February 10, 1997

Mr. Donald A. Reid
Vice President, Operations
Vermont Yankee Nuclear Power Corporation
Ferry Road
Brattleboro, VT 05301

SUBJECT: TECHNICAL REVIEW OF DRAFT INFORMATION NOTICE

Dear Mr. Reid:

The staff is developing an information notice to alert licensees to potential failure of subcomponents in General Electric Type AM and AM 4.16kV Magne-Blast circuit breakers. Because your plant has been involved with these failures, we request that you perform a technical review of the applicable portions of the enclosed draft notice to ensure the technical information is correct. The draft information notice is also being sent to General Electric for technical review. This draft notice was faxed to Jim Duffy of your staff on February 4, 1997. If no telephone comments are received by February 14, 1997, we will assume the technical information in the notice is correct. Please provide a written response within 30 days of the date of this letter.

Sincerely,

(Original Signed By)

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Vernon L. Rooney, Sr. Project Manager
Project Directorate I-3
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosure: As stated

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

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

February xx, 1997

NRC INFORMATION NOTICE 97-XX: POTENTIAL FAILURES OF GE MAGNE-BLAST CIRCUIT BREAKER SUBCOMPONENTS

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 six subcomponents in General Electric (GE) Type AM or AMH 4.16 Kv circuit breakers that can render the breakers inoperable. The subcomponents in question are: (1) the trip crank; (2) the CR2940 contact blocks that make up the power switch assembly; (3) the manual trip lever and its supporting "L" bracket in the AMH horizontal drawout breakers; (4) the cotter pin that holds the latch pawl hinge pin in place; (5) the spring charging motor tie bolts; and (6) the Type HMA control relay. 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 - Trip Crank Failures

The NRC has learned that several plants have experienced failures of the trip crank (GE Part No. 105C9316G1, Piece No. 29 of Figure 1 in GE ML-13 Mechanism Renewal Parts Bulletin GEF-4379) in Magne-Blast circuit breakers in which the pin at the end of the trip crank breaks off upon energizing the trip coil. The trip crank pin goes into a hole in the lower end of the link between the trip crank and the trip coil armature. If the pin breaks off before the trip crank can successfully rotate the trip shaft (which has been the case in most instances), the breaker will fail to trip remotely (although it can still be tripped with its local manual push button).

Discussion - Trip Crank Failures

GE has attributed the broken pins to three principal factors: (1) lack of adequate control of one of the critical machined dimensions on the pin during

the early 1970s, lack of adequate fusion in some of the pin-to-plate welds, and (3) grinding flush of the weld reinforcements on the back of the trip crank plates. Upon being informed of the first of the instances of pin failure in 1988 (at TVA's Watts Bar Nuclear Plant), in addition to instituting more rigorous QC checks on the pins and finished trip cranks, GE added a note to the pin weld detail on its trip crank fabrication drawing (105C9316) warning "DO NOT GRIND FLUSH." Several instances of failures were reported after the initial Watts Bar report and many potentially susceptible breakers were found in the field, all with their original trip cranks made in the early 1970s. However, there have been no reported instances of failures of trip cranks manufactured after 1988.

Also, if the remote trip signal (either from a protective relay or a manual hand switch) is applied for more than a few seconds (and it normally is) and the breaker fails to trip (such as it would if the trip crank pin broke), neither the breaker mounted auxiliary switch, nor the stationary (cubicle-mounted) auxiliary switch will signal control circuits that the breaker has opened and thus the trip signal will normally remain applied. Energizing the trip coil (which is normally energized only momentarily) for an extended period of time may open-circuit the coil, rendering it permanently inoperable.

Trip cranks that are potentially susceptible to this failure are easily identified without disassembly of the breaker mechanism. With the mechanism front cover removed, the gap between the trip crank and the right side of the mechanism frame may be seen. It is then possible to see if the weld reinforcement has been ground off. GE is preparing a SAL on this problem in which they intend to recommend replacement of any trip cranks without the proper thickness of pin weld reinforcement (1/32-1/16 inch). GE SBP will provide the replacement cranks.

Description of Circumstances - Contact Block CR2940 Contact Resistance

On February 12, 1996, the Fitzpatrick licensee experienced failures of two residual heat removal service water (RHRSW) pumps to start on demand because their supply breakers failed to close. RHRSW pump C failed to start on demand during monthly surveillance testing and RHRSW pump A failed to start while attempting to place it in service as part of a suppression pool cooling evolution. Licensee investigation found that the Magne-Blast breakers failed to close because high resistance across one of the power switch assembly contacts prevented the closing coil from being energized.

Discussion - Contact Block CR2940 Contact Resistance

The power switch assembly consists of 3 GE Type CR2940 contact blocks stacked together so that all 3 sets of contacts are actuated by a single striker. Two of the contacts (1-2 and 3-4) are normally open and are held closed by the striker during the spring charging operation. When the charging cycle is complete the contacts spring-return to the open position to cut off power to the spring charging motor and the control (anti-pump) relay (52Y). The third set of contacts (5-6) is normally closed and is included as an option to allow remote indication of the closing spring status (charged/discharged) usually by means of a white indicator light in the control room. This third contact is often called the "white light" contact for this reason. This contact is wired into the breaker control circuitry such that failure of the contact to close

will prevent the breaker closing coil (52X) from being energized and the breaker cannot be closed electrically.

The licensee determined that the CR2940 contacts were misapplied in the Magne-Blast breaker control circuitry because the contacts are rated for only 2.2 amps dc and are required to interrupt 6.0 amps dc (LER 50/333 96-002, Accession No. 960410298). The licensee also observed that the contacts seemed to show signs of arcing (blackened, pitted surface) after about 2,000 operations, even though the recommended breaker service life is 10,000 operations. Resistance readings across the failed contacts were between 200-1000 ohms. Contacts with 1,500 operations or less did not have the arcing indications nor did they have high resistance readings. The licensee also noted that there were no recommendations to check the contact resistance during periodic preventive maintenance in the vendor's maintenance manual. There was disagreement between the plant drawings and the manufacturer's wiring diagrams. The manufacturer's wiring diagram indicates that the 5-6 contact should be jumpered out when not used. One of the plant drawings shows that when the 5-6 contact is "not furnished" it should be jumpered. The 5-6 contact are not shown at all on the plant RHRSW pump circuit breaker elementary drawing.

In a letter dated June 14, 1996, GE Nuclear Energy informed the Fitzpatrick licensee that the suitability of the CR2940 contact blocks in the ML-13 operating mechanism for the Magne-Blast breaker was confirmed by testing the breaker in accordance with applicable ANSI and NEMA standards. Operability of the contacts was demonstrated by breaker life cycle testing of 10,000 operations with no failure of the contact blocks, and there is no requirement to replace the contacts based on age or number of operations. However, GE stated that according to applicable NEMA standards, the maximum number of operations between servicing is 2,000 operations. The operations listed are on the basis of servicing at intervals of 6 months or less. GE also stated that while the published instructions do not specifically address the contact block resistance, instructions for checking the control power during servicing includes measuring the operating voltage at the closing coil, the trip coil, and the charging motor terminals. GE believes that this type of testing would reveal whether the contacts required replacement. GE stated that the wiring diagram clearly indicates that the 5-6 contact should be jumpered out when the white light function is not utilized. In addition, the drawing shows another CR2940 contact used as a latch check switch in the closing coil circuit should also be jumpered out when this feature is not used.

GE concluded that although the contact blocks were suitable for use in the Magne-Blast breakers, the operability demands of the nuclear power industry and the recently reported problems from the field indicated that the contact blocks were a weak link in the design of the control circuitry. GE recommends the following actions:

> In control schemes where the "52 SM/LS" (5-6) contact is installed but not utilized, it should be jumpered out of the circuit.
>
> In control schemes where the "52 SM/LS" (5-6) contact is installed and utilized for "white light" indication, but the "auto reclose" function is not used, the wiring should be revised to remove the contact from the

close coil circuit. GE can furnish a revised wiring diagram and nameplate.

For the CL/MS application, where the contact block is used to break charging motor current, GE is evaluating a replacement device. The new switch will have a higher dc interrupting rating and will be furnished for those applications where breaker applications require the increased durability.

GE plans to issue a SAL concerning the CR2940 contact blocks but no date of issuance was available at the time this information notice was issued.

Description of Circumstances - Bent Manual Trip Lever and Cracked "L" Bracket

During surveillance testing in June and July 1996, the licensee for Calvert Cliffs identified two problems with type AMH-4.76-250 (horizontal draw out) Magne-Blast circuit breakers. In the first case, a low pressure safety injection (LPSI) pump breaker failed to close. The licensee found that the trip lever was bent and there was no gap between the trip lever and the manual trip rod. Although no gap value is given in the vendor manual, there is generally a small gap between the trip lever paddle and the manual trip rod. The bent trip lever prevented the trip latch from fully rotating onto the stop pin, resulting in a less than optimal area of contact (wipe) between latch and the stop pin. As a result, the breaker would experience intermittent failure to close.

A second LPSI pump circuit breaker failed to close during monthly testing at Calvert Cliffs in July 1996. Investigation found that in addition to the trip lever being bent, the "L" bracket support for the trip lever was also cracked. The "L" bracket is designed to support the trip lever and provide additional stiffness. A subsequent inspection of other breakers at Calvert Cliffs found that one other breaker had a bent trip lever and two other breakers were found with cracked "L" brackets.

Discussion - Bent Manual Trip Lever and Cracked "L" Bracket

GE performed extensive testing on one of the failed Calvert Cliffs breakers and concluded that the most probable cause was insufficient trip latch reset spring force caused by either incorrect or damaged springs originally installed at the factory. GE recommended a modification to the Calvert Cliffs breakers to prevent further cases of trip lever bending and "L" bracket failures. The modification consists of replacing the trip paddles, support bracket and spring discharge link. The trip lever material was changed from AISI 1005 Carbon Steel to AISI 1018 Carbon Steel. The "L" bracket was changed from AISI 1005 steel to aluminum. The configuration of the components was also changed.

The modification corrects for the weak spring and allows the breaker to retain operability with the weak spring installed. Replacement of the trip latch reset spring is not part of the normal maintenance or overhaul activity. Replacement of the spring requires that a V-notch be cut into the breaker angle support to allow removal of the trip shaft. The Calvert Cliffs licensee plans to replace the weak springs in the breakers during the next scheduled overhaul.

Description of Circumstances - Latch Pawl Hinge Pin Cotter Pins and Charging Motor Tie Bolts

On September 13, 1996, the licensee for Vermont Yankee Nuclear Power Station (Vermont Yankee) discovered during a tagging procedure that the "A" Emergency Diesel Generator (EDG) was inoperable. The EDG output circuit breaker (GE Type AM-4.16kV Magne-Blast) was found in its normally open position, but its closing springs were discharged. With the springs discharged the breaker was incapable of closing.

Subsequent investigation by the Vermont Yankee licensee determined that the spring charging motor had run to failure because the cotter pin that holds the latch pawl hinge pin in position broke. The ears of the cotter pin had apparently broken and allowed the cotter pin to fall out, allowing the hinge pin to work its way out of position and prevent the latch pawls from holding the ratchet wheel in place during the charging operation. The charging springs were not compressed and the charging motor continued to run until it overheated and the motor winding open-circuited. Three of the four charging motor tie bolts that connect the motor portion to the gear housing were also found lying on the floor of the breaker cell. Vermont Yankee personnel inspected other similar breakers and found that 18 cotter pins were either degraded (one or both "ears" broken off) or undersized, and in one case a cotter pin was missing from the latch pawl hinge pin. Three breakers were also found with one or more loose charging motor tie bolts.

On November 25, 1996, after learning of the event at Vermont Yankee, the licensee for Fitzpatrick performed an inspection and identified 7 out of 16 safety-related Magne-Blast breakers with degraded latch pawl hinge pin cotter pins. Similar to Vermont Yankee, the cotter pins had one or both ears broken off, or were undersized, and in one case, the cotter pin was missing.

Discussion - Latch Pawl Hinge Pin Cotter Pins and Charging Motor Tie Bolts

The latch pawl hinge pin was originally designed in 1962 to be held in place by cotter pins at either end. In 1979, GE enhanced the design of the hinge pin assembly by tapping an existing hole in the hinge pin support bracket and installing a bolt with a washer large enough to overlap the hinge pin. Using the bolt and washer to hold the hinge pin in place precluded the need for cotter pins. According to GE, this enhancement was made to aid in disassembly and re-assembly of the breaker during maintenance, not because of any perceived problem with the cotter pins. As a result, GE did not deem it necessary to inform customers of the change in 1979.

Two different styles of charging motors are used in Magne-Blast breakers. Initially, GE used motors manufactured by Sioux Motors, of Sioux City, Iowa. In the early 1970's, GE switched to motors made by Millers Falls (later bought by Ingersoll/Rand). In the late 1970's, GE went back to using Sioux Motors as the charging motor supplier for the Magne-Blast breakers and still uses them today when customers order replacements.

The two different types of charging motor can be easily identified. Two black cover plates conceal the tie bolts on the Sioux motors and thus, the bolts are not visible from the outside. The cover plates have to be removed to gain access to the four bolt heads and the tie bolts are inserted from the motor

housing into the gear housing. In contrast, the tie bolts on the Millers Falls (Ingersoll/Rand) motors have exposed heads and are inserted from the gear housing into the motor housing. The motors with the loose bolts at Vermont Yankee were Millers Falls motors.

Description of Circumstances - Type HMA Control Relay

On December 1, 1996, a Magne-Blast breaker serving as a vital bus feed breaker failed to close on demand during surveillance testing at Salem Electric Generating Station. The licensee determined that the Type HMA control relay (the anti-pump relay [52Y]) failed to change state (to the open position) because of binding of the armature against the molded phenolic post. With the relay stuck in the open position, the closing circuit cannot be completed and the breaker cannot be closed electrically.

Discussion - Type HMA Control Relay

The relay was sent to the vendor (GE Power Management [GE PM], Malvern, PA) for detailed failure analysis. The vendor found that there was no clearance between one side of the armature tailpiece and the molded post. Normally, when an HMA relay is assembled at the factory the armature is centered between the two molded posts with a gap of 0.005 inches on each side.

The vendor recalled that a similar situation occurred in 1982 and prompted the issuance of Service Advice Letter (SAL) 721-PSM No. 171.1, "HMA Relay Armature Binding," on December 17, 1982. The original SAL stated that a tool problem at the factory in 1974 caused several relays to have improper clearance between the armature and the molded posts. The SAL suggested that the proper clearance could be achieved by first removing the armature stop clamping nut and lifting the stop and armature tailpiece from in between the molded posts, and then removing some of the phenolic post material.

The NRC discussed this issue with GE PM. The vendor stated that the armature could easily be checked for the proper clearance between the armature and the molded posts by use of feeler gauges. A gap of less than 0.002 inches on either side indicates an adjustment is needed. However, the original SAL stated that the solution was to remove some of the phenolic material from the posts and did not mention that customers could first try to adjust the armature to achieve the proper clearance. If the relay does not have the proper clearance, usually all that is needed is to loosen the armature stop clamping nut, center the armature between the two posts, and retighten the nut. The vendor also stated that while the recommended minimum gap given in the original SAL is 0.005 inches on each side, a gap of 0.002 inches is considered adequate for reliable operation.

Related Generic Communications

GE issued SAL 073-352.1, "Latest Design Configuration: GE Type AM Circuit Breakers and Medium Voltage Switchgear," on July 7, 1995, to alert customers to design changes made in the circuit breakers, their operating mechanisms, and the switchgear. Some of the listed design changes were discussed in previous SALs while other changes were not originally conveyed to customers because the changes were made to facilitate assembly, maintenance, or operation of the equipment. The SAL states that customers should evaluate each item listed and consider the applicability to their particular equipment.

Recent NRC Information Notices (IN) concerning Magne-Blast circuit breakers:

IN 90-41, "Potential Failure of General Electric Magne-Blast Circuit Breakers and AK Circuit Breakers," issued June 12, 1990.

IN 93-91, "Misadjustment Between General Electric 4.16-kV Circuit Breakers and Their Associated Cubicles," issued December 3, 1993.

IN 94-54, "Failures of General Electric Magne-Blast Circuit Breakers to Latch Closed," issued August 1, 1994.

IN 96-43, "Failures of General Electric Magne-Blast Circuit Breakers," issued August 12, 1996.

IN 96-46, "Zinc Plating of Hardened Metal Parts and Removal of Protective Coatings in Refurbished Circuit Breakers," issued August 12, 1996.

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

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