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

May 18, 1988

NRC INFORMATION NOTICE NO. 88-27: DEFICIENT ELECTRICAL TERMINATIONS
IDENTIFIED IN SAFETY-RELATED COMPONENTS

Addressees:

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

Purpose:

This information notice is being provided to alert addressees of deficiencies identified in electrical terminations in safety-related components. 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:

The Nuclear Regulatory Commission (NRC) has been notified of several recently identified deficiencies in electrical terminations in safety-related components that, if they had remained uncorrected, would have jeopardized the ability of these components to perform their intended safety function. These deficiencies were identified at River Bend Station, Unit 1; Shoreham Nuclear Power Station; Vermont Yankee Nuclear Power Station; and Oyster Creek, Unit 1.

River Bend Station, Unit 1

On January 19, 1988, the Gulf States Utility Company (GSU) submitted a notification to the NRC, pursuant to 10 CFR Part 21, regarding oversized motor operator termination lugs in three main steam shutoff valves and two feedwater isolation valves. GSU reported that during functional testing of a main steam shutoff valve on December 7, 1987, the valve motor operator experienced a high current surge, which tripped its motor overload heater and prevented the valve from fully closing. During GSU's investigation, two motor leads were found burned and separated from the lugs. A third lug was easily pulled from the motor lead by GSU personnel after they removed the heat shrink insulation. The lugs were found to be oversized for the motor lead conductors. In addition, during maintenance on a feedwater isolation valve, a lug on one motor lead was found to be

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oversized for the conductor and not crimped. These lugs were manufactured by Thomas & Betts. They were marked "T&B Navy 23-30 E-6" and were sized for use with a #5-#6 AWG conductor. The actual motor leads were #10 AWG stranded conductors.

Further investigation by GSU personnel found that both valves used Limitorque SMB-4 motor operators with terminal blocks that had one-quarter-inch diameter terminal screws. The lugs were the correct size for the one-quarter-inch screw, but not for the conductor. All SMB-4 operators used in safety-related applications were inspected by the licensee to determine lug size. Ten SMB-4 operators were inspected, and five were found with oversized lugs that were deemed unreliable by the licensee, although they passed their surveillance requirements. GSU personnel replaced the defective lugs with correctly sized lugs. GSU is also revising its procedures for inspecting Limitorque motor operators when they are received to include inspection of lug size on the motor leads to prevent recurrence of this condition, since the defective wire lugs were contained in valve operators supplied by the Limitorque Corporation during the construction of River Bend Station.

In a separate 10 CFR Part 21 notification dated December 23, 1987, GSU reported that several defective terminations were identified in electrical heater panels supplied by NUTHERM International, Inc. The defective wire terminations were in heater panel circuits of the fuel storage building engineered safety feature charcoal filters. The deficiency involved improper stripping of conductors that resulted in insulation under the termination lugs. This insulation inhibited a good connection and jeopardized the ability of the filters to perform their function. GSU reported that it had notified NUTHERM International of the defect.

Shoreham Nuclear Power Station

On October 19, 1987, the Long Island Lighting Company (LILCO) submitted a notification to the NRC pursuant to 10 CFR Part 21 regarding inadequately crimped termination lugs discovered at the Shoreham Nuclear Power Station. The subject lugs, which were manufactured by AMP Special Industries, were installed in control wiring in 4160-volt switchgear equipment manufactured by the General Electric Company (GE). The licensee discovered that many of the GE-installed termination lugs were inadequately crimped to the control wires and, in some cases, the lugs could be removed by hand. When LILCO personnel inspected these lugs in equipment supplied by GE, they found that of approximately 1400 lugs installed by GE, 42% had to be replaced.

GE determined that its personnel had deviated from the crimp process described in their installation procedures during the manufacture of the equipment. Therefore, the insulation around the control wires was not properly stripped before being inserted into the AMP lugs and an AMP crimper was not used as required. GE also determined that this problem was limited to equipment supplied to

Shoreham and Salem. GE stated that it had notified both facilities of the problem and that its personnel had been requalified on the proper crimping procedures to preclude any further similar incidents.

Vermont Yankee Nuclear Power Station

On September 28, 1987, Vermont Yankee Nuclear Power Station (Vermont Yankee) personnel were conducting pre-startup operability tests on the residual heat removal (RHR) pumps and core spray pumps. During the operability tests, the "B" RHR pump motor experienced severe arcing problems and was quickly secured, preventing damage to the motor windings.

Vermont Yankee personnel investigated the problem and found that the arcing resulted from a failed AMP motor lead to power lead termination lug. Motor lead and power lead termination lugs were subsequently inspected on three other RHR pumps and core spray pumps fitted with AMP lugs. Termination lugs manufactured by Thomas & Betts (T&B) that are used on RHR service water pumps and station service water pumps also were inspected. These inspections identified evidence of cracking of varying severity on seven AMP motor lead termination lugs; however, no cracks were found on power lead terminations. Little or no cracking was identified on terminations manufactured by T&B. The AMP motor lead termination lugs were of the ring tongue type, #2 AWG, model #35184, manufactured by AMP Special Industries. The terminations were supplied in conjunction with the motors by GE.

Several of the cracked lugs were discovered by direct visual inspection, while the remainder were identified using 10X magnification and/or dye penetrant testing. During inspection of the lugs, it appeared that the manufacturer's stamping on the throat of the lug contributed to the observed cracking because a shallow "AMP" die stamp was found at the throat section of the lug. A stamp (a numeral 1, 2, or 3) on the opposite side of the throat, believed to be a phase indication, was also suspected of being a contributor. The cracking identified on these lugs was ultimately attributed to excessive bending during maintenance activities, with the manufacturer's stamping providing pre-stressed flaws for crack initiation and propagation. The small cramped work space inside the motor terminal housings, coupled with the rigidity of the required Raychem splices, contributed to fatiguing the lugs during maintenance activities.

Oyster Creek, Unit 1

GPU Nuclear Corporation (GPUNC) submitted Licensee Event Report (LER) 219-87-011, Revision 1, to the NRC on May 4, 1987, regarding deficient electrical terminations at Oyster Creek, Unit 1. GPUNC reported that on February 10, 1987, an electrical technician who was verifying proper wiring connections inadvertently moved a wiring harness in a control room panel. This movement disconnected the "A" feedwater flow rate signal wire and initiated a sequence of events that resulted in a

turbine trip and an anticipatory scram. On February 26, 1987, an electrical technician, performing an inspection of wire terminations in response to the previous event, disturbed a wire that caused the automatic closure of the main steam isolation valves.

The GPUNC investigation determined that the cause of the first event was insufficient procedural controls over wire termination practices. The wire terminations used in the control room panel were compression-type terminations, which capture wires under a metal plate compressed by a screw, rather than lug-type terminations. GPUNC personnel found that different size wires were used in the same termination and that sometimes the plate in the compression terminations was removed when wires were too large to fit under the plate. The GPUNC investigation also found terminations with cracked or broken pressure plates, as well as wires that were unlabeled, unterminated, and uninsulated. Furthermore, GPUNC personnel discovered that when new cables were pulled to support modification work, existing wire terminations were stressed by the new wires that lay on top of the original wiring.

The second event was attributed to faulty wire installation, either during plant construction or during subsequent maintenance. Inspection of the wire termination showed that the screw used to fasten the wire was loose. Movement of this wire caused four relays to deenergize, resulting in automatic closure of the main steam isolation valves.

GPUNC personnel identified and corrected a total of 123 deficient terminations, both compression-type and lug-type. GPUNC has revised its Installation Specifications for wire terminations and Quality Assurance Procedures for inspecting wire terminations to ensure and verify proper electrical terminations. These revisions will ensure that an adequate structural integrity of the termination exists, require that a post-modification and maintenance tug test be performed, and eliminate the practice of terminating two wires with significant gauge differences in compression-type terminations unless it is endorsed by the termination manufacturer. In addition, GPUNC indicated that it was in the process of identifying those terminations that are frequently accessed for surveillance and maintenance purposes and will install test connections to minimize movement and stress on the terminations.

Discussion:

These examples emphasize the need to carefully monitor the receipt, installation, and maintenance of safety-related components with respect to their cable or wire terminations. Licensees may wish to review their current receipt, installation, and maintenance procedures to assure that proper quality controls and measures exist to preclude such events as those discussed above.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact one of the technical contacts listed below or the Regional Administrator of the appropriate regional office.

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

Technical Contacts: Jaime Guillen, NRR
(301) 492-1153

Carl S. Schulten, NRR
(301) 492-1192

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
85-35, Supplement 1	Failure of Air Check Valves to Seat	5/17/88	All holders of OLs or CPs for nuclear power reactors.
88-26	Falsified Pre-Employment Screening Records	5/16/88	All holders of OLs or CPs for nuclear power reactors and all major fuel facility licensees.
88-25	Minimum Edge Distance for Expansion Anchor Bolts	5/16/88	All holders of OLs or CPs for nuclear power reactors.
88-24	Failures of Air-Operated Valves Affecting Safety-Related Systems	5/13/88	All holders of OLs or CPs for nuclear power reactors.
88-23	Potential for Gas Binding of High-Pressure Safety Injection Pumps During a Loss-of-Coolant Accident	5/12/88	All holders of OLs or CPs for PWRs.
88-22	Disposal of Sludge from Onsite Sewage Treatment Facilities at Nuclear Power Stations	5/12/88	All holders of OLs or CPs for nuclear power reactors.
88-21	Inadvertent Criticality Events at Oskarshamn and at U.S. Nuclear Power Plants	5/9/88	All holders of OLs or CPs for nuclear power reactors.
88-20	Unauthorized Individuals Manipulating Controls and Performing Control Room Activities	5/5/88	All holders of OLs or CPs for nuclear power, test and research reactors, and all licensed operators.

OL = Operating License
CP = Construction Permit

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Initially transmitted by memorandum dated November 20, 1987, to C. H. Berlinger from W. D. Lanning

*SEE PREVIOUS CONCURRENCES

D/DOEA-NRR
~~C/Rossi~~

05/12/88

*C/OGCB:DOEA:NRR *PPMB:ARM

CHBerlinger

TechEd

05/10/88

02/29/88

*OGCB:DOEA:NRR

JGuillen

03/02/88

CSchulten

03/03/88

*DRP:RI

WFKane

03/ /88

PWBaranowsky

03/03/88

*D/DEST:NRR

LCShao

04/13/88

WDLanning

03/31/88

*SAD/DEST:NRR

ATHadani

04/12/88

*C/EAB:DOEA:NRR *C/SELB:DEST:NRR

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03/21/88

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03/03/88

*DRP:RI

WFKane

03/ /88

*SC/OEAB:DOEA:NRR

PWBaranowsky

03/03/88

*D/DEST:NRR

LCShao

04/13/88

*C/EAB:DOEA:NRR

WDLanning

03/31/88

*SAD/DEST:NRR

ATHadanf

04/12/88

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DIR:RI

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03/ /88

PWBaranowsky

03/03/88

D/DEST:NRR

LCShao

04/13/88

WDLanning

03/9 /88

SAD/DEST:NRR

ATHadani

03/14/88

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03/21/88

Handwritten notes:
JG
WFKane
w/changed
indicated
LCShao
04/13/88
WDLanning
03/9/88

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03/3/88

C/OGCB:DOEA:NRR
CHBerlinger
03/1/88
C/SELB:DEST:NRR
FRosa
03/21/88

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			02/ /88	02/ /88