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

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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

**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 |

| ID# | PLANT | UNIT/ TRAIN | RELAY ID # | RELAY TYPE | TEST PERIOD (months) | OPERAT. CYCLES | EVENT/ DATE | FAILURE | ROOT CAUSE | NOTES |
|---|---|---|---|---|---|---|---|---|---|---|
| | **TABLE 9-8 - RELAY NON-FAILURES** | | | | | | | | | |
| 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.