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

September 7, 1989

NRC INFORMATION NOTICE NO. 89-64: ELECTRICAL BUS BAR FAILURES

Addressees:

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

Purpose:

This information notice is intended to alert addressees to potential problems resulting from the failure of electrical bus bars caused by cracked insulation and moisture or debris buildup in bus bar housings. 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:

(1) Palo Verde Unit 1 (Licensee Event Report No. 88-010)

On July 6, 1988, a phase B to ground fault occurred on 13.8-kv non-Class 1E electrical bus E-NAN-S02. This fault ionized the air surrounding the bus and caused all three phases to short to ground. Feeder breakers to non-Class 1E buses E-NAN-S01 and S02 did not open immediately, resulting in excessive currents being supplied by the unit auxiliary transformer (UAT) and the subsequent rupture and ignition of the UAT. This caused the supply breakers to buses E-NAN-S01 and S02 and the main generator output breaker to open on a UAT sudden overpressure signal. As expected, a reactor trip on low departure from nucleate boiling ratio occurred because the reactor coolant pumps were powered from buses E-NAN-S01 and S02. The reactor was subsequently stabilized in hot standby on natural circulation.

Failure of bus E-NAN-S02, initiated by the phase B to ground fault, was attributed to cracked and brittle Noryl insulation and dirt that had accumulated in the cubicles. These conditions led to arc tracking, which caused the single phase to ground fault. This fault subsequently propagated into a three-phase to ground fault.

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(2) Kewaunee (Licensee Event Report Nos. 88-001 and 87-009)

On March 2, 1988, when the plant was at 93.3 percent power, a reactor trip and associated turbine trip were generated as a result of undervoltage (UV) conditions on 4160-volt electrical buses 1-1 and 1-2, which supply power to the reactor coolant pump and main feedwater pump motors.

Investigations of the UV condition on the buses revealed that an electrical fault had occurred on the bus from the "Y" winding of the main auxiliary transformer to buses 1-1 and 1-2 because of insulation failure. The bus bar, which was a 1/2-inch by 4-inch flat copper bar, was rated at 4000 amperes per phase and was manufactured by the Calvert Company. The bus bar, which was encapsulated with Noryl flame-retardant insulation, was enclosed in aluminum ducting with screened ventilation slots on the top and bottom.

The licensee determined that the cause of the event was failure of the insulation on the bus bar and the accumulation of water and debris around the bus, which provided a tracking path for the fault. The bus bar runs horizontally into the auxiliary building underneath areas where debris can fall into the bus work. Additionally, water from a plastic drain hose, located on the floor above the faulted section of the bus, was suspected to have dripped onto the bus work.

A similar event had occurred at Kewaunee on July 10, 1987, when a reactor trip and associated turbine trip occurred as a result of an UV transient on the same 4160-volt buses. In this case, however, a phase to ground fault occurred on the bus bar from the "X" winding of the main auxiliary transformer to 4160-volt buses 1-3, 1-4, 1-5, and 1-6. This bus bar was similar to the one identified above, except that it was a flat aluminum bar that was rated at 3000 amperes.

The cause of this event was also failure of insulation on the bus bar compounded by the accumulation of particulate debris. The bus bar was located perpendicular to the turbine building ventilation fans, which pulled dust-filled air through a section of the bus bar. Dust and metallic powder that had collected on the cracked bus bar insulation provided a tracking path for the phase to ground fault.

(3) Millstone Unit 1 (Licensee Event Report No. 87-001-01)

On January 13, 1987, when Unit 1 was at 100-percent power, a visual inspection of the 4160-volt ac (VAC) load centers showed that horizontal Noryl bus bar insulation was cracked. The problem was attributed to a manufacturing defect on General Electric Company (GE) metal-clad switchgear type M-26 (4160 VAC) and type M-36 (6900 VAC). Apparently, during the manufacturing process, "black" bus bar joint compound (GE # D50H47) contaminated the Noryl insulation and over several years caused the insulation to crack.

(4) Sequoyah Unit 1 (Licensee Event Report No. 83-067)

On May 18, 1983, when Unit 1 was at 100-percent power, startup bus 1B at Unit 1 failed because of a phase B to phase C fault, which propagated to ground. The failure was attributed to degradation of Noryl insulation on the Westinghouse Model EN-265 bus. Further investigation revealed several degraded areas in the bus insulation at the support blocks, and startup bus 1B was declared inoperable.

(5) Browns Ferry Unit 2 (Licensee Event Report No. 89-008)

On March 9, 1989, a bus fault to ground occurred on the secondary (4160-volt) side of the unit station service transformer, causing an engineered safety feature actuation. This electrical fault also caused damage to the 4160-volt bus, the bus duct, and the transformer bushing connections on all three phases.

The fault was attributed to (a) deterioration of the Noryl insulation above the bus joint, (b) poor design of the bus duct, which allowed condensation to collect, and (c) inadequate implementation of the vendor-recommended preventive maintenance.

Discussion:

Failures of medium-voltage electrical bus bars, principally involving 4160- and 6900-volt ac buses, have resulted in bus bar electrical faults and fires, electrical power system undervoltage conditions, plant transients, reactor trips, and engineered safety feature actuations.

Failure of the bus bars has been attributed to cracked bus bar insulation (bus sleeving) combined with the accumulation of moisture or debris in the bus bar housings. Insulation failure, along with the presence of moisture or debris, provided undesired phase to phase, or phase to ground, electrical tracking paths, which resulted in catastrophic failure of the buses.

Corrective actions taken by the involved utilities included replacing damaged bus bar sections with bus bars that were covered with insulation of a different type, substituting "yellow" bus bar joint compound (GE # D50H109) for the "black" joint compound previously used, modifying bus bar enclosures to restrict ingress and accumulation of water and debris, and instituting enhanced periodic inspections and cleaning of bus bars and their housings.

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

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

Technical Contacts: Mark Padovan, AEOD
(301) 492-4445

Argil Toalston, NRR
(301) 492-0831

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-63	Possible Submergence of Electrical Circuits Located Above the Flood Level Because of Water Intrusion and Lack of Drainage	9/5/89	All holders of OLs or CPs for nuclear power reactors.
89-62	Malfunction of Borg-Warner Pressure Seal Bonnet Check Valves Caused By Vertical Misalignment of Disk	8/31/89	All holders of OLs or CPs for nuclear power reactors.
89-61	Failure of Borg-Warner Gate Valves to Close Against Differential Pressure	8/30/89	All holders of OLs or CPs for nuclear power reactors.
88-48, Supp. 2	Licensee Report of Defective Refurbished Valves	8/22/89	All holders of OLs or CPs for nuclear power reactors.
89-60	Maintenance of Teletherapy Units	8/18/89	All NRC Medical Teletherapy Licensees.
89-59	Suppliers of Potentially Misrepresented Fasteners	8/16/89	All holders of OLs or CPs for nuclear power reactors.
89-58	Disablement of Turbine-Driven Auxiliary Feedwater Pump Due to Closure of One of the Parallel Steam Supply Valves	8/3/89	All holders of OLs or CPs for PWRs.
89-57	Unqualified Electrical Splices in Vendor-Supplied Environmentally Qualified Equipment	7/26/89	All holders of OLs or CPs for nuclear power reactors.
89-56	Questionable Certification of Material Supplied to the Defense Department by Nuclear Suppliers	7/20/89	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

(5) Browns Ferry Unit 2 (Licensee Event Report No. 89-008)

On March 9, 1989, a bus fault to ground occurred on the secondary (4160-volt) side of the unit station service transformer, causing an engineered safety feature actuation. This electrical fault also caused damage to the 4160-volt bus, the bus duct, and the transformer bushing connections on all three phases.

The fault was attributed to (a) deterioration of the Noryl insulation above the bus joint, (b) poor design of the bus duct, which allowed condensation to collect, and (c) inadequate implementation of the vendor-recommended preventive maintenance.

Discussion:

Failures of medium-voltage electrical bus bars, principally involving 4160- and 6900-volt ac buses, have resulted in bus bar electrical faults and fires, electrical power system undervoltage conditions, plant transients, reactor trips, and engineered safety feature actuations.

Failure of the bus bars has been attributed to cracked bus bar insulation (bus sleeving) combined with the accumulation of moisture or debris in the bus bar housings. Insulation failure, along with the presence of moisture or debris, provided undesired phase to phase, or phase to ground, electrical tracking paths, which resulted in catastrophic failure of the buses.

Corrective actions taken by the involved utilities included replacing damaged bus bar sections with bus bars that were covered with insulation of a different type, substituting "yellow" bus bar joint compound (GE # D50H109) for the "black" joint compound previously used, modifying bus bar enclosures to restrict ingress and accumulation of water and debris, and instituting enhanced periodic inspections and cleaning of bus bars and their housings.

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*SEE PREVIOUS CONCURRENCES

		D/DOEA:NRR	*C/OGCB:DOEA:NRR	*RPB:ARM
		CERossi	CHBerlinger	TechEd
		08/ /89	08/31/89	08/30/89
*OGCB:DOEA:NRR	*SELB:DEST:NRR	*C/SELB:DEST:NRR	*ROAB:DSP:AEOD	*C/ROAB:DSP:AEOD
PCWen	ALToalston	FRosa	LMPadovan	JERosenthal
08/29/89	08/30/89	08/30/89	08/29/89	08/31/89

bus insulation at the support blocks, and startup bus 1B was declared inoperable.

(5) Browns Ferry Unit 2 (Licensee Event Report No. 89-008)

On March 9, 1989, a bus fault to ground occurred on the secondary (4160-volt) side of the unit station service transformer, causing an engineered safety feature actuation. This electrical fault also caused damage to the 4160-volt bus, the bus duct, and the transformer bushing connections on all three phases.

The fault was attributed to (a) deterioration of the Noryl insulation above the bus joint, (b) poor design of the bus duct, which allowed condensation to collect, and (c) inadequate implementation of the vendor-recommended preventive maintenance.

Discussion:

Failures of medium-voltage electrical bus bars, principally involving 4160- and 6900-volt ac buses, have resulted in bus bar electrical faults and fires, electrical power system undervoltage conditions, plant transients, reactor trips, and engineered safety feature actuations.

Failure of the bus bars has been attributed to cracked bus bar insulation (bus sleeving) combined with the accumulation of moisture or debris in the bus bar housings. Insulation failure, along with the presence of moisture or debris, provided undesired phase to phase, or phase to ground, electrical tracking paths, which resulted in catastrophic failure of the buses.

Corrective actions taken by the involved utilities included replacing damaged bus bar sections with bus bars that were covered with insulation of a different type, substituting "yellow" bus bar joint compound (GE # D50H109) for the "black" joint compound previously used, modifying bus bar enclosures to restrict ingress and accumulation of water and debris, and instituting enhanced periodic inspections and cleaning of bus bars and their housings.

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(5) Browns Ferry Unit 2 (Licensee Event Report No. 89-008)

On March 9, 1989, a bus fault to ground occurred on the secondary (4160-volt) side of the unit station service transformer, causing an engineered safety feature actuation. This electrical fault also caused damage to the 4160-volt bus, the bus duct, and the transformer bushing connections on all three phases. Inadequate insulation and the collection of condensation led to the deterioration of the Noryl sleeving at the factory-cut end. The deterioration extended appropriately 1/4 inch above the bus flex connector.

The fault was attributed to (a) inadequate insulation above the bus joint, (b) poor design of the bus duct, which allowed condensation to collect, and (c) inadequate implementation of the vendor-recommended preventative maintenance.

Discussion:

Failures of medium-voltage electrical bus bars, principally involving 4160- and 6900-volt ac buses, have resulted in bus bar electrical faults and fires, electrical power system undervoltage conditions, plant transients, reactor trips, and engineered safety feature actuations.

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