ORGANIZATION: GE ELECTRICAL DISTRIBUTION AND CONTROL
PLAINVILLE, CONNECTICUT

REPORT NO.: 99900786/90-01	INSPECTION DATE: May 24, 1990	INSPECTION ON-SITE HOURS: 7

CORRESPONDENCE ADDRESS: GE Electrical Distribution and Control
41 Woodford Avenue
Plainville, Connecticut 06062

ORGANIZATIONAL CONTACT: Norman R. Beaudoin, Quality Control Engineer

TELEPHONE NUMBER: (203) 747-7269

NUCLEAR INDUSTRY ACTIVITY: GE Electrical Distribution and Control (GE-ED&C) is the product department of the General Electric Company (GE) that manufactures and distributes various lines of GE products, including molded-case circuit breakers (MCCBs), some of which are sold to the nuclear industry as commercial-grade equipment only.

ASSIGNED INSPECTOR: _____ 10/29/90
Stephen D. Alexander, Reactive Inspection Section No. 2, (RIS-2) Vendor Inspection Branch, DRIS, NRR — Date

APPROVED BY: _____ 10/30/90
Chris VanDenburgh, Chief, RIS-2, Vendor Inspection Branch DRIS, NRR — Date

INSPECTION BASES AND SCOPE:

A. BASES: 10 CFR Part 50, Appendix B and 10 CFR Part 21

B. SCOPE: To obtain information on the cause of phase-C thermal overcurrent trip failures of GE TED136- and THED136-type MCCBs with undervoltage release (UVR) devices at the Oyster Creek Nuclear Generating Station (Oyster Creek).

PLANT SITE APPLICABILITY: Potentially generic

A. VIOLATIONS:

None.

B. NONCONFORMANCES:

None.

C. UNRESOLVED ITEMS:

None.

D. STATUS OF PREVIOUS INSPECTION FINDINGS:

Not addressed.

E. OTHER FINDINGS AND COMMENTS:

1. Background

GPU Nuclear Corporation (GPUN), the licensee for Oyster Creek, purchased 170 TED- and THED-type MCCBs in 1989 from GE Nuclear Energy (GENE) in San Jose, California. The MCCBs were purchased as safety-related items and were received with GENE product quality certificates (PQCs). GENE purchased the MCCBs as commercial grade items (CGIs) from GE-ED&C, who manufactured them at their Humacao Puerto Rico, factory and had the UVRs installed by their accessory installation facility at Mascot (Knoxville), Tennessee. GENE then dedicated the MCCBs for use in safety-related applications at Oyster Creek based, in part, on testing performed at the Puerto Rico factory.

In November 1989, Oyster Creek technicians performed a routine, pre-installation bench test on a single, 15-ampere, TED-type MCCB from this order. The MCCB had a UVR installed in the standard location by phase C (righthand side). The MCCB failed to trip when 300 percent of rated current was applied to phase C of the MCCB (a time-overcurrent test of the thermal trip function), whereas on phases A and B, the thermal trips operated satisfactorily. Oyster Creek returned the MCCB to GENE for failure and root cause analysis, the results of which have not yet been reported.

According to reports from Oyster Creek, their technicians bench-tested seven more MCCBs from the same order with UVRs installed in May 1990 and found that five of the seven failed to pass the

300-percent overcurrent test on phase C only. Oyster Creek also reported opening one of the failed MCCBs, removing the UVR, and retesting the MCCB with satisfactory results for the thermal overcurrent trip test on phase C. These experimental results suggested that the UVR had been interfering with the operation of the phase-C thermal overcurrent trip element due to its close proximity to the phase-C element. Note that the UVR is not intended to act on the thermal element, but rather on the common tripper bar that trips all three phases.

In response to NRC and licensee inquiries, GENE reported that the Oyster Creek MCCBs had ostensibly passed thermal overcurrent trip tests at the GE-ED&C factory in Puerto Rico, but they had not been fully retested for all normal functions after the UVRs were installed at GE-ED&C's Knoxville facility. GENE's initial explanation, on the basis of their preliminary investigation, was that the Knoxville facility had probably installed the UVRs incorrectly.

2. Findings

During this inspection, the NRC inspector observed the examination and testing of the five GE TED-type MCCBs with installed UVRs (GE catalog number TED136100UV4RS) that had failed pre-installation testing at Oyster Creek. The inspector also reviewed results of testing performed by GE-ED&C during the previous week using on-hand TED136 MCCBs of similar vintage to those sold to Oyster Creek. Inspection and testing indicated that the root cause of the failure of the overcurrent trip function was improper installation of calibration screw spring clips by the GE-ED&C factory in Puerto Rico instead of improper installation of the UVRs by the GE-ED&C Knoxville facility as previously believed by GENE. The inspector noted, however, that failure to retest the MCCBs' normal trip functions after UVR installation, led to their being sent to Oyster Creek in their defective condition.

3. External Examination

Oyster Creek shipped the five faulty MCCBs back to GE-ED&C under GE-ED&C Product Service Report and Return Authorization number 36486D, dated May 11, 1990, listing five TED136100WL MCCBs and five TEDUV4RS UVRs (listed separately as they had been on the original invoice). Attached was GPUN Return to Vendor Sheet 4748 listing the same material and showing GPUN purchase order number 078793. GE-ED&C engineers and technicians and the NRC inspector

externally examined the MCCBs. Each of the MCCBs bore several identifying markings in addition to their data plates including GENE dedication work order (WO) numbers, factory test card (GE-ED&C Form 22R2) serial numbers, factory date codes, Knoxville date codes, and various QA and QC inspectors' marks as follows:

GENE WO No.	22R2 No.	FACTORY DATE CODE	KNOXVILLE DATE CODE
D89728-0002D	241242	D944+	KX946+
D89728-0004D	241244	D944+	KX946+
D90012-0001D	241492	D004	KX007
D90012-0002D	241493	D004	KX007
D90012-0003D	241494	D004	KX007

4. Internal Examination

GE-ED&C and the NRC inspector examined the MCCBs internally and found that the calibration screw spring clips on the thermal elements of the MCCBs had been installed by the GE-ED&C factory in Puerto Rico with the opposite orientation to that shown in the applicable design drawing (GE-ED&C Drawing 425D210). GE-ED&C had also found this condition in similar type and vintage MCCBs they had on hand while investigating this issue during the week prior to this inspection. It also appeared that someone (presumably at Oyster Creek) had opened the cases and attempted to adjust the phase-C calibration screw on MCCBs with serial numbers 241492, 241493, and 241494 as evidenced by chipped and broken ceramic sealant material on the phase-C thermal element of those MCCBs. Also, on MCCBs 241493 and 241494, the phase-C spring clip had been repositioned to the orientation shown on the drawing; i.e., opposite to the orientation of those on phases A and B. On one of these two, MCCB 241493, the phase-C thermal calibration screw had been resealed in position by what appeared to be a white RTV compound, apparently in an attempt to replace the chipped-off sealant material. GE-ED&C also unsealed and opened for inspection the cases of MCCBs 241242 and 241244. The spring clips on MCCB 241242 were misoriented and the calibration screws appeared to be nominally adjusted with the sealant intact. However, the calibration phase-C screw on MCCB 241244 was not sealed and appeared to be backed out by two turns.

5. Testing

The NRC inspector observed the testing of the MCCBs by GE-ED&C using a special case cover in which GE-ED&C had cut a "window" to allow viewing of the operation of the phase-C thermal trip

element and any interaction with the UVR installed adjacent to it. The testing showed that because of the incorrect orientation of the spring clip on an otherwise normally calibrated MCCB, the edge of the clip, held in place by its ceramic sealant material, would contact the end of the UVR "hook" (which pulls on the MCCB tripper bar in UVR actuation) before the calibration screw could push the tripper bar far enough to trip the breaker as the bimetal thermal element flexes in an overcurrent condition. Despite the force exerted by the bimetal, the hook was immobilized by the normal action of a cam interlock mechanism (part of the UVR assembly) when the UVR is energized (as it normally is), thus preventing the bimetal from bending far enough to actuate the thermal overcurrent trip function from that phase.

The primary injection tests of the phase-C thermal-inverse time, overcurrent trip function were conducted at 300 percent of rated load (300 amps) which is a nominal field verification test point. In order for the MCCBs to be reset, the UVRs were energized (with their external dropping resistors in the circuit) with 480 VAC; thus locking the UVR hooks in the extended (normal) position. The applicable MCCB time-current characteristic curve, GES-6121B, showed minimum and maximum clearing times of approximately 32 and 120 seconds respectively on the 300-percent line.

Individual results were as follows:

- MCCB 241244 (the one that was apparently not tampered with by Oyster Creek) failed to trip thermally and was tripped by deenergizing the UVR after 155 seconds.

- MCCB 241242 failed to trip thermally and was tripped after 160 seconds by UVR. Immediately following this test, the phase-C thermal element of MCCB 241242 was cooled and GE-ED&C technicians repositioned its phase-C calibration screw spring-clip to the correct orientation. Upon retesting, phase-C of MCCB 241242 tripped satisfactorily on thermal at 75 seconds.

- MCCB 241494, which was found with its spring clips repositioned correctly, tripped at 65 seconds, but did not trip after 200 seconds when retested with its phase-C clip misoriented.

- MCCB 241493 was tested with its phase-C clip in the as-found (correct) position and tripped at 98 seconds.

- MCCB 241492, having apparently been overloaded previously (based on the discoloration of the braided conductors), and having chipped ceramic sealant, was not tested electrically, but manual manipulation of its mechanism by GE-ED&C technicians indicated that the UVR interference with the thermal element would have prevented a thermal trip on phase C.

6. Conclusions:

On the basis of these findings and its previous investigation into this issue, GE-ED&C concluded that the GE-ED&C factory in Puerto Rico had installed the calibration screw spring clips incorrectly on the Oyster Creek MCCBs as well as possibly many others. This condition led to interference with the thermal trip function when UVRs were installed.

Although GE-ED&C's failure analysis was confirmed by the inspection and testing, neither GE-ED&C nor GENE have firmly established that this condition was isolated to the MCCB shipment in question because GE-ED&C has not yet determined which TED and THED MCCBs may have been produced with the spring clips misoriented, when and to whom they were sold, and which of these may have had UVRs installed. Accordingly GE-ED&C stated that the matter would be investigated to determine the root cause(s) of the problem and the time period bounding this condition. Furthermore, GE-ED&C committed to take corrective action, including design changes if necessary, to prevent improper installation of the spring-clips or interference with installed accessories in the future.

GE-ED&C determined that the scope of the problem was bounded as follows: (1) The problem is limited to GE 3-pole, E-frame MCCBs (types TEB or TED and THEB or THED) as a result of the integral overcurrent trip mechanisms in the E-frame design (unlike the self-contained trip units in larger frame sizes) and the proximity of the phase-C thermal trip mechanism to the tripping arm or "hook" of an installed UVR; (2) the misoriented clips have no effect on MCCB operability without an internal UVR with which to interfere; (3) based on observation (during testing) of the interaction of the UVRs with the trip mechanisms, the instantaneous magnetic trip function is unaffected by the spring clips or the presence of a UVR or other internal accessories; and (4) the thermal trip function on phase A (lefthand side) would not be similarly affected by the installation of shunt trip devices (normally installed on that side) due to their differences in construction from UVRs regardless of spring clip position.

On the basis of this testing and analysis GENE and GE-ED&C both have concluded that under overload conditions affecting all three phases and under "single-phasing" conditions in which the unaffected phase(s) will experience a significant increase in load, the MCCB thermal trips on phases A and/or B should function normally and cause the MCCB to trip regardless of any impairment of the phase C thermal trip. GENE and GE-ED&C admitted that a large leakage current on phase C only could result in an affected MCCB failing to trip, but they maintained that this condition is highly unlikely. Nevertheless, GENE reported that they classified this issue as a "Potential Safety Concern" and were in the process of evaluating its reportability under 10 CFR Part 21.

GE-ED&C also stated that they had instituted full functional retesting of MCCBs after accessory installation at their Mascot (Knoxville) facility and had installed a 480-VAC power supply with which properly to energize 480-VAC-rated UVRs with their external dropping resistors in the circuit.

The undetected improper installation of the spring clips and lack of adequate retesting following installation of accessory devices or other component modifications which introduce a potential for interference with normal function represent deficiencies in manufacturing quality control and in the program for dedication of CGIs for safety-related applications. Dedication deficiencies of this type were previously identified during an inspection in April 1990 at GENE as dicussed in NRC Inspection Report No. 99900403/90-01.

GE-ED&C's commercial quality control programmatic deficiencies that led to the improper installation of the clips and failure to detect it and failure to establish retesting of the MCCBs following accessory installation were not addressed, but will be reviewed in future NRC inspections.

F. PERSONS CONTACTED:

Norman R. Beaudoin, Quality Control Engineer,
Manufacturing & Technology

Joseph Kelaita, Jr., Product Engineer

Robert Wolfe, Inspector, Evaluation & Process A

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

June 29, 1990

NRC INFORMATION NOTICE NO. 90-43: MECHANICAL INTERFERENCE WITH THERMAL TRIP FUNCTION IN GE MOLDED-CASE CIRCUIT BREAKERS

Addressees:

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

Purpose:

This information notice is intended to alert addressees of a manufacturing deviation in certain General Electric (GE) molded-case circuit breakers (MCCBs) which may result in mechanical interference with the thermal overcurrent trip function when internal accessory undervoltage release (UVR) devices are installed. In addition, the information contained herein is intended to emphasize the importance of conducting thorough pre-installation testing to verify that plant components meet the functional performance requirements of their safety-related applications. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

In 1989, General Public Utilities-Nuclear (GPUN), the licensee for the Oyster Creek Nuclear Power Plant (Oyster Creek), purchased 170 TED-type and THED-type MCCBs from GE Nuclear Energy in San Jose, California. The MCCBs were purchased as safety-related items and were supplied with GE Nuclear Energy product quality certificates (PQCs). GE Nuclear Energy purchased the MCCBs as commercial grade items (CGIs) from the GE Electrical Distribution and Control Department in Plainville, Connecticut (GE-ED&C), who manufactured the MCCBs at their Humacao, Puerto Rico, factory and installed UVRs at their accessory installation facility in Mascot (Knoxville), Tennessee. The MCCBs were dedicated by GE Nuclear Energy for use in safety-related applications at Oyster Creek, in part, on the basis of testing performed at the Puerto Rico factory.

In November 1989, one 15-ampere TED-type MCCB from this order was bench-tested at Oyster Creek prior to installation. This MCCB had a UVR installed in the standard location by phase "C" (right-hand side). The MCCB failed to trip when 300-percent of rated current was applied to phase C of the MCCB (a time-overcurrent test of the thermal trip function), whereas on phases A and B,

the thermal trips operated satisfactorily. The licensee returned the MCCB to GE Nuclear Energy for failure and root cause analysis. The results of the analysis have not yet been reported.

In May 1990, according to GPUN reports, Oyster Creek technicians bench-tested seven more UVR-equipped MCCBs from the same order. Five of the seven failed to pass the overcurrent trip test (also at 300 percent of rated current) on phase C only. In addition, GPUN reported opening one of the failed MCCBs, removing the UVR, and retesting the MCCB with satisfactory results for the thermal overcurrent trip test on phase C. These experimental results suggested that the UVR had been interfering with the operation of the phase-C thermal overcurrent trip element because of its close proximity to the phase-C element. However, it should be noted that the UVR is not intended to act on the thermal element, but rather on the common tripper bar that trips all three phases or poles.

Discussion:

On May 24, 1990, an NRC representative observed the GE ED&C testing of the five GE TED-type MCCBs with UVRs installed (GE catalog number TED136100UV4RS) which had failed pre-installation testing at Oyster Creek. Inspection and testing revealed that the cause of the failure of the overcurrent trip function was improper installation of the calibration screw spring clips by the Puerto Rico factory, instead of improper installation of the UVRs by the Knoxville facility, as previously believed by GE Nuclear Energy. GE ED&C stated that the misoriented calibration screw spring clips have no effect on the operability of the MCCBs unless internal UVRs are installed. The Oyster Creek MCCBs passed the thermal overcurrent trip tests at the GE Puerto Rico factory because the UVRs had not yet been installed. After the UVRs were installed at the GE ED&C Knoxville facility, the presence of the misoriented calibration screw spring clips caused mechanical interference between the UVR and the thermal overcurrent trip function. This was not detected at the GE ED&C Knoxville facility, because testing of all MCCBs normal functions was not performed.

Deficiencies in manufacturing quality control and in the program for dedication of CGIs for safety-related applications were exhibited by the undetected misorientation of the calibration screw spring clips and the lack of adequate retesting following installation of the UVRs. GE ED&C has indicated that action will be taken, including design changes if necessary, to prevent interference between the calibration screw spring clips and the UVRs. In addition, GE ED&C has now instituted overcurrent trip testing of MCCBs following the installation of UVRs at their Knoxville facility.

Although GE ED&C's failure analysis was demonstrated by testing, it has not been firmly established that this condition is isolated to the MCCB shipment in question. However, GE ED&C has stated that the problem is limited only to the thermal overcurrent trip functions on phase C of their 3-pole, E-frame MCCBs (types TED13XXXX and THED13XXXX), and only those equipped with UVRs. This is a result of this model's unique, integral overcurrent trip mechanisms and the proximity of the phase C thermal trip mechanism to the tripping arm of an installed UVR.

Oyster Creek's routine pre-installation testing procedures detected and prevented the use of the faulty MCCBs. Although the MCCBs were procured as safety-related components through GE Nuclear Energy and were supplied with the vendor's 10 CFR Part 50 Appendix B quality assurance certifications, this testing was performed by the licensee in addition to the normal quality assurance receipt inspection.

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 NRR project manager.

Charles E. Rossi

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: K. R. Naidu, NRR
(301) 492-0980

S. D. Alexander, NRR
(301) 492-0995

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
90-32, Supp. 1	Surface Crack and Subsurface Indications in the Head of a Reactor Vessel Head	6/19/90	All holders of OLs or CPs for nuclear power reactors.
90-42	Failure of Electrical Power Equipment Due to Solar Magnetic Disturbances	6/19/90	All holders of OLs or CPs for nuclear power reactors.
90-41	Potential Failure of General Electric Magne-Blast Circuit Breakers and AK Circuit Breakers	6/12/90	All holders of OLs or CPs for nuclear power reactors.
90-40	Results of NRC-Sponsored Testing of Motor-Operated Valves	6/5/90	All holders of OLs or CPs for nuclear power reactors.
90-39	Recent Problems With Service Water Systems	6/1/90	All holders of OLs or CPs for nuclear power reactors.
90-38	Requirements for Processing Financial Assurance Submittals for Decommissioning	5/29/90	All fuel facility and materials licensees.
90-37	Observed Pinion Gear-to-Shaft Gaps in Limitorque Motor Actuators	5/24/90	All holders of OLs or CPs for nuclear power reactors.
90-36	Apparent Falsification of State of Connecticut Weight Certificates	5/24/90	All holders of OLs or CPs for nuclear power reactors, and 10 CFR 70 licensees.
90-35	Transportation of Type A Quantities of Non-Fissile Radioactive Materials	5/24/90	All U.S. NRC licensees.

OL = Operating License
CP = Construction Permit

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We acknowledge your intention to conduct appropriate final testing procedures at Knoxville and to take corrective action, including design changes that may be required, to prevent further UVR-spring clip interference. Nevertheless, we would appreciate being informed of any additional information you may obtain regarding the time frames during which MCCBs may have been built with the incorrectly oriented spring clips. In addition, please inform us of any plans that you may have for instituting similar final testing procedures at your other post-manufacturing facilities or other facilities licensed or approved by GE-ED&C to install MCCB accessories. We appreciate your cooperation and assistance in determining the cause of this problem and providing us with the requested information so that licensees may prevent the recurrence of similar problems in their plants.

In accordance with 10 CFR 2.790 of the Commission's regulations, a copy of the letter and the enclosed inspection report will be placed in the NRC's Public Document Room. Should you have any questions regarding this matter, we would be pleased to discuss them with you.

Sincerely,

/S/ by Greg Cwalina

Uldis Potapovs, Acting Chief
Vendor Inspection Branch
Division of Reactor Inspection and Safeguards
Office of Nuclear Reactor Regulation

Enclosures:
1. Inspection Report 99900786/90-01
2. NRC Information Notice 90-43

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