UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

January 17, 1995

NRC INFORMATION NOTICE 95-02: PROBLEMS WITH GENERAL ELECTRIC CR2940 CONTACT BLOCKS IN MEDIUM-VOLTAGE CIRCUIT BREAKERS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to potential failures of General Electric (GE) Magne-Blast (Types AM and AMH) and Ge/Vac (Type VVC), medium-voltage (4.16, 7.2, and 13.8-kilovolt) circuit breakers to operate properly because of defective GE Type CR2940 contact blocks used as control switches in the breaker control circuits. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

In the fall of 1993, during post-overhaul testing of some safety-related (Class 1E) 4160-Vac circuit breakers (GE Model AM-4.16-250-8HB) at the Maine Yankee Atomic Power Station (Maine Yankee), there were several failures of the breakers to close electrically. In two instances, troubleshooting revealed that although the closing springs for the breakers were fully charged, which would allow the breakers to be closed manually, the electrical closing control circuits in the breakers were not being completed. The cause was found to be stuck open contacts of a CR2940U301 (normally-closed shelf state) contact block which is one of the three contact blocks in breaker-mounted "power switch" assembly 52-SM/LS.

In another instance at Maine Yankee, a breaker failed to close electrically because one of two normally-open configuration CR2940U310 contact blocks used in cubicle interlock switch assembly 52IS was not being closed as required. The cause was found to be that the contact block had come loose from its mounting due to a defective fastener and improper installation.

Attachment 1 to this notice explains in more detail the operation of the switches and their failure modes and effects. Attachment 2 illustrates the arrangement and operation of these switches.

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Discussion

Power Switch Failures

During a recent overhaul of the 4160-Vac Class 1E breakers at Maine Yankee by a team from GE Apparatus Service Division (Philadelphia), the over 10-year-old original CR2940 contact blocks were replaced. Internal examination of the failed switches revealed that the moving contacts (5 and 6) of the normally-closed contact block were stuck in the open position. This appeared to result from mechanical interference that prevented reclosure of the contacts by their internal return springs. These observations raised the question of the reliability of at least this batch of new CR2940s (their date codes, e.g., "MA316=" indicated 1993 manufacture). The NRC is pursuing this issue with the CR2940 manufacturer (GE Electrical Distribution & Control or ED&C), the breaker manufacturer (GE Specialty Breaker Plant or SBP), and GE Nuclear Energy (GE NE). Preliminary reports indicate that the affected contact blocks came from a batch or batches that had some excess plastic injection mould flashing that was apparently interfering with the movement of the moving contact bar or its carrier assembly. GE ED&C is continuing to investigate to determine the root cause(s) and scope of the problem, but has already instituted some initial corrective actions and preventive measures at its factory in Puerto Rico.

GE SBP has informed the NRC that contacts 5-6 are provided when another accessory function called [trip] latch checking is supplied as an option. In some applications, contacts 5 and 6 provide a white light indication on the switchgear panel that the closing spring is charged and also that control power is available (hence the term "white light switch").

According to a technical evaluation by the Maine Yankee Plant Engineering Department, done as part of a modification screening pursuant to Section 50.59 of Part 50 of the *Code of Federal Regulations* (10 CFR 50.59), contacts 5 and 6 are not required for a close-permissive function to inhibit closing attempts during closing spring charging, because the Magne-Blast mechanism design does not permit breaker closure before the closing spring is fully charged. Although contacts 5 and 6 have no required function at Maine Yankee, they can disable the breaker electrical closing circuit should they stick open. In consultation with GE, Maine Yankee has determined that no required function of the breaker would be impaired if contacts 5 and 6 are bypassed. However, in this condition, the light would not indicate closing spring status. The suitability of such a modification for a given plant would need to be determined through a technical evaluation.

For certain safety-related loads (e.g., low-pressure safety injection pumps), the breakers are normally open, but close on engineered safety feature actuation signals during design basis events. To ensure the reliability of the affected breakers until the white light switches could be jumpered out, Maine Yankee required electricians to check the continuity across contacts

5 and 6 immediately after each Magne-Blast breaker closure. In this manner, the ability of the breaker to be reclosed electrically (by a control room operator, by an engineered safety feature actuation signal, or by the emergency diesel generator load sequencer) following a loss of offsite power in which a breaker has been opened for initial load shedding, can be confirmed.

Interlock Switch Failure

The two normally open (shelf state) configuration CR2940U310 contact blocks in interlock switch assembly 52IS are ganged together such that they are both held closed when the vertical lift breaker is fully elevated in its cubicle or in the test position. However, in one breaker, the hole drilled in the head of one of the two special mounting screws in the upper contact block (fastening it to its mounting bracket) had no female threads tapped into it. Consequently, the technician installing the new lower contact block as part of the overhaul was not able to use both screws. Apparently the lower contact block nevertheless was mounted onto the upper block by only one screw. As a result, during subsequent operations of the breaker, the lower block became loose. Its plunger could not be depressed to close it by the moving contact carrier of the upper contact block, and the breaker closing circuit therefore did not function.

Several other special fasteners among those in the contact blocks used for the Maine Yankee breaker overhaul were found to contain deviations such as incomplete threading and/or shallow screwdriver slots. The manufacturer has determined that the problems occurred when a screw making machine shut itself down due to a broken tool. On this occasion, a number of defective screws that passed through during the shutdown sequence were not captured. The manufacturer corrected the problem and believes that it is limited to a few screws in contact blocks with MA3XX= (1993) date codes. The manufacturer has instituted tighter controls to prevent recurrence and has inspected its stock. In addition, GE Nuclear Energy has reported upgrading its process for dedicating the commercial grade components used in manufacturing and overhauling safety-related breakers. Defective fasteners may be identified by examination of each contact block upon delivery.

Another problem reported has been CR2940 contacts in the charging motor circuit becoming welded shut when interrupting charging motor current. In normal operation, one of the CR2940s in 52SM/LS interrupts motor running current and very few instances of welding have been reported. However, during manual interlock lever operation with control power applied, if motor fuses are not removed, one of the 52IS contact blocks will momentarily energize the charging motor. When the contacts reopen, they must interrupt motor starting current (which is much higher than the current normally seen) sometimes severely pitting or even welding the contacts. In addition, new contact blocks occasionally have been found to not function during receipt/acceptance testing (sometimes as part of commercial grade dedication), some due to incorrect installation of internal parts.

At the request of GE NE, the breaker product department is looking into using a different switch, at least for nuclear safety-related service, that is more reliable for these Magne-Blast applications, and is planning to issue a Service Advice Letter (SAL) that will address these problems. Inquiries on this subject may be directed to GE Nuclear Energy Power Delivery Services in King of Prussia, Pennsylvania (Phone: 610-992-6049/Fax: 610-992-6191).

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact the technical contact listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

Brian K. Grimes, Director
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Office of Nuclear Reactor Regulation

Technical contact: Stephen D. Alexander, NRR
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Attachments:
1. Operation and Failure Modes of Magne-Blast Control Switches
2. Arrangement and Operation of AM-4.16 Control Switches
3. List of Recently Issued NRC Information Notices

OPERATION AND FAILURE MODES OF MAGNE-BLAST CONTROL SWITCHES

The stuck open power switch contacts are shown on the breaker connection diagram as contacts 5 and 6 of "power switch" assembly 52-SM/LS, which consists of three CR2940 contact blocks or switches ganged together. Depending on the breaker configuration with the various control options available, contacts 5 and 6 of 52-SM/LS are known as the "close permissive switch," the "control power available/closing spring charged switch," or most commonly, the "white light switch." The breaker electrical connection diagram (also shown in Attachment 2) shows the three CR2940 contact blocks that comprise power switch 52-SM/LS as normally open contacts 1, 2, 3, and 4, and normally closed contacts 5 and 6. Note that at some plants, plant diagrams may designate these as switches S-1 (5 and 6), S-2 (3 and 4), and S-3 (1 and 2). The three contact blocks are opened or closed simultaneously by the interaction of their plungers and moving contact carriers, according to the state of the breaker closing spring. A striker and cam mechanism, which operates by the action of the breaker closing spring and its charging and release mechanism, actuates the first contact block plunger. Its moving contact carrier in turn operates the plunger of the next (middle) tandem contact block, the moving contact carrier of which then operates the plunger of the third contact block. Contacts 3 and 4 are in the anti-pump (52Y relay) circuit and contacts 1 and 2 control the closing spring charging motor. The switch with contacts 3 and 4 and the switch with contacts 1 and 2 are both of the normally open (or "momentary contact") configuration with catalog number CR2940U310. Contacts 5 and 6 are in series with the breaker closing circuit. The switch with contacts 5 and 6 is a normally closed or "maintain contact" configuration; catalog number CR2940U301.

In operation, immediately after the breaker closing spring discharges to close the breaker, contacts 1, 2, 3 and 4 of power switch assembly 52-SM/LS are held closed during the charging cycle of the closing spring and are allowed to reopen (by means of their individual internal contact return springs) when the breaker closing spring is fully charged. There were no reported instances of mechanical interference and failure to return to the normally open state. Contacts 5 and 6, held open during closing spring charging, are supposed to reclose by means of their internal contact return springs when released upon completion of the breaker closing spring charging cycle. However, the CR2940U301 contact block containing contacts 5 and 6 in two of the Magne-Blast breakers being tested failed to reclose when required, thus disabling the closing control circuits of the breakers. The moving contact bar of the normally-open configuration contact block (CR2940U310) was a relatively straight piece; whereas, the moving contact bar of the failed normally-closed configuration contact block (CR2940U301) was a complex curved piece, which appeared to make it more susceptible to interference, apparently from excess plastic mould flashing.

The two normally open (shelf state) configuration CR2940U310 contact blocks in interlock switch assembly 52IS are ganged together such that they are both held closed when the vertical lift breaker is fully elevated in its cubicle

(they can also be closed in the test position). The contact block or switch containing 52IS contacts 1 and 2 (in series with the breaker closing spring charging motor circuit) is mounted on the bottom of a small bracket at the top of the left side of the operating mechanism frame by means of two special machine screws. The heads of these screws are to be drilled and tapped with female threads to accept the male threads of the mounting screws of the other 52IS contact block (containing contacts 3 and 4 in the breaker closing circuit) that is designed to be mounted onto the bottom of the first contact block. A lever of the breaker cubicle interlock mechanism operates the plunger of the upper (charging motor interlock) contact block. Simultaneously, the moving contact carrier assembly inside the upper switch operates the plunger of the lower (closing interlock) contact block that protrudes into the case of the upper contact block. The lack of female threads being cut into the hole drilled in the head of one of the two special mounting screws in the upper contact block prevented the use of one screw in mounting the lower contact block properly. As a result, during subsequent operations of the breaker, the lower block became loose such that its plunger could not be depressed to close it by the moving contact carrier of the upper contact block. The breaker closing circuit therefore did not function.

ARRANGEMENT AND OPERATION OF AM-4.16 CONTROL SWITCHES

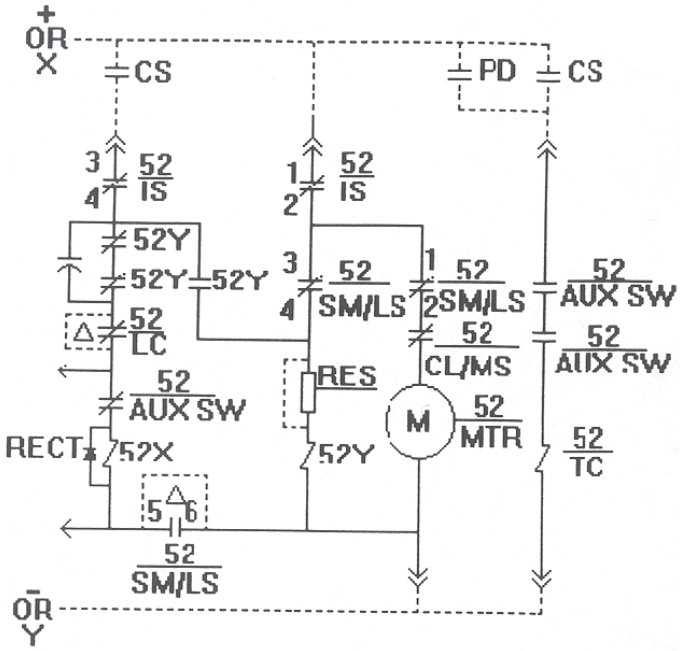

FIG. 1 MAGNE-BLAST CONTROL CIRCUIT SCHEMATIC
(ADAPTED FROM INSTRUCTION BOOK GEI-88761)

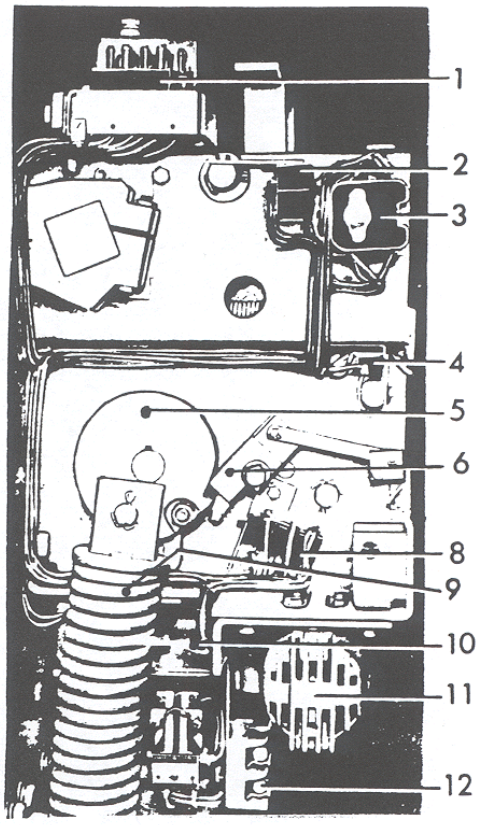

FIG. 2 - LEFT SIDE VIEW
ML-13 OPERATING MECHANISM

FIG 2 REF	COMPONENT	REF	COMPONENT
1	2ndy CONNECTOR	10	LATCH MONITOR SW
6	CAM STRIKER	12	MOTOR FUSES

CIRCUIT SYMBOL	CONTACT	NOMENCLATURE AND FUNCTION	FIGURE 2 REF	SHELF STATE CATALOG NO.
52 / SM/LS	1 and 2	Power Switch Assembly Charging Motor Control	8-POWER SW 11-MOTOR	NO CR2940U310
52 / SM/LS	3 and 4	Power Switch Assembly 52Y Relay Enable	8-POWER SW 3-AUX SW	NO CR2940U310
52 / SM/LS	5 and 6	Power Switch Assembly "White Light"	8-POWER SW 4-LTCH CK SW	NC CR2940U301
52 / IS	1 and 2	Interlock Switch Assembly Charging Motor Control	2-IS (UPPER) 5-SWITCH CAM	NO CR2940U310
52 / IS	3 and 4	Interlock Switch Assembly Closing Circuit Enable	2-IS (LOWER) 9-CLSG SPRNG	NO CR2940U310