	Beaver Valley	1B	K641	A4	1		Replaced 4/5/91	Co	CF	Contacts failed to open after test, contacts 3-4 r
20	North Anna	2B	K608	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
21	North Anna	2B	K610	A8L	18	14	8/25/87	UL	U	Did not unlatch, return to service
23	Sequoyah	1A	K603				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
24	Sequoyah	1A	K604				9/15/81	UL	U	Did not unlatch on control demand, but responded to test cabinet demand, returned to service
25	Sequoyah	1A	K647	A4L	18	9	Repaired 8/27/85	UL	U/TE	Did not unlatch, non-repeatable
27	Sequoyah	1B	K615	A8L	18	2	Replaced 11/6/89	N	N	Replaced old non-class 1E relay

TABLE 9-8 - RELAY NON-FAILURES										
ID#	PLANT	UNIT/ TRAIN	RELAY ID #	RELAY TYPE	TEST PERIOD (months)	OPERAT. CYCLES	EVENT/ DATE	FAILURE	ROOT CAUSE	NOTES
28	Sequoyah	2A	K610	A8L	18	8	10/1/87	UL	U/te	Did not unlatch on reset, non-repeated
29	Sequoyah	2A	K615	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated
31	Sequoyah	2A	K622	A8L	18	8	Repaired 11/2/87	L	AE	Loose cross-bar screw
32	Sequoyah	2B	K607	A8L	18	8	Repaired 4/15/92	A/L	TE	Did not latch, non-repeated
33	Sequoyah	2B	K615	A8L	18	8	Repaired 12/15/82	UL	U/TE	Non-repeated, replace latch
34	Sequoyah	2B	K620	A8	18	8	Repaired 10/19/87	A/L	U/OE	Did not actuate, non-repeated
35	Sequoyah	2B	K622	A8L	18	1	Replaced 12/15/82	UL	U/TE	Non-repeated, replace latch
37	Sequoyah	2B	K622	A8L	18	3	10/19/87	L	U	Did not latch, non-repeated
38	Sequoyah	2B	K622	A8L	18	1	Replaced 6/19/88	L	U	Did not latch
	Note: Appendix B, WOG Survey Data Sheets, lists the definitions of the various codes used on this table.									

ENCLOSURE 3

COMMITMENTS

1. WBN will perform a contact loading analysis of the relays used in the slave relay application which are subject to the Technical Specification slave relay test surveillance requirement. A summary of the completed analysis will be provided to support approval of the license amendment request. This will be completed by December 12, 1997.

2. WBN will perform a plant-specific aging assessment for the normally energized and periodically energized slave relays to determine a service life which satisfies the recommendations and guidance set forth in WCAP-13877. The aging assessment will be complete and the results implemented prior to completion of the second refueling outage.

3. Based on the recommendations of WCAP-13877, if it should become necessary to transfer an ARLA latch mechanism to another AR relay at WBN, a minimum of twenty operations will be made after assembly to assure that the relay assembly functions properly. This will be captured in a procedure as a programmatic commitment by December 19, 1998.

4. The following new and revised sections and revised tables will be included in a revision to WCAP-13877 after the SER is available for inclusion:

Section or Table	WCAP Page Nos.
Section 9.3.1.7	9-7
Section 9.3.3	9-8a
Section 9.3.4	9-8a
Section 9.3.5	9-8b
Table 9-6	9-14,15,16
Table 9-7	9-17,18
Table 9-8	9-19,20

The above revisions and additions to the WCAP will be completed within three months after receipt of the SER from NRC.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 3, 1996

Received Site Licensing SEP 05 '96 2293 Watts Bar Nuclear Plant			
Route to	FYI	XC	Action
Licensing Mgr.			
Compliance Mgr.			
Regulatory Mgr.			
Unit 2 Mgr.			
File			

Mr. Oliver D. Kingsley, Jr.
President, TVA Nuclear and
Chief Nuclear Officer
Tennessee Valley Authority
6A Lookout Place
1101 Market Street
Chattanooga, Tennessee 37402-2801

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING SLAVE RELAY TEST FREQUENCY, WATTS BAR UNIT 1 (TAC NO. M94425)

Dear Mr. Kingsley:

On February 28, 1996 the Tennessee Valley Authority (TVA) submitted an application for amendment of the Watts Bar Unit 1 Technical Specification on the surveillance frequency for Westinghouse type AR relays. The proposed amendment would change the surveillance frequency from quarterly to a refueling outage frequency. Your letter stated that Watts Bar is the lead plant for the Westinghouse Owners Group for relaxation of the slave relay test frequency for Westinghouse type AR relays. Your letter also submitted the Westinghouse Electric Company reports WCAP-13877 (Proprietary), "Reliability Assessment for Westinghouse Type AR Relays Used as SSPS Slave Relays," and its non-proprietary version, WCAP-14129, "Reliability Assessment of Westinghouse Type AR Relays used as SSPS Slave Relays." The NRC staff has reviewed the reports and has identified a number of issues requiring additional information as stated in the enclosure.

We are transmitting this request for information to TVA even though several of the issues relate to Westinghouse-designed plants other than Watts Bar. We understand that TVA, as the lead plant for the Westinghouse Owners Group on this issue, will coordinate the submittal of answers for those issues with Westinghouse. To facilitate this, at your staff's suggestion, we are providing a copy of this letter to Mr. J.W. Irons of the Westinghouse Electric Corporation.

Sincerely,

Robert Martin

Robert E. Martin, Senior Project Manager
Project Directorate II-3
Division of Reactor Projects I/II
Office of Nuclear Reactor Regulation

Docket No. 50-390

Enclosure: Request For Additional Information

cc w/enclosure: See next page

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

REQUEST FOR ADDITIONAL INFORMATION

SLAVE RELAY TEST FREQUENCY EXTENSION

WOG TOPICAL REPORT WCAP-13877

WATTS BAR NUCLEAR PLANT

1. Applicability of topical report: Westinghouse topical report WCAP-13877 is applicable for certain types of AR relays. The submittal of February 28, 1996 did not demonstrate the applicability of the topical report for the Watts Bar Nuclear Plant (WBN). Provide this information.

2. Section 3.3, page 3-2: Since the ARLA latch attachment is obsolete and has been replaced by the new latch attachment which is not covered by this topical report, how are plants that have replaced the old latch attachment with the new attachment covered by this topical report?

3. Section 4.2.2, page 4-3: How is the reliability of AR relays as stated in WCAP-13877 affected for plants which do not have AR relays with their armature pin bonded with epoxy to the crossbar?

ENCLOSURE

4. Section 5.3, page 5-3, first full paragraph: The last sentence of this paragraph states that, "The contacts selected for the AR relays exhibited greater reliability". However, no reliability number or basis for this statement was provided. Please provide this basis.

5. Section 5.4.1, page 5-5, bracketed paragraphs: The second bracketed paragraph states that the original lubricant material would have attacked and consumed the polycarbonate carrier material and the AR relays would, therefore, not have survived. This lubricant material was replaced by other suitable material. Has the lubricant material been replaced in all Westinghouse plants? How was the new suitable material qualified?

6. Section 5.4.3, page 5-6: This section discusses a failure mode in certain applications of the AR relays and the modification that was implemented in 1984 to eliminate this failure mode. This failure mode occurred after several million relay operations. Were these relays normally energized? If not, is it possible for this failure mode to occur after a small number of cycles for those relays which are normally energized?

7. Section 5.4.2, page 5-6, second paragraph: A design change was incorporated for AR relays in January 1994 to improve their reliability. Has this change been implemented for all Westinghouse designed plants?

8. Table 5-1 lists the expected temperature rise for non-metallic materials. However, no basis is provided for this temperature rise. It appears that the temperature rise for the normally energized relays must be higher than listed in the table. Explain this apparent discrepancy.

9. Section 6.5, page 6-4: The reliability analysis in WCAP-13877 does not account for failures based on excess loading on relay contacts. Provide the contact loading analysis for WBN to justify excluding this failure mode at WBN.

10. Section 8.2, page 8-2: Thermogravimetric Analysis (TGA) is used for aging. The staff has not accepted this methodology for aging. Provide the basis for the acceptability of TGA for this purpose.

11. Sections 8.3.1 and 8.3.2, pages 8-6 and 8-7: The qualified life of normally energized AR relays based on the 8°C, 5°C and 3°C cabinet temperature rise has been calculated as 5.3 years, 6.8 years and 8.1 years, respectively. Also the qualified life for periodically energized AR relays has been limited to 20 years. However, WBN has not provided any analysis to establish the life of these relays. Provide the appropriate analysis.

12. Section 9.0, page 9-1, table 9-8: Table 9.8 and Section 9.0 identify events which are considered non-failures of AR relays. However, no justification is provided for why these events are considered non-failures. Please provide the appropriate justification.

13. Section 9.2.1, page 9-4: The last sentence on this page states that the post-maintenance testing requirements did not require multiple actuation of the relay to verify operability. Do all Westinghouse designed plants use multiple actuation tests to identify this failure mode?

14. Section 9.3, page 9-5: This section lists non-verifiable events of AR relay failures. Has Westinghouse approached the utilities for more information in order to determine the rpot cause of these events? From the discussion in section 9.3.1, it appears that most of these failures are blamed on technician's error, which may not be the true cause of these failures. Provide additional information justifying the disposition of these non-failures.

15. Section 9.3.1.7, page 9-7, lists a failure of relay K620B at Sequoyah Unit 2 on November 19, 1987, while table 9-6, page 9-16, lists the failure of the same relay at Sequoyah Unit 2 on October 19, 1987. Are these the same event?

16. Section 9.3.1.1, page 9-6, discusses failures of relays K603A and K604A at Sequoyah Unit 1 on September 15, 1981, but these failures have not been listed in tables 9-6 thru 9-8. Please resolve this discrepancy.

17. All failures or non-failures of AR relays listed in tables 9-7 and 9-8 are not discussed in sections 9.2 and 9.3. Also some of the failures discussed in sections 9.2 and 9.3 are not listed in tables 9-6 thru 9-8. Please resolve this discrepancy.

18. When two or more AR relays fail in a 12-month period, the staff requires licensees to re-evaluate the adequacy of the proposed extended surveillance interval and if it is determined that the interval is inadequate for detecting single relay failures, the surveillance interval should be decreased. The revised surveillance interval should be such that the licensee can detect an ESFAS subgroup relay failure prior to the occurrence of a second failure. Provide a commitment to implement this requirement.

T04 960228 296

Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381

FEB 28 1996

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

Gentlemen:

In the matter of) Docket No. 50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT (WBN) - PROPOSED LICENSE AMENDMENT, SLAVE RELAY TEST FREQUENCY (TAC NO. 94425)

In accordance with 10 CFR 50.90, the Tennessee Valley Authority (TVA) requests that Appendix A of Facility Operating License NPF-90, Watts Bar Unit 1 Technical Specifications, be amended to revise the surveillance frequency for Westinghouse type AR relays, used as solid state protection system slave relays or auxiliary relays, from quarterly to a refueling outage frequency.

Watts Bar is the lead plant for the Westinghouse Owners Group for relaxation of the slave relay test frequency for Westinghouse type AR relays. The relaxation of the surveillance frequency for Westinghouse type AR relays is based on information contained in Westinghouse Electric Company (Westinghouse) reports WCAP-13877 (proprietary), "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays," and WCAP-14129 (non-proprietary), "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays." WCAP-13877 and WCAP-14129 are included as Enclosures 4 and 5. Diablo Canyon is the lead plant for the Westinghouse Owners Group for relaxation of the slave relay test frequency for Potter & Brumfield MDR Series relays. The Diablo Canyon license amendment request is currently being reviewed by the NRC staff.

A description of the proposed amendment, and the bases for it, is included in Enclosure 1. TVA's analysis of the issue of no significant hazards consideration, as required by 10 CFR 50.91(a), is included in Enclosure 2. Proposed revised technical specification pages are included in Enclosure 3.

The proposed amendment has been reviewed by the Watts Bar Plant Operations Review Committee and the TVA Nuclear Safety Review Board.

WCAP-13877 contains information proprietary to Westinghouse. Accordingly, Enclosure 6 includes a Westinghouse Application for Withholding Proprietary Information from Public Disclosure, and an accompanying Affidavit CAW-95-816 signed by Westinghouse, the owner of the information. Also included are a Proprietary Information Notice and a Copyright Notice. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission, and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR 2.790 of the Commission's regulations. TVA requests that the Westinghouse proprietary information be withheld from public disclosure in accordance with 10 CFR 2.790.

Correspondence regarding the proprietary aspects of the Westinghouse report listed above, the Copyright Notice, or the supporting affidavit, should reference Westinghouse letter CAW-95-816 and be addressed to N. J. Liparulo, Manager, Nuclear Safety Regulatory and Licensing Activities, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Although the proposed changes are not required to address an immediate safety concern, TVA would like to implement them as soon as possible to reduce the risk of inadvertent actuation of engineered safety features equipment and reactor trips by reducing the number of surveillance tests performed at power. Additionally, the reduction in surveillance testing will save TVA more than $100,000 over the life of the plant and, therefore, would be considered a cost beneficial licensing action. TVA requests that review and approval of this request be given a high priority.

In accordance with 10 CFR 50.91(b)(1), a copy of this proposed license amendment is being forwarded to the State Designee for the State of Tennessee.

If you should have any questions, please contact John Vorees at (423) 365-8819.

Sincerely,

D. V. Kehoe
Nuclear Assurance
and Licensing Manager

Sworn to and subscribed before me
this 28th day of February 1996

E. Jeannette Long
Notary Public
My Commission Expires July 1, 1997

Enclosures
cc: See page 4

BSS:JV:TCG
cc (Enclosures 1, 2, and 3):
NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. P. S. Tam, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Mr. Michael H. Mobley, Director
Division of Radiological Health
3rd Floor
L & C Annex
401 Church Street
Nashville, Tennessee 37243

R. R. Baron, ADM 1V-WBN
P. P. Carier, BR 4G-C
S. O. Casteel, FSB 2V-WBN
E. S. Christenbury, ET 10A-K
W. L. Elliott, IOB 1A-WBN
K. N. Harris, LP 3B-C
T. J. McGrath, LP 3B-C
J. P. Maciejewski, LP 3B-C
M. O. Medford, LP 3B-C
T. W. Overlid, BR 4J-C
R. T. Purcell, MOB 2R-WBN
J. R. Rupert, IOB 1A-WBN
J. A. Scalice, ADM 1V-WBN
S. W. Spencer, QAC 1A-WBN
K. Whittenburg, BR 4F-C
O. J. Zeringue, ADM 1V-WBN
Sequoyah Licensing Files, OPS 4C-SQN
RIMS, TSB 1A-WBN

S:\TGROZAN\LICAM01.TCG

ENCLOSURE 1

PROPOSED LICENSE AMENDMENT - SLAVE RELAY TEST FREQUENCY

Description of Proposed License Amendment

The proposed amendment would revise the Watts Bar Unit 1 Technical Specifications to change the surveillance frequency for Westinghouse type AR relays, used as solid state protection system slave relays or auxiliary relays, from quarterly to a refueling outage frequency.

Specifically, Surveillance Requirements (SR) 3.3.2.5 and 3.3.6.5 would be revised to change the frequency from "92 days" to "92 days OR 18 months for Westinghouse type AR relays".

To support these changes, the Watts Bar Unit 1 Technical Specification Bases would be revised as follows:

Technical Specification basis for B 3.3.2 would be revised by adding the following paragraph to the basis for SR 3.3.2.5: "For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The Frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 13."

The following reference would be added to B 3.3.2:
13. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

Technical Specification basis B 3.3.6 would be revised by adding the following paragraph to the basis for SR 3.3.6.5: "For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The Frequency is based on the relay reliability assessment presented in Reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 3."

The following reference would be added to B 3.3.6:
3. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

Basis for Proposed License Amendment

I. BACKGROUND

Generic Letter (GL) 93-05, "Line Item Technical Specification Improvements to Reduce Surveillance Requirements for Testing During Power Operation," was approved in September 1993. This GL is the result of recommendations from a 1983 NRC task group formed to investigate problems with surveillance testing required

by TS. The objectives of the NRC task group were: 1) to review the basis for test frequencies; 2) to ensure that the tests promote safety and do not degrade equipment; and 3) to review surveillance tests for unnecessary burden on plant personnel. The studies found that while some testing at power is essential to verify equipment and system operability, safety can be improved, equipment degradation decreased, and unnecessary personnel burden relaxed by reducing the amount of testing at power. The relaxation of the slave relay test frequency is consistent with the objectives of the NRC task group. The results of the studies were documented in WCAP-13877 (proprietary) and WCAP-14129 (non-proprietary).

A. SSPS Overview

The solid state protection system (SSPS) is designed to actuate plant engineered safety feature (ESF) components when it receives the appropriate combination of input signals. The SSPS consists of two redundant, electrically independent trains. ESF components are arranged so that a failure of either SSPS train will not result in the loss of a required safety function.

ESF components are actuated by slave relays in the SSPS. The slave relays are actuated by master relays, which are actuated by the logic circuits of the SSPS. Each slave relay actuates multiple ESF components either directly or indirectly. Most slave relays actuate the ESF component directly. A number of slave relays actuate auxiliary (interposing) relays that actuate the ESF components.

A safeguards test cabinet (STC) is also provided to allow testing of the slave relays. The STC consists of test switches that apply voltage to a particular slave relay to determine operability of the relay. Each slave relay has a unique test switch.

Several tests are performed to verify the operability of all parts of the SSPS. An actuation logic test verifies the reactor trip and ESF logic signal output when simulated input signals are provided to the SSPS. A master relay test circuit energizes each master relay and verifies the continuity of the circuit through each slave relay coil associated with the particular master relay. Slave relay coil continuity is demonstrated by a reduced voltage test signal, which is sufficient to light a test lamp, but not sufficient to cause actuation of the slave relay. Finally, a slave relay test is performed that actuates each slave relay. Each slave relay is actuated via a test switch in the STC that applies normal voltage to the associated slave relay. The slave relay is then verified operable through a continuity check or actuation of the associated components.

B. Relay types and Construction

The SSPS slave relays used at Watts Bar are Westinghouse type AR relays.

The basic Westinghouse type AR relay consists of a coil assembly and a contact block assembly. The principal components of the contact block assembly are the cover, crossbar, and a set of contact cartridge assemblies. A contact assembly adder block provides four additional contact poles and is functionally identical to the four-pole contact block assembly. Type AR relays can be equipped with a latch assembly.

A detailed description of the Westinghouse type AR relay subcomponents, drawings, and photographs are included in WCAP-13877.

C. Relay Operation

Westinghouse type AR non-latching relays are either normally energized (NE) or normally de-energized (ND). A relay is considered to be NE if its coil is energized to maintain a desired contact position under normal plant operating conditions. A relay is considered to be ND if its coil is de-energized during normal plant operating conditions. Latching relays are ND. Typically, a latching relay is used to control functions where loss of power should not cause an inadvertent reset, or where deliberate action is required to reset or terminate a function, such as safety injection.

Type AR relays are designed to operate without the aid of gravity. The de-energized contact state is maintained or restored by a return spring. When the relay coil is energized, the upper-half armature is drawn into the coil block assembly, overcoming the resistance of the return spring. The crossbar is pulled along by the action of the relay coil assembly, causing the change of state of the relay contacts.

Type AR latching relays are equipped with an ARLA latch attachment which is engaged when the relay coil is energized and do not change position when the coil is de-energized. The latch is disengaged by momentarily energizing the latch (reset) coil, allowing the contacts to return to the de-energized state.

D. Interposing Relays

A number of the slave relays actuate interposing relays that actuate the ESF components. Interposing relays are typically tested during slave relay testing; however, some interposing relays are tested during performance of TS-required equipment testing other than slave relay testing. The reliability assessments performed in the referenced WCAPs encompass these interposing relays if they are Westinghouse type AR relays. Relays which are not Westinghouse type AR will continue to be tested every 92 days.

II. JUSTIFICATION

Some slave relay testing results in actuation of ESF equipment. These actuations have caused plant transients at other plants, such as inadvertent ESF actuations and reactor trips. Failures in the STC circuits, particularly for those ESF components which are not intended to be actuated during the test, can also contribute to an increase in inadvertent plant trips due to slave relay testing. Changing the frequency of slave relay testing from quarterly to a refueling frequency will minimize the risks associated with unnecessary ESF actuations or reactor trips.

Performance of some slave relay testing requires that the associated safety systems be removed from service. Examples of systems that must be removed from service for slave relay testing include the auxiliary feedwater system, the containment spray system, and portions of the safety injection system. Relaxing the surveillance interval reduces the frequency that safety systems will be removed from service and, therefore, increases their availability to perform their required safety functions. This results in a reduction in risk.

A reduction in slave relay testing frequency will also be cost beneficial by reducing the burden on the plant operations, maintenance, and engineering staff.

III. SAFETY EVALUATION

Slave relays are used to actuate ESF components upon receipt of the appropriate signals from the SSPS logic. If a slave relay fails to actuate, ESF equipment associated with the slave relay will not automatically actuate in response to an accident condition.

Similarly, if an interposing relay fails to actuate when actuated by a slave relay, the equipment associated with the interposing relay will not actuate. Reliability of interposing relays is addressed in a subsequent section of this safety evaluation.

Slave relay testing can identify slave relay failures before the slave relay is required to perform its intended function. However, slave relay testing can result in ESF actuations or reactor trips. Relaxing the slave relay test frequency reduces the number of tests performed on the relays and reduces the number of opportunities to identify problems with slave relays. Relaxation of the slave relay test frequency also reduces the risk of unnecessary ESF actuations or reactor trips.

Westinghouse performed an evaluation to determine the reliability of the Westinghouse AR relays used in the SSPS and auxiliary relay cabinets for actuation of ESF components. The evaluation documented in WCAP-13877 includes: 1) a generic review of industry information on relay problems; 2) a slave relay surveillance test failure study; 3) a failure modes and effects analysis; and 4) an aging assessment. A summary of the evaluation is presented below.

A. Generic Issues Review

A review of NRC documents, such as Information Notices, Circulars, and Bulletins, and Westinghouse technical bulletins associated with relays was performed to identify potential relay failure modes and mechanisms. The issues identified and considered in the analysis included performance of potting materials and lubricants, contact block assembly binding, excessive loading of relay contacts, insufficient contact travel, latch attachment seismic qualification, and material degradation. The results of this review and the documents reviewed are documented in Section 6 of WCAP-13877.

B. Slave Relay Surveillance Test Failure Study

To identify potential relay failure modes, data regarding the failure of slave relays were collected from the Nuclear Plant Reliability Database System and supplemented with survey information on slave relay failures from Westinghouse designed plants. The data collected included slave relay failures occurring after entry into commercial operation. The data were subdivided based on the surveillance interval (1-month, 2- or 3-month, and 18-month). The type AR relay survey data collected from Westinghouse plants indicated that after approximately 43,000 valid slave relay actuations and tests, 17 possible failures of the relay or latch attachment occurred in the ND relay population. Four of the 17 failures involved the ARLA latch attachment. Failure of the latch attachment will not prevent successful automatic actuation of the Engineered Safety Features Actuation System. Details of the failure experience review are provided in Section 9 of WCAP-13877.

Since a minimal number of failures were identified, no firm statistical conclusions could be drawn from the data. However, the data indicate a higher reliability than that assumed by IEEE 500, "Guide to the Collection and Presentation of Electrical, Sensing Component, and Mechanical Equipment Reliability Data for Nuclear Power Generating Stations." The data also indicated that even slave relays used in high-demand applications would be actuated significantly less than their design life limit when installed in the SSPS.

C. Failure Modes and Effects Analyses

Failure Modes and Effects Analyses (FMEA) were performed for the AR relays. The FMEAs considered the design and design history of the relays, failure modes and mechanisms based on failure history, materials performance data, and included input from design and manufacturing engineers. The FMEAs were performed based on guidance in IEEE 352-1987, "IEEE Guide for General Principles of Reliability Analysis of Nuclear Power Generating Station Safety Systems." Based on the results of the FMEAs, aging assessments were performed to determine the effects of thermal aging and out-gassing on slave relay reliability. The details of the FMEAs are included in Section 3 and 7 of WCAP-13877.

D. Aging Assessment

Continuously energized coils experience significant self-heating, resulting in accelerated age/temperature dependent degradation of components used in the relays. The temperature rise expected in normally energized type AR relays is between 10°C and 30°C. Actual temperature rises are dependent on relay sub-component location with respect to the coil and the ambient temperature. Since no actual failures of type AR AC relay coils were identified, the life expectancy determination was conservatively based on failure data for DC coil relays (type ARD).

To identify the type AR relay materials most susceptible to temperature accelerated aging and most likely to out-gas, available thermogravimetric analyses (TGA) applicable to temperature sensitive materials used in the construction of type AR relays were reviewed. The TGA is based on material performance data and considers the effect of temperature changes on the material. The materials identified as likely out-gassers and likely to degrade and cause relay degradation are neoprene rubber and Nylon Zytel 101. The other organic materials in the type AR relays are not susceptible to temperature accelerated aging. As such, there is little likelihood of significant out-gassing or evolution of corrosive compounds, such as hydrochloric acid, from the other materials. A detailed evaluation of the thermogravimetric analysis for the type AR relay components is included in Section 8 of WCAP-13877.

Conclusion of Aging Assessment

Westinghouse type AR relays used as ND SSPS slave relays will not experience temperature-induced, age-related degradation sufficient to result in failure within the 40-year plant life. Degradation of critical components requires substantial time and would result in no perceptible change in relay performance. Degradation of non-critical components, such as the neoprene armature sponge or magnet rubber, will result in perceptible changes to both appearance and material characteristics; however, no adverse impact to relay performance or reliability would occur.

Type AR relays used as NE SSPS slave relays will experience temperature-induced, age-related degradation sufficient to result in failure within the 40-year plant life and, therefore, should be replaced periodically dependent on temperature data specific to the location in the plant. Although no actual failures of type AR AC relay coils were identified, the life expectancy was conservatively determined based on failure data from type ARD DC coil relays. With replacement at a conservative interval, NE type AR relays will exhibit the same reliability as ND relays. WBN will implement a program to replace normally energized type AR slave relays at an appropriate interval as recommended in WCAP-13877.

Based on the results of the aging assessment, the probability of a relay malfunctioning or the reliability of slave relays

decreasing as a result of a refueling interval test frequency (i.e., 18 to 24 months) is low.

E. **Interposing Relay Reliability**

Since interposing relays can affect the ultimate function of the slave relay to start the required equipment, interposing relay reliability must be comparable to that of the associated slave relay. All of the slave relays and their actuated devices were evaluated for the presence of interposing relays. The majority of slave relays directly actuate ESF equipment, although some slave relays actuate a combination of equipment both directly and via interposing relays. Testing on a refueling frequency is adequate to confirm reliability and continuing operability of the type AR relays, subject to service life limitations of NE relays, based on the results of WCAP-13877. Interposing relays which are not type AR will continue to be tested every 92 days.

F. **Safety Evaluation Conclusions**

The slave relay reliability study verified that Westinghouse type AR relays are highly reliable. The aging assessment concludes that the degradation of ND and NE relays is sufficiently slow that a refueling frequency surveillance interval will adequately identify relay failures. The aging assessment also demonstrates that ND relays can be expected to operate reliably for a 40-year service life. NE relays will be replaced at an interval determined specifically for their location so as to maximize their reliability.

Testing on a refueling frequency is also adequate to confirm reliability and continuing operability of interposing relays which are Westinghouse type AR relays, subject to service life limitations of NE relays. Relays which are not Westinghouse type AR will continue to be tested every 92 days.

Based on the above evaluation, TVA concludes that there is reasonable assurance that the health and safety of the public will not be affected by the proposed changes.

Environmental Consideration

The proposed changes do not involve a significant hazards consideration, a significant change in the types of or significant increase in the amounts of any effluents that may be released offsite, or a significant increase in individual or cumulative occupational radiation exposure. Therefore, the proposed change meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), an environmental assessment of the proposed changes is not required.

ENCLOSURE 2

NO SIGNIFICANT HAZARDS CONSIDERATION DETERMINATION

Description of Proposed License Amendment

The proposed amendment would revise the Watts Bar Unit 1 Technical Specifications to change the surveillance frequency for Westinghouse type AR relays, used as solid state protection system slave relays or auxiliary relays, from quarterly to a refueling outage frequency.

Specifically, Surveillance Requirements (SR) 3.3.2.5 and 3.3.6.5 would be revised to change the frequency from "92 days" to "92 days OR 18 months for Westinghouse type AR relays".

To support these changes, the Watts Bar Unit 1 Technical Specification Bases would be revised as follows:

Technical Specification basis for B 3.3.2 would be revised by adding the following paragraph to the basis for SR 3.3.2.5: "For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The Frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 13."

The following reference would be added to B 3.3.2:
13. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

Technical Specification basis B 3.3.6 would be revised by adding the following paragraph to the basis for SR 3.3.6.5: "For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The Frequency is based on the relay reliability assessment presented in Reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 3."

The following reference would be added to B 3.3.6:
3. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

Basis for No Significant Hazards Consideration Determination

The Nuclear Regulatory Commission has provided standards for determining whether a significant hazards consideration exists (10 CFR 50.92 (c)). A proposed amendment to an operating license for a facility involves no significant hazards consideration if operation of the facility in accordance with the proposed amendment would not (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a

new or different kind of accident from any accident previously evaluated; or (3) involve a significant reduction in a margin of safety. Each standard is discussed below for the proposed amendment.

(1) Operation of the facility in accordance with the proposed amendment would not involve a significant increase in the probability or consequences of an accident previously evaluated.

This change to the Technical Specifications does not result in a condition where the design, material, and construction standards that were applicable prior to the change are altered. The same ESFAS instrumentation is being used and the same ESFAS system reliability is expected. The proposed change will not modify any system interface or function and could not increase the likelihood of an accident since these events are independent of this change. The proposed activity will not change, degrade or prevent the performance of any accident mitigation systems or alter any assumptions previously made in evaluating the radiological consequences of an accident described in the safety analysis report. Therefore, the proposed amendment does not result in any increase in the probability or consequences of an accident previously evaluated.

(2) Operation of the facility in accordance with the proposed amendment would not create the possibility of a new or different kind of accident from any accident previously evaluated.

This change does not alter the performance of the ESFAS mitigation systems assumed in the plant safety analysis. Changing the interval for periodically verifying ESFAS slave relays (assuring equipment operability) will not create any new accident initiators or scenarios. Implementation of the proposed amendment does not create the possibility of a new or different kind of accident from any accident previously evaluated.

(3) Operation of the facility in accordance with the proposed amendment would not involve a significant reduction in a margin of safety.

This change does not affect the total ESFAS system response assumed in the safety analysis. The periodic slave relay functional verification is relaxed because of the demonstrated high reliability of the relay and its insensitivity to any short term wear or aging effects. Implementation of the proposed amendment does not result in a reduction in a margin of safety.

Summary

Based on the above analysis, TVA has determined that operation of Watts Bar in accordance with the proposed amendment would not (1) involve a significant increase in the probability or consequences of an accident previously evaluated, (2) create the possibility of a new or different kind of accident from any accident previously evaluated, or (3) involve a significant reduction in a margin of safety;

therefore, operation of Watts Bar in accordance with the proposed amendment would not involve a significant hazards consideration as defined in 10 CFR 50.92.

ENCLOSURE 3

PROPOSED TECHNICAL SPECIFICATIONS

Marked-up Technical Specification and Bases Pages:

3.3-32
3.3-55
B 3.3-116
B 3.3-120
B 3.3-161
B 3.3-162

(Revised Technical Specification pages incorporating the proposed changes are also attached.)

3.3-32
3.3-35
B 3.3-116
B 3.3-116a
B 3.3-120
B 3.3-162

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.3.2.5	----------NOTE---------- Slave relays tested by SR 3.3.2.7 are excluded from this surveillance. ---------- Perform SLAVE RELAY TEST.	OR 18 months for Westinghouse type AR relays 92 days
SR 3.3.2.6	----------NOTE---------- Verification of relay setpoints not required. ---------- Perform TADOT.	92 days
SR 3.3.2.7	Perform SLAVE RELAY TEST on slave relays K603A, K603B, K604A, K604B, K607A, K607B, K609A, K609B, K612A, K625A, and K625B.	18 months
SR 3.3.2.8	----------NOTE---------- Verification of setpoint not required. ---------- Perform TADOT.	18 months
SR 3.3.2.9	----------NOTE---------- This Surveillance shall include verification that the time constants are adjusted to the prescribed values. ---------- Perform CHANNEL CALIBRATION.	18 months

(continued)

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.6-1 to determine which SRs apply for each Containment Vent Isolation Function.

SURVEILLANCE		FREQUENCY
SR 3.3.6.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.6.2	Perform ACTUATION LOGIC TEST.	31 days on a STAGGERED TEST BASIS
SR 3.3.6.3	Perform MASTER RELAY TEST.	31 days on a STAGGERED TEST BASIS
SR 3.3.6.4	Perform COT.	92 days
SR 3.3.6.5	Perform SLAVE RELAY TEST.	92 days OR 18 months for Westinghouse type AR relays
SR 3.3.6.6	----------NOTE---------- Verification of setpoint is not required. ---------- Perform TADOT.	18 months
SR 3.3.6.7	Perform CHANNEL CALIBRATION.	18 months

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.2.4 (continued)

The Frequency of 92 days is justified in Reference 7, except for Function 7. The Frequency for Function 7 is justified in Reference 10.

SR 3.3.2.5

SR 3.3.2.5 is the performance of a SLAVE RELAY TEST. The SLAVE RELAY TEST is the energizing of the slave relays. Contact operation is verified in one of two ways. Actuation equipment that may be operated in the design mitigation MODE is either allowed to function, or is placed in a condition where the relay contact operation can be verified without operation of the equipment. Actuation equipment that may not be operated in the design mitigation MODE is prevented from operation by the SLAVE RELAY TEST circuit. For this latter case, contact operation is verified by a continuity check of the circuit containing the slave relay. This test is performed every 92 days. The Frequency is adequate, based on industry operating experience, considering instrument reliability and operating history data.

INSERT A →

This SR is modified by a Note, which states that performance of this test is not required for those relays tested by SR 3.3.2.7.

SR 3.3.2.6

SR 3.3.2.6 is the performance of a TADOT every 92 days. This test is a check of the Loss of Offsite Power (Function 6.d), AFW Pump Suction Transfer on Suction Pressure – Low for motor driven and turbine driven pumps (Functions 6.f and 6.g respectively), and Turbine Trip and Feedwater Isolation - Main Steam Valve Vault Rooms Water Level - High (Function 5.d).

The SR is modified by a Note that excludes verification of setpoints for relays. Relay setpoints require elaborate bench calibration and are verified during CHANNEL CALIBRATION. The Frequency is adequate. It is based on industry operating experience, considering instrument reliability and operating history data.

(continued)

INSERT A (SR 3.3.2.5)

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The Frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 13.

BASES

REFERENCES (continued)

6. WCAP-12096, Rev. 6, "Westinghouse Setpoint Methodology for Protection System, Watts Bar 1 and 2," May 1994.

7. WCAP-10271-P-A, Supplement 1 and Supplement 2, Rev. 1, "Evaluation of Surveillance Frequencies and Out of Service Times for the Reactor Protection Instrumentation System," and "Evaluation of Surveillance Frequencies and Out of Service Times for the Engineered Safety Features Actuation System." May 1986 and June 1990.

8. Watts Bar Technical Requirements Manual, Section 3.3.2, "Engineered Safety Feature Response Times."

9. TVA Letter to NRC, November 9, 1984, "Request for Exemption of Quarterly Slave Relay Testing, (L44 841109 808)."

10. Evaluation of the applicability of WCAP-10271-P-A, Supplement 1, and Supplement 2, Revision 1, to Watts Bar.

11. Westinghouse letter to TVA (WAT-D-8347), September 25, 1990, "Charging/Letdown Isolation Transients" (T33 911231 810).

12. Design Change Notice W-38238 associated documentation.

13. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.6.3

SR 3.3.6.3 is the performance of a MASTER RELAY TEST. The MASTER RELAY TEST is the energizing of the master relay, verifying contact operation and a low voltage continuity check of the slave relay coil. Upon master relay contact operation, a low voltage is injected to the slave relay coil. This voltage is insufficient to pick up the slave relay, but large enough to demonstrate signal path continuity. This test is performed every 31 days on a STAGGERED TEST BASIS. The Surveillance interval is acceptable based on instrument reliability and industry operating experience.

SR 3.3.6.4

A COT is performed every 92 days on each required channel to ensure the entire channel will perform the intended Function. The Frequency is based on the staff recommendation for increasing the availability of radiation monitors according to NUREG-1366 (Ref. 2). This test verifies the capability of the instrumentation to provide the containment vent system isolation. The setpoint shall be left consistent with the current unit specific calibration procedure tolerance.

SR 3.3.6.5

SR 3.3.6.5 is the performance of a SLAVE RELAY TEST. The SLAVE RELAY TEST is the energizing of the slave relays. Contact operation is verified in one of two ways. Actuation equipment that may be operated in the design mitigation mode is either allowed to function or is placed in a condition where the relay contact operation can be verified without operation of the equipment. Actuation equipment that may not be operated in the design mitigation mode is prevented from operation by the SLAVE RELAY TEST circuit. For this latter case, contact operation is verified by a continuity check of the circuit containing the slave relay. This test is performed every 92 days. The Frequency is acceptable based on instrument reliability and industry operating experience.

INSERT B →

(continued)

INSERT B (SR 3.3.6.5)

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The Frequency is based on the relay reliability assessment presented in Reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 3.

BASES

SURVEILLANCE REQUIREMENTS (continued)

SR 3.3.6.6

SR 3.3.6.6 is the performance of a TADOT. This test is a check of the Manual Actuation Functions and is performed every 18 months. Each Manual Actuation Function is tested up to, and including, the master relay coils. In some instances, the test includes actuation of the end device (i.e., pump starts, valve cycles, etc.).

For these tests, the relay trip setpoints are verified and adjusted as necessary. The Frequency is based on the known reliability of the Function and the redundancy available, and has been shown to be acceptable through operating experience.

The SR is modified by a Note that excludes verification of setpoints during the TADOT. The Functions tested have no setpoints associated with them.

SR 3.3.6.7

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy.

The Frequency is based on operating experience and is consistent with the typical industry refueling cycle.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."

2. NUREG-1366, "Improvement to Technical Specification Surveillance Requirements," December 1992.

3. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.3.2.5	----------NOTE---------- Slave relays tested by SR 3.3.2.7 are excluded from this surveillance. ---------- Perform SLAVE RELAY TEST.	92 days OR 18 months for Westinghouse type AR relays
SR 3.3.2.6	----------NOTE---------- Verification of relay setpoints not required. ---------- Perform TADOT.	92 days
SR 3.3.2.7	Perform SLAVE RELAY TEST on slave relays K603A, K603B, K604A, K604B, K607A, K607B, K609A, K609B, K612A, K625A, and K625B.	18 months
SR 3.3.2.8	----------NOTE---------- Verification of setpoint not required. ---------- Perform TADOT.	18 months
SR 3.3.2.9	----------NOTE---------- This Surveillance shall include verification that the time constants are adjusted to the prescribed values. ---------- Perform CHANNEL CALIBRATION.	18 months

(continued)

SURVEILLANCE REQUIREMENTS

----------NOTE----------
Refer to Table 3.3.6-1 to determine which SRs apply for each Containment Vent Isolation Function.

SURVEILLANCE		FREQUENCY
SR 3.3.6.1	Perform CHANNEL CHECK.	12 hours
SR 3.3.6.2	Perform ACTUATION LOGIC TEST.	31 days on a STAGGERED TEST BASIS
SR 3.3.6.3	Perform MASTER RELAY TEST.	31 days on a STAGGERED TEST BASIS
SR 3.3.6.4	Perform COT.	92 days
SR 3.3.6.5	Perform SLAVE RELAY TEST.	92 days OR 18 months for Westinghouse type AR relays
SR 3.3.6.6	----------NOTE---------- Verification of setpoint is not required. --- Perform TADOT.	18 months
SR 3.3.6.7	Perform CHANNEL CALIBRATION.	18 months

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.2.4 (continued)

The Frequency of 92 days is justified in Reference 7, except for Function 7. The Frequency for Function 7 is justified in Reference 10.

SR 3.3.2.5

SR 3.3.2.5 is the performance of a SLAVE RELAY TEST. The SLAVE RELAY TEST is the energizing of the slave relays. Contact operation is verified in one of two ways. Actuation equipment that may be operated in the design mitigation MODE is either allowed to function, or is placed in a condition where the relay contact operation can be verified without operation of the equipment. Actuation equipment that may not be operated in the design mitigation MODE is prevented from operation by the SLAVE RELAY TEST circuit. For this latter case, contact operation is verified by a continuity check of the circuit containing the slave relay. This test is performed every 92 days. The Frequency is adequate, based on industry operating experience, considering instrument reliability and operating history data.

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in Reference 13. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 13.

This SR is modified by a Note, which states that performance of this test is not required for those relays tested by SR 3.3.2.7.

SR 3.3.2.6

SR 3.3.2.6 is the performance of a TADOT every 92 days. This test is a check of the Loss of Offsite Power (Function 6.d), AFW Pump Suction Transfer on Suction Pressure – Low for motor driven and turbine driven pumps (Functions 6.f and 6.g respectively), and Turbine Trip and Feedwater Isolation - Main Steam Valve Vault Rooms Water Level - High (Function 5.d).

(continued)

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.2.6 (continued)

The SR is modified by a Note that excludes verification of setpoints for relays. Relay setpoints require elaborate bench calibration and are verified during CHANNEL CALIBRATION. The Frequency is adequate. It is based on industry operating experience, considering instrument reliability and operating history data.

(continued)

BASES

REFERENCES (continued)

6. WCAP-12096, Rev. 6, "Westinghouse Setpoint Methodology for Protection System, Watts Bar 1 and 2," May 1994.

7. WCAP-10271-P-A, Supplement 1 and Supplement 2, Rev. 1, "Evaluation of Surveillance Frequencies and Out of Service Times for the Reactor Protection Instrumentation System," and "Evaluation of Surveillance Frequencies and Out of Service Times for the Engineered Safety Features Actuation System." May 1986 and June 1990.

8. Watts Bar Technical Requirements Manual, Section 3.3.2, "Engineered Safety Feature Response Times."

9. TVA Letter to NRC, November 9, 1984, "Request for Exemption of Quarterly Slave Relay Testing, (L44 841109 808)."

10. Evaluation of the applicability of WCAP-10271-P-A, Supplement 1, and Supplement 2, Revision 1, to Watts Bar.

11. Westinghouse letter to TVA (WAT-D-8347), September 25, 1990, "Charging/Letdown Isolation Transients" (T33 911231 810).

12. Design Change Notice W-38238 associated documentation.

13. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.6.5 (continued)

For ESFAS slave relays which are Westinghouse type AR relays, the SLAVE RELAY TEST is performed every 18 months. The frequency is based on the relay reliability assessment presented in reference 3. This reliability assessment is relay specific and applies only to Westinghouse type AR relays. Note that, for normally energized applications, the relays may require periodic replacement in accordance with the guidance given in Reference 3.

SR 3.3.6.6

SR 3.3.6.6 is the performance of a TADOT. This test is a check of the Manual Actuation Functions and is performed every 18 months. Each Manual Actuation Function is tested up to, and including, the master relay coils. In some instances, the test includes actuation of the end device (i.e., pump starts, valve cycles, etc.).

For these tests, the relay trip setpoints are verified and adjusted as necessary. The Frequency is based on the known reliability of the Function and the redundancy available, and has been shown to be acceptable through operating experience.

The SR is modified by a Note that excludes verification of setpoints during the TADOT. The Functions tested have no setpoints associated with them.

SR 3.3.6.7

A CHANNEL CALIBRATION is performed every 18 months, or approximately at every refueling. CHANNEL CALIBRATION is a complete check of the instrument loop, including the sensor. The test verifies that the channel responds to a measured parameter within the necessary range and accuracy.

The Frequency is based on operating experience and is consistent with the typical industry refueling cycle.

REFERENCES

1. Title 10, Code of Federal Regulations, Part 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."

2. NUREG-1366, "Improvement to Technical Specification Surveillance Requirements," December 1992.

3. WCAP-13877, Rev. 0, "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slave Relays," January 1994.

ENCLOSURE 6

WESTINGHOUSE APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE AND AFFIDAVIT; PROPRIETARY INFORMATION NOTICE; AND COPYRIGHT NOTICE

(Documents are attached)

Westinghouse Electric Corporation
Energy Systems
Box 355
Pittsburgh Pennsylvania 15230-0355

May 1, 1995
CAW-95-816

Office of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. William T. Russell, Director

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Reliability Assessment of Westinghouse Type AR Relays Used As SSPS Slaves Relays" (WCAP-13877)

Dear Mr. Russell:

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-95-816 signed by the owner of the proprietary information, Westinghouse Electric Corporation. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by Tennessee Valley Authority.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-95-816, and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety Regulatory & Licensing Activities

LVT/bbp
Attachment

cc: Kevin Bohrer/NRC(12H5)

N3RLA208L/CAW816

CAW-95-816

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Henry A. Sepp, Manager
Regulatory and Licensing Initiatives

Sworn to and subscribed
before me this 2nd day
of May, 1995

Denise K Henderson
Notary Public

Notarial Seal
Denise K. Henderson, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Oct. 28, 1996
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory and Licensing Initiatives, in the Nuclear Technology Division, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in "Reliability Assessment of Westinghouse Type AR Relays Used as SSPS Slave Relays", WCAP-13877 (Proprietary), January, 1994 for Watts Bar Units 1 and 2, being transmitted by Tennessee Valley Authority letter and Application for Withholding Proprietary Information from Public Disclosure, to Document Control Desk, Attention William T. Russell. The proprietary information as submitted for use by Tennessee Valley Authority for Watts Bar Units 1 and 2 is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of Westinghouse type AR relay reliability.

This information is part of that which will enable Westinghouse to:

(a) Provide a basis for assessing slave relay reliability.

(b) Provide an FMEA for Westinghouse type AR relay DC coil.

(c) Provide failure experience.

(d) Assist the customer in obtaining NRC approval.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar methodologies and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing testing and analytical methods and performing testing.

Further the deponent sayeth not.

Proprietary Information Notice

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

Copyright Notice

The reports transmitted herewith each bear a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary versions of these reports, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document room in Washington, DC and in local public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.