

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

April 21, 1995

NRC INFORMATION NOTICE 95-22: HARDENED OR CONTAMINATED LUBRICANTS CAUSE
METAL-CLAD CIRCUIT BREAKER FAILURES

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 problems that could result from failing to periodically check the condition of lubricants that may become hardened or contain contaminants used in HK series (4-kV and 6.9-kV) and K-Line (600-V) circuit breakers manufactured by Asea Brown Boveri (ABB, formerly ITE) and DB-50 (480-V) breakers manufactured by Westinghouse. It is expected that recipients will review this 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

Hardened Grease in Breaker Operating Mechanisms

On October 4, 1988, during surveillance testing of the low-pressure core spray pump at River Bend, Unit 1, the safety-related ABB HK 4-kV circuit breaker failed to close after the closing circuit was energized from the control room. The failure was attributed to breaker linkage grease that had solidified with age, thus causing the closing mechanism to bind.

On February 8, 1989, during post maintenance testing at D.C. Cook, Unit 1, an ABB HK 4-kV breaker failed to close after the closing circuit was energized. On February 27, 1989, another HK breaker failed to close during a test. Both failures were attributed to hardened grease that caused the operating mechanism to bind. Seven additional HK series breakers used in safety-related and balance-of-plant applications also failed in this manner. The breakers were 17 years old and had been inspected and serviced several times. However, the revision of the vendor manual in use and, consequently, licensee procedures did not state the need to disassemble, clean or relubricate the operating mechanism on a periodic basis, except when grease is found to be "contaminated" or when parts are replaced (see NRC Inspection Report 50-315/89031 for additional information).

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updated on
4/25/95

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During an October 1992 surveillance test at LaSalle, Unit 1, an ABB HK 4-kV reactor recirculation pump breaker failed to trip. The failure was attributed to hardened grease in the operating mechanism. In October 1993, during a Unit 2 refueling outage, a nonsafety-related ABB HK 4-kV pump breaker failed to close. This failure also was attributed to hardened operating mechanism grease. The licensee breaker maintenance procedures did not require inspection (other than visual), disassembly, or relubrication of the breaker operating mechanism on a periodic basis (see NRC Inspection Report 50-373/93031 for additional information).

Contamination of Grease on Sliding Electrical Parts

On November 5, 1989, during surveillance testing at D.C. Cook, a Westinghouse DB-50 480-V "B" train reactor trip bypass breaker failed to close electrically because of high resistance in the auxiliary contacts that were part of the closing circuit. The high resistance may have resulted from contamination of the conductive graphite grease prescribed by the vendor manual. The revision of the Westinghouse instruction manual in use at D.C. Cook did not contain a recommendation for periodically replacing the graphite grease or checking its condition (e.g., by measuring contact resistance). However, recent guidance issued by the vendor provided for such checking and replacement, as required.

Discussion

The ABB HK breakers failed because lubricating grease solidified with age in the breaker operating mechanisms. As the grease hardened, friction increased in the metal-to-metal contact areas. The additional metal friction, as well as some interference from hardened grease deposits, caused the mechanism to become increasingly difficult to operate freely, eventually resulting in failures of the breakers to open or close. The circuit breakers discussed above had been routinely inspected on numerous occasions. However, while the licensees adequately verified cleanliness in the visual inspections, they failed to identify lubricant that was solidified or contaminated. Preventive maintenance activities did not include periodic cleaning or disassembly of the operating mechanism to determine if the operating mechanism should be relubricated.

Until 1991, all the revisions to the ITE/ABB HK and K-Line vendor manuals stated that breaker operating mechanisms were factory lubricated and should not require additional lubrication during breaker service life. However, as early as 1972, ABB manuals, such as ITE HK Switchgear Instruction Book IB-8.2.7-1, and medium-voltage switchgear maintenance and surveillance manuals MS 3.2.1.9-1B (for HK) and MS 3.1.1.9-2B (for K-Line), did call for cleaning and relubrication of the mechanism with ANDEROL 757 grease (or NO-OX-ID grease for mating surfaces of moving, current-carrying joints) should any lubricant be found contaminated or when parts are replaced.

In response to a 1989 10 CFR Part 21 report from D.C. Cook of mechanism binding due to hardened grease, ABB sent a letter to the NRC and all known affected licensees or purchasers of HK and K-Line breakers that described the

problem and recommended solutions. LaSalle, for example, had received this letter, yet had not updated procedures to prevent the 1992 and 1993 failures. Other plants with the affected breakers included Perry, Comanche Peak, and Fermi. Comanche Peak had taken action to prevent these failures.

In 1991, ABB issued revisions to the HK and K-Line manuals that called for periodic (10-year) cleaning and relubrication of the operating mechanism with ANDEROL 757 and the mating surfaces of moving, current-carrying joints with the NO-OX-ID, although mechanical failures to operate have only been attributed to hardened mechanism lubricant. In September 29 and October 3, 1994, letters to the NRC, ABB stated, on the basis of recent refurbishments, that the condition of the mechanism lubricant cannot be determined without complete disassembly of the mechanism. The October letter also cited failures of K3000 breakers as a result of hardened mechanism lubricant, but stated that although failures of smaller K-Line breakers attributable to hardened mechanism grease had not been reported, some had operated sluggishly. Reportedly, most of these breakers also have not been periodically disassembled, cleaned, or relubricated in service. In performing post maintenance testing, licensees found no evidence of impending breaker failures due to hardened grease because the tests were performed primarily to determine whether the breaker tripped or closed.

Unusual service conditions such as high ambient temperatures, very dirty atmosphere during construction or outages or mixing of incompatible greases were not specifically identified in the instances cited. However, such conditions accelerate hardening of mechanism lubricants and are conducive to dirt or chemical contamination and increased electrical resistance of electrical part lubricants. Note that ESSO/Humble (now EXXON) NEBULA EP5F grease was used for these breakers prior to March 1972. After this date, new breaker mechanisms were factory-lubricated with ANDEROL 757. Manufacturers have warned that old (or unidentified) grease should be completely removed before relubricating.

Although referring to a different type of circuit breaker, NRC IN 93-26, "Grease Solidification Causes Molded-Case Circuit Breaker Failure to Close," issued April 7, 1993, and its supplement issued January 31, 1994, described a similar problem. In addition, addressees are reminded of commitments made in response to the staff position in Generic Letter 90-03 and its Supplement 1, to maintain contact with certain key vendors (which include Class 1E switchgear vendors), in order to ensure that manuals (and equipment) are kept up to date and the latest technical information (including 10 CFR Part 21 reports and related correspondence) is promptly obtained, evaluated for applicability, and acted on, as appropriate. Recommendations for switchgear maintenance can also be found in owners group documents (e.g., the Westinghouse Owners Group guidelines on DB and DS breaker maintenance) and industry guidance such as National Electrical Manufacturers Association (NEMA) publications, American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) standards, and various Electric Power Research Institute (EPRI) reports such as NP-7410, "Breaker Maintenance."

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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Information Notice No.	Subject	Date of Issuance	Issued to
95-21	Unexpected Degradation of Lead Storage Batteries	04/20/95	All holders of OLs or CPs for nuclear power reactors.
94-64, Supp. 1	Reactivity Insertion Transient and Accident Limits for High Burnup Fuel	04/06/95	All holders of OLs or CPs for nuclear power reactors
95-18, Supp. 1	Potential Pressure-Locking of Safety-Related Power-Operated Gate Valves	03/31/95	All holders of OLs or CPs for nuclear power reactors.
95-20	Failures in Rosemount Pressure Transmitters due to Hydrogen Permeation into the Sensor Cell	03/22/95	All holders of OLs or CPs for nuclear power reactors.
95-19	Failure of Reactor Trip Breaker to Open Because of Cutoff Switch Material Lodged in the Trip Latch Mechanism	03/22/95	All holders of OLs or CPs for nuclear power reactors.
95-18	Potential Pressure-Locking of Safety-Related Power-Operated Gate Valves	03/15/95	All holders of OLs or CPs for nuclear power reactors.
95-17	Reactor Vessel Top Guide and Core Plate Cracking	03/10/95	All holders of OLs or CPs for boiling water reactors.
95-16	Vibration Caused by Increased Recirculation Flow in a Boiling Water Reactor	03/09/95	All holders of OLs or CPs for boiling water reactors.
95-15	Inadequate Logic Testing of Safety-Related Circuits	03/07/95	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
 CP = Construction Permit

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* See EGGreenman memorandum to RLDennig dated June 15, 1994 and previous concurrence pages.

DOCUMENT NAME: 95-22.IN

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OFFICE	Region III	E	Region III	E	Region III	E	Region III	E		
NAME	TTella*		RMendez*		GGrant*		EGGreenman*			
DATE	09/07/94		06/10/94		06/10/94		06/13/94			
OFFICE	SIB/DOTS	E	TECH ED	N	SC:SIB/DOTS	E	C:SIB/DOTS	E	D:DOTS:NRR	N
NAME	SAlexander*		BCalure*		GCwalina*		RGallo*		RLSpessard*	
DATE	01/03/95		12/29/94		01/03/95		01/06/95		01/06/95	
OFFICE	EELB/DE	E	C:EELB/DE		ECB:DOPS		C:ECB/DOPS		D:DOPS	
NAME	SMitra*		CBerlinger*		RKiesel		AChaffee		BKGrimes	<i>for</i>
DATE	09/22/94		10/26/94		03/29/95		04/07/95		04/18/95	

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OFFICE	SIB/DOTS	E	TECH ED	N	SC:SIB/DOTS	E	C:SIB/DOTS	E	D:DOTS:NRR	N
NAME	SAlexander*		BCalure*		GCwalina*		RGallo*		RLSpessard*	
DATE	01/03/95		12/29/94		01/03/95		01/06/95		01/06/95	
OFFICE	EELB/DE	E	C:EELB/DE		ECB:DOPS		C:ECB/DOPS		D:DOPS	
NAME	SMitra*		CBerlinger*		RKiesel		AChapree		BKGrimes	
DATE	09/22/94		10/26/94		03/29/95		09/7/95		03/ /95	

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DATE	09/07/94		06/10/94		06/10/94		06/13/94		01/ /95	
OFFICE	SIB/DOTS	E	TECH ED	N	SC: SIB/DOTS		C: SIB/DOTS	E	D: DOTS	NRR
NAME	SAlexander		BCalure*		GGrant*		RGalt*		RLSpessard	
DATE	01/3/95		12/29/94		01/3/95		01/6/95		01/6/95	
OFFICE	EELB/DE	E	C: EELB/DE		D: DE/NRR		C: ECB/DOPS		D: DOPS	
NAME	SMitra		CBerlinger		BWSheron		AChaffee		BKGrimes	
DATE	01/ /95		01/ /95		01/ /95		01/ /95		01/ /95	

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NAME	TTella*		RMendez*		GGrant*		EGGreenman*			
DATE	09/07/94		06/10/94		06/10/94		06/13/94			
OFFICE	OGCB/NRR	E	TECH ED		EELB/NRR	E	C:ECB/DOPS		D:DOPS	
NAME	RKiesel*		<i>B. Colure</i>		SMitra*		CBerlinger*		BKGrimes	
DATE	09/07/94		12/29/94		09/22/94		10/26/94		12/ /94	
OFFICE	D:DE/NRR	E	C:SIB/DOTS		D/DOTS		C:ECB/DOPS		D:DOPS	
NAME	BWSheron*		RGallo		RLSpessard		AChaffee		BKGrimes	
DATE	11/01/94		12/ /94		12/ /94		12/ /94		12/ /94	

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NAME	TTella	RMendez	GEGrant	EGGreenman
DATE	9/ 7/94	6/10/94	6/10/94	6/13/94
OFFICE	*OGCB/NRR	*Tech Ed	*EELB/NRR	*C:EELB/NRR
NAME	RJKiessel	JMain JM	SKMitra	CHBerlinger
DATE	9/ 7/94	9/12/94	9/22/94	10/26/94
*D:DE/NRR	C:RVIB/NRR	D:DOTS/NRR	C:OECB/NRR	D:DOPS/NRR
BWSheron	RGallo	RLSpessard	AEChaffee	BKGrimes
11/01/94	12/ /94	12/ /94	12/ /94	12/ /94

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In doing post maintenance testing, the licensees did not find evidence of impending breaker failures because the tests were done mainly to determine whether the breaker tripped or closed.

Related Generic Communications

Although involving a different type of circuit breaker, NRC IN 93-26, "Grease Solidification Causes Molded-Case Circuit Breaker Failure to Close," issued April 7, 1993, and its supplement issued January 31, 1994, described a similar problem with grease solidification.

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NAME	TTella	RMendez	GEGrant	EGGreenman
DATE	9/ 7/94	6/10/94	6/10/94	6/13/94
OFFICE	*OGCB/NRR	*Tech Ed	*EELB/NRR	*C:EELB/NRR
NAME	RJKiessel	JMain JM	SKMitra	CHBerlinger
DATE	9/ 7/94	9/12/94	9/22/94	10/26/94
*D:DE/NRR	C:RVIB/NRR	D:DOTS/NRR	C:OECB/NRR	D:DOPS/NRR
BWSheron	RGallo	RLSpessard	AEChaffee	BKGrimes
11/01/94	11/ /94	11/ /94	11/ /94	11/ /94

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DATE	9/ 7/94	6/10/94	6/10/94	6/13/94
OFFICE	*OGCB/NRR	*Tech Ed	*EELB/NRR	C: FELB/NRR
NAME	RJKiessel	JMain JM	SKMitra	CHBerlinger
DATE	9/ 7/94	9/12/94	9/22/94	10/6/94
OFFICE	D:DE/NRR	C:OECB/NRR	D:DOPS/NRR	
NAME	BSheron	AEChaffee	BKGrimes	
DATE	10/ 1/94	10/ /94	10/ /94	

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DATE	9/ 7/94	6/10/94	6/10/94	6/13/94
OFFICE	*OGCB/NRR	*Tech Ed	EELB/NRR	C:EELB/NRR ^{of}
NAME	RJKiesel	JMain JM	SKMitra <i>SKM</i>	CHBerlinger <i>CHB</i>
DATE	9/ 7/94	9/12/94	9/22/94	9/ /94
OFFICE	D:DE/NRR	C:OGCB/NRR	D:DORS/NRR	
NAME	BWSheron	ELDoolittle	BKGrimes	
DATE	9/ /94	9/ /94	9/ /94	

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