UNITED STATES
NUCLEAR REGULATORY COMMISSION
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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."