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Office of Nuclear Reactor Regulation, Director (Post 870411

SUBJECT: Supplement to 910812 Part 21 rept re potential generic defects in ABB Type RHMH2 Model RK223068-EA & 069-EA relays. Caused by tape fold back condition.New method for installing insulation tape initiated.

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UNITED CONTROLS

December 12, 1991

Director, Office Of Nuclear Reactor Regulation
US Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: United Controls 10CFR Part 21
Notification Dated 08/12/91

Subject: Investigation Results Of Potential Generic Defect Of
ABB Type RHMH2 Model RK223068-EA and 069-EA Relays

Representatives from United Controls traveled to the ABB Manufacturing Facility of the subject relays in Bollnas, Sweden on August 13-16, 1991. The objective was to provide in-process inspection of replacement relays being manufactured for the Turkey Point Plant, and to investigate the root cause of the relay failure and potential coil defect. The following paragraphs describe the investigation results.

Background

As defined in the 10CFR Part 21 Notification of 08/12/91, the subject relays were procured commercially, and dedicated by qualification testing for Nuclear Safety Related Application. The relays are utilized in the Emergency Diesel Generators Bus Load Sequencers at Turkey Point 3 and 4. During performance of a pre-operational test, one stripping relay short circuited. Examination of the relay indicated the burnout of a coil lead wire causing a short circuit across the coil. The failed relay was provided to ABB by FP&L for root cause analysis.

After examining the relay, ABB decided to send a team from the Bollnas, Sweden factory to inspect a sample of more relays at the Turkey Point Plant. The inspection was based on a special inspection procedure dated 08/05/91. This procedure defined a minimum coverage of 1mm of tape to be over the lead wire and the terminal edges (It should be noted that when design and inspection documents were checked at the ABB factory, there was no indication the 1mm tape coverage criteria had been previously utilized). When relays in storage at the plant were disassembled, it was found that many were in violation of this criteria. Due to the parallel tape placement, the lead wire commonly comes very close to the inside edge of the tape. As a result, ABB rejected the samples examined, and subsequently the entire population of relays in the sequencers and spares. At this point, the 10CFR Part 21 was initiated.

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Design Control

The design control function for the Type RXMH2 is the responsibility of the ABB Vasteras, Sweden facility. It was established that this relay design was originated in 1962, and revised to its current configuration in 1969. The design of the coil has remained basically unchanged since 1962. Each newly developed relay design is run through a "Type Testing" program. This consists of functional and endurance testing to establish the specification limits. For example, normal pickup and drop out times. The Product Engineering Manager for the RXMH line stated that to the best of his knowledge, there has been no other coil failures of the type in question. In industrial application, if isolated coil failures occurred, they would probably not be noted.

A critical portion of the root cause investigation was to establish if any other ABB relay designs could be affected by the insulation tape placement problem. Based on review of various design documents/drawings and statements made by ABB Engineering, it is clear the unique coil design of the Type RXMH2 is the only possible design affected. No other coil design possess leads which are directly against the windings. All of the other types of coils (three different designs) manufactured at the Bollnas plant were examined to further verify no other coil designs could be affected.

The hierarchy of drawings for the RHMH2 RK223 were reviewed during the investigation. The general configuration drawing tiers down through two levels to the coil/terminal drawing 1227-051. This drawing was last revised in 1982. The tape placement indicated by this drawing is consistent with the failed relay. However, for the operator to physically place this tape in this configuration, it would be required to pre-cut the tape in a shape that would not overlap the core of the spool. In actual manufacturing practice, the tape was being placed along the edge of the core. This resulted in the lead wire being very close to the tape edge.

Contrary to the coil drawing, the Bollnas plant changed the tape application method in late 1989. ABB stated that sometime in late 1989, the tape manufacturer could no longer supply the required width of 13mm. As a result, it was decided the tape would then be placed at an angle across the lead to insure adequate coverage. This change was never documented.

Manufacturing Process

The coil consists of a plastic spool, two terminals, winding wire, lead wire insulation tape, and an insulating cover. ABB manufactures the plastic spool, and assembles the coil from vendor supplied sub-components. The first step in the coil assembly process is soldering the lead wire to the appropriate terminal. Next is the placement and taping of the lead wire around the spool. The spool is then placed onto the fixture of an automated winding machine. After the required count of winding turns is complete, the wire is then soldered to the remaining terminal.

The coils at the Bollnas facility are built on a per order basis. There is no inventory kept that could be inspected for the subject lead insulation problem. Although the coils are assembled for a specific job, there is no date code or operator identification on the coil assembly.

Inprocess Inspection

To establish that adequate insulation tape coverage on the coil lead wire is now obtained, approximately 120 of the Turkey Point replacement coils were examined. It was apparent that the new angled tape placement method will provide a high confidence of achieving total coil lead coverage. Since this design change had not been documented, and no other documentation existed to indicate when the change was made, no conclusive date can be established for when the tape placement method changed.

ABB committed to revise the coil assembly drawing to reflect the current tape placement practice. This is to be accomplished by 10/01/91.

ABB Investigation Results

ABB had investigated the possible cause(s) of the actual coil failure, and determined two contributing factors. As previously referenced, one of these was the tape manufacturer no longer supplying the 13mm tape width specified on Drawing 1227 051 Rev. 7. It was said this initiated the change to an angled application of the insulation tape. During the shop inspection, the current supply of tape was measured to be 12.5mm, which would not appear to be a size difference that would necessitate a design/manufacturing change.

In connection with this change, it was also stated that one of the three coil assembly operators was not notified of the revised tape application method. The March 1989 to September 1990 time frame referenced by ABB as the potentially affected date codes; is based on the theory that this operator was unaware of the change during these times. Unfortunately, there was no documentation available to substantiate these dates. It was also stated by ABB Bollnas, that this particular operator was determined to be inadequate for the fine detail of work required for coil production, and was ultimately removed from this function.

United Controls Supplemental Test Program

It was not until the last day of the audit that the UCI representatives were able to examine (for the first time) the actual Turkey Point failed relay coil. The coil exhibited a blackened burn area where the lead wire had shorted against the coil windings. This was clearly caused by a lack of the required insulation tape. However, the tape placement on the coil was not what caused this particular burnout. Rather the tape end had been folded back over its self (see attached drawing). This left about 3mm of the lead wire completely exposed to the windings. Even with this condition, the relay passed functional testing at the ABB factory and at United Controls, and several pre-operational tests at Turkey Point before failure occurred. The ABB Relays Manger of Protection Equipment was asked, if the failed coil may have had the tape folded back by the rotating wire on the winding machine. He thought this was a definite possibility.

Since it is evident that the only known failed coil suffered from an entirely different problem than the coils that were rejected by ABB from the sample checked at Turkey Point, there is the possibility that no generic defect exists. If only coils possessing a folded back condition on the insulating tape are subject to failure, then it may not be correct to define a lead wire in violation of the 1mm distance to the tape edge criteria, as a generic defect. To test this hypothesis, it was decided to run endurance cycling on a relay that fails the 1mm inspection criteria.

Test Results

A test apparatus was designed to allow any time sequence for relay actuation desired. This was accomplished with an Allen-Bradley

programmable logic controller. The test was designed to achieve a simulation of actual relay use in the FP&L sequencers, and to establish cycling endurance capabilities. A diagram of the test set-up is attached.

The first portion of the test cycled the relay for 5 minutes of coil actuation, followed by a 3 second release and pickup. This was designed to simulate the in service application at Turkey Point in the EDG Sequencers. This was performed over a 48 hour period for a total of 621 cycles. The following readings were recorded by calibrated M&TE during the test:

1. Test Equipment

   - Volt Box AC Power Supply
   - Allen Bradley SLC 100 PLC
   - Veeder Root Timer/Counter
   - Fluke 8060A True RMS Multimeter

2. Measurements

   - 121.7 Volts AC Supplied To Relay
   - 29.4 Millamps Across The Coil During Actuation
   - 47 Millamps Peak In Rush Current Across The Coil During Cycling

The second test was designed to simulate the maximum cycling that would be anticipated over the lifetime for an RXMH relay in any application. This test generated a total of 22013 cycles. The cycle timing was 5 seconds actuated, 3 seconds release and pick-up.

The third test performed was at a 20% over-voltage condition. A reading of 136.78 VAC (.47 mA AC coil current) was supplied to the relay. The relay was cycled at 3 seconds actuated, 2 seconds release/pick-up, for a total of 20140 cycles.

The final phase of the testing was to complete the UL required forty-eight hour temperature-humidity test. These environmental conditions are the only other influences that would be likely to impact coil insulation integrity. The test was comprised of forty-eight hours in a chamber at 40° C, and 90% humidity. This was followed by a current leakage test (.773 micro amps), and a hi-pot (no breakdown). ABB rates the maximum allowable current leakage to be .5mA.

Inspection of the coil after the endurance testing indicated no sign of any degradation.

Conclusion

It is difficult to establish any absolute conclusion based on the information provided in this report.

Consider the following facts:

1. The new method of installing insulation tape nearly eliminates the possibility of inadequate lead wire coverage.

2. There is no conclusive evidence to define what time frame(s) may limit the relays that possess coils which violate the 1mm tape coverage inspection criteria.

3. The relay that actually failed was the result of a tape fold back condition that has not been found on any other coil.

4. The functional/endurance testing performed on a relay possessing a coil that violated the 1mm tape coverage criteria, significantly exceeded normal lifetime cycling expectations in the subject application.

5. There is no previously known pattern of failure for the Type RXMH relay.

Since the 1mm criteria does not appear to be indicative of a coil that will fail, and the failed coil resulted from an apparent isolated incident, it is the opinion of United Controls that there is no evidence to indicate a generic defect exists.

Appendix 1

Relay Endurance Test Data

Test 1 Start 09/18/91 at 3:18 p.m., cycles 621 @ 5 minutes energized, and 3 seconds de-energized. End on 09/20/91 at 11:15 a.m.

Test 2 Start 09/20/91 at 3:25 p.m., cycles 22013 @ 5 seconds energized, 3 seconds de-energized. End on 09/22/91 at 9:40 a.m.

<u>Test 3</u> Start 10/03/91 at 7:45 a.m., cycles 20140 @ 3 seconds energized, 2 seconds de-energized. End on 10/14/91 at 11:40 a.m.

Relay Lot Code 8938

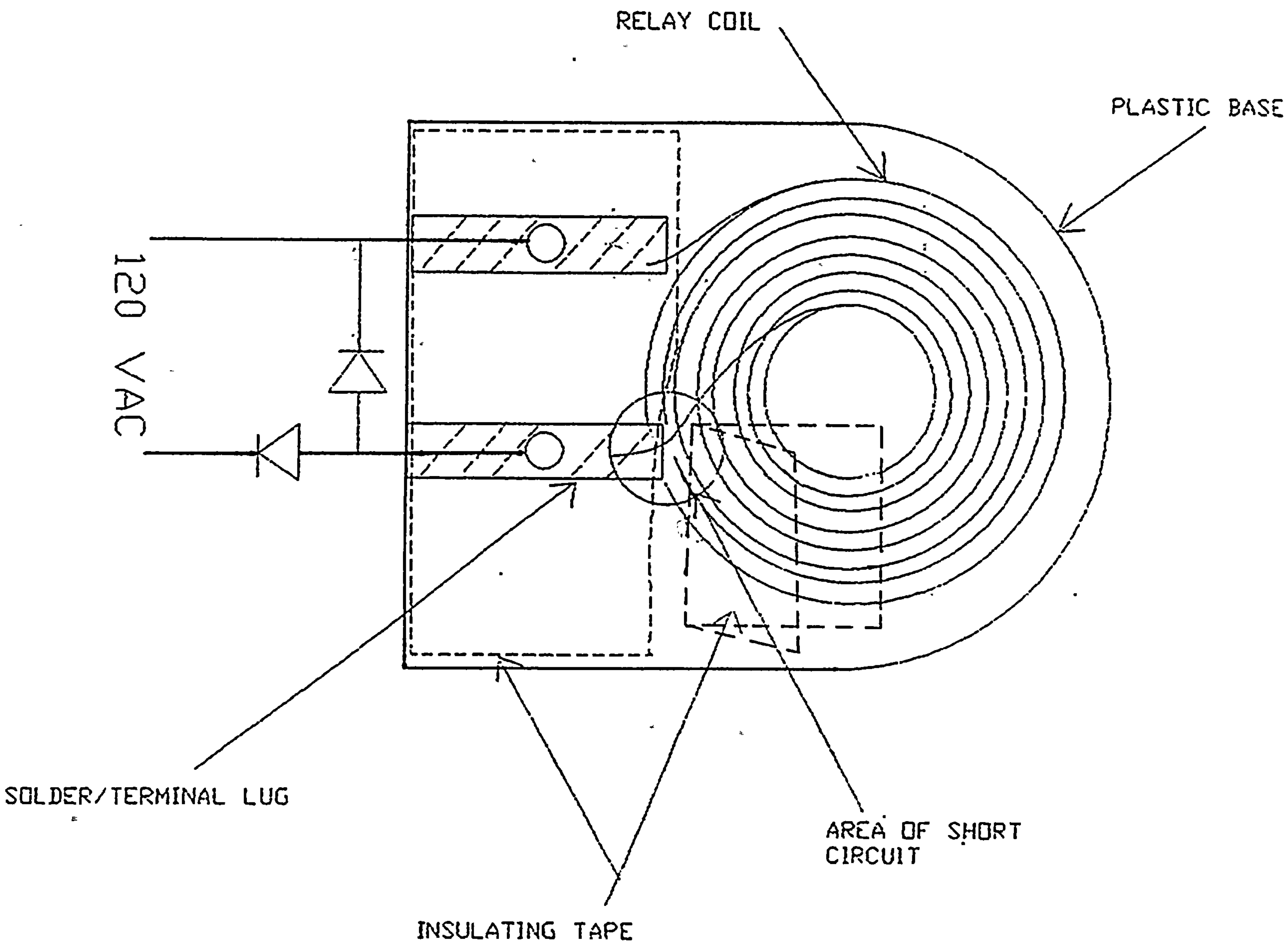
<u>Attachments</u>

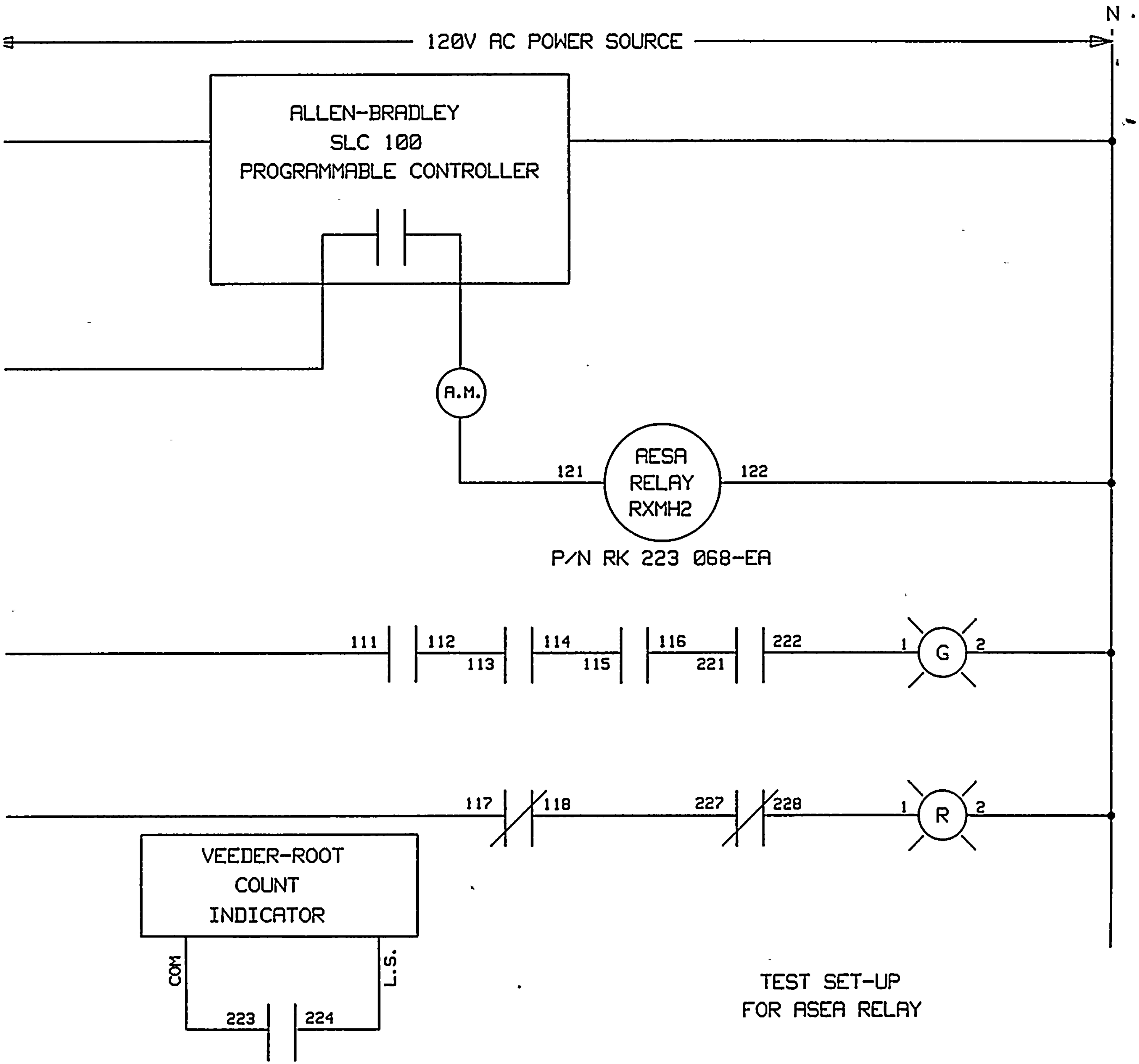
1. Drawing depicting coil insulation tape fold back condition.

2. Test set-up diagram for cycling test relay

Prepared by: [signature] Date: 12/20/90
Director of Quality & Tech.
Services United Controls Div. Hub Inc.

ATTACHMENT 1





TEST SET-UP
FOR ASEA RELAY

ATTACHMENT 2