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

April 11, 1994

NRC INFORMATION NOTICE 92-51, SUPPLEMENT 1: MISAPPLICATION AND INADEQUATE TESTING OF MOLDED-CASE CIRCUIT BREAKERS

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 supplement to clarify the original information notice and to provide additional references and information. 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.

Background

On July 9, 1992, the NRC issued Information Notice (IN) 92-51, "Misapplication and Inadequate Testing of Molded-Case Circuit Breakers" (MCCBs). This notice informed addressees about problems that can cause certain MCCBs to trip when starting their safety-related motor loads. The main problems mentioned were (1) that the effect of the inrush transient current when starting a large, highly inductive load was not always being properly accounted for in selecting ratings and settings for replacement MCCBs and (2) that some replacement MCCBs, although correctly selected and set, were tripping out of tolerance during post installation testing or operation because inadequate bench test methods had failed to detect this condition.

Description of Circumstances

The first two sentences of the second paragraph of IN 92-51 under "Description of Circumstances" incorrectly stated the magnitude of inrush transient current and how it can vary. The first sentence stated that the inrush transient current could be as much as three times locked-rotor current. The second sentence stated that, depending on the impedance of the motor when started, the inrush transient current can increase to as much as approximately six times the value of the locked-rotor current. However, the notice should have stated that, for most industrial applications, the inrush transient current should seldom reach much more than two times the locked-rotor current, but that, within this limit, the magnitude of the inrush transient current can vary widely depending on factors that will be described below.

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IN 92-51 also commented on certain guidelines in National Fire Protection Association Publication NFPA-70, "The National Electric Code," (NEC) in a manner that could be misinterpreted as written. It stated that the level of protection recommended by the NEC might be insufficient to prevent an unwanted trip. However, this statement was not intended as a comment on the adequacy of the NEC guideline because the guideline was not intended to prevent unwanted trips, but rather to ensure circuit protection. Instead, the statement was meant to explain that by adhering to the NEC guideline for maximum overload trip settings or fixed trip points (e.g., 13 times full load), unwanted tripping may result if the various rating factors used in selecting and setting MCCBs are not correctly applied. Certain exceptions in the NEC provide for the limited use of rating factors.

Finally, IN 92-51 cited references (such as National Electrical Manufacturers Association Standard AB4-1991) that contain standard test methods for MCCBs. However, the notice was originally intended also to highlight certain recommendations in those references that the NRC had found were often not being followed in field testing procedures and practice. The recommendations were meant to ensure that the test methods prescribed could accurately and conclusively demonstrate that an MCCB is not only tripping when required, but also not tripping prematurely. These points were that (1) the pulse method is generally more accurate than the runup method, (2) the asymmetrical current error inherent in the pulse test method test could be minimized and/or compensated for by using equipment capable either of capturing and recording the instantaneous values of the inrush transient or capable of sensing the phase angle of the source voltage and initiating current flow at the instant the voltage waveform is at the peak, (3) initial test current pulses are injected at values just at or below the lower limit of the manufacturer's specified trip band (adjustable or fixed) with appropriate test tolerance applied, and (4) the expected result at this current level is that no instantaneous-magnetic trip will occur. In some cases, a thermal trip may occur during the test, but the inherent, measurable time delay would indicate the absence of an instantaneous trip and hence confirm no premature trip by the magnetic trip function being tested.

Discussion

The peak amplitude of the inrush transient current depends on the reactance-to-resistance (X/R) ratio of the load and decays exponentially during the first few cycles after the starter contacts close. Within the boundaries determined by the electrical properties of the circuit, the inrush transient current also varies randomly with the phase angle of the supply voltage at the particular instant that the starter contacts close. However, the point of IN 92-51 remains the same: that is, sometimes, the peak amplitude and duration of the inrush transient current may be sufficient for very sensitive (and sometimes inaccurate, misadjusted, and/or misapplied) magnetic trip mechanisms in the supply breaker to respond to and trip the breaker prematurely.

Examples of the rating factors used by the application engineer that could lead to premature tripping with settings that are in compliance with the NEC

would include load class (type/duty cycle), cable type and size, ambient temperature and altitude, frequency, and safety margin. These factors, used in specifying the nominal load rating of the breaker in relation to the expected or actual steady-state full-load current of the load, are given in manufacturers' application guides and other technical documentation, such as published by the American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA), and Electric Power Research Institute (EPRI).

The available industry guidance is intended to aid in selecting appropriate breaker types, ratings and/or settings that will support the safety function of the load equipment (Class 1E circuit) by (1) providing power reliably and not unnecessarily inhibiting normal starts, (2) providing adequate fault protection for the affected circuit(s) (equipment damage/fire protection), and (3) maintaining adequate protection for other safety functions or Class 1E circuits by isolating only the affected circuit(s) on faults or sustained overload conditions (breaker coordination). Attachment 1 gives examples of the available industry guidance.

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C T Grimes for

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contact: Stephen Alexander, NRR
(301) 504-2995

Attachments:
1. Examples of Industry Guidance on Application and Testing of Molded-Case Circuit Breakers
2. List of Recently Issued NRC Information Notices

EXAMPLES OF INDUSTRY GUIDANCE ON APPLICATION AND TESTING OF MOLDED-CASE CIRCUIT BREAKERS

1. ANSI/IEEE Standard 242-1986, "IEEE Recommended Practice for Protection and Coordination in Industrial and Commercial Power Systems."

2. EPRI Report NP-7410, "Breaker Maintenance," Volume 3, "Molded Case Circuit Breakers," September 1991.

3. EPRI Report EL-5036, "Power Plant Electrical Reference Series," Volume 8, "Station Protection," pp. 8-61, 8-64, 8-66, and 8-147.

4. NEMA Standards Publication AB 3-1984, "Molded Case Circuit Breakers and Their Application."

5. Heberflein, G. Erich, Jr. (IEEE, Allen-Bradley Co.), "Addressing Nuisance Tripping of Instantaneous Trip Breakers in High Efficiency Motor Applications," Pulp and Paper Industry Conference, 89-07.

6. Bartheld, R.G., "Motor Inrush Currents," NEMA Presentation, SCI2 Motor Control Center Committee, June 1985.

7. Hartman, C.N., "Understanding Asymmetry," "IEEE Transactions on Industrial Applications," Volume IA-21, No. 4, July/August 1985.

8. NEMA Standard MG 1-1988, "Motors and Generators" (nominal values for locked-rotor KVA per HP designated by a nameplate letter code).

9. NEMA Publication AB 4-1991, "Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications" (cited in original notice)

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
94-28	Potential Problems with Fire-Barrier Penetration Seals	04/05/94	All holders of OLs or CPs for nuclear power reactors.
94-27	Facility Operating Concerns Resulting from Local Area Flooding	03/31/94	All holders of OLs or CPs for nuclear power reactors.
94-26	Personnel Hazards and Other Problems from Smoldering Fire-Retardant Material in the Drywell of a Boiling-Water Reactor	03/28/94	All holders of OLs or CPs for nuclear power reactors.
93-17, Rev. 1	Safety Systems Response to Loss of Coolant and Loss of Offsite Power	03/25/94	All holders of OLs or CPs for nuclear power.
94-25	Failure of Containment Spray Header Valve to Open due to Excessive Pressure from Inertial Effects of Water	03/25/94	All holders of OLs or CPs for nuclear power reactors.
94-24	Inadequate Maintenance of Uninterruptible Power Supplies and Inverters	03/24/94	All holders of OLs or CPs for nuclear power reactors.
94-23	Guidance to Hazardous, Radioactive and Mixed Waste Generators on the Elements of a Waste Minimization Program	03/25/94	All NRC Licensees.
94-22	Fire Endurance and Ampacity Derating Test Results for 3-Hour Fire-Rated Thermo-Lag 330-1 Fire Barriers	03/16/94	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

would include load class (type/duty cycle), cable type and size, ambient temperature and altitude, frequency, and safety margin. These factors, used in specifying the nominal load rating of the breaker in relation to the expected or actual steady-state full-load current of the load, are given in manufacturers' application guides and other technical documentation, such as published by the American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA), and Electric Power Research Institute (EPRI).

The available industry guidance is intended to aid in selecting appropriate breaker types, ratings and/or settings that will support the safety function of the load equipment (Class 1E circuit) by (1) providing power reliably and not unnecessarily inhibiting normal starts, (2) providing adequate fault protection for the affected circuit(s) (equipment damage/fire protection), and (3) maintaining adequate protection for other safety functions or Class 1E circuits by isolating only the affected circuit(s) on faults or sustained overload conditions (breaker coordination). Attachment 1 gives examples of the available industry guidance.

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NAME	SALEXANDER*	GCWALINA*	CBERLINGER*	SAGGARWAL*	LNORRHOLM*
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DATE	6/17/93	6/24/93	7/23/93	7/23/93	6/28/93
COPY	YES	YES	YES	YES	YES

OFFICE	TECHED	D/DRIL/NRR	OGCB/DORS	BC/OGCB/DORS	D/DORS/NRR
NAME	DGABLE*	CEROSSI*	NCAMPBELL*	AKUGLER	BKGRIMES
DATE	10/25/93	7/23/93	10/15/93	03/04/94	03/ /94
COPY	NO	YES	NO	(YES) NO	YES NO

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DATE	6/17/93	6/24/93	7/23/93	7/23/93	6/28/93
COPY	YES	YES	YES	YES	YES

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NAME	DGABLE*	CEROSSI*	NCAMPBELL*	~~CMARCUS~~ AJKugler	BKGRIMES
DATE	10/25/93	7/23/93	10/15/93	03 ~~10~~/ /94	03/ /94
COPY	NO	YES	NO	YES NO	YES NO

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3. EPRI Report EL-5036, Power Plant Electrical Reference Series, Volume 8, Station Protection, pp. 8-61, 8-64, 8-66, and 8-147
4. NEMA Standards Publication AB 3-1984, "Molded Case Circuit Breakers and Their Application"
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COPY	YES	YES	YES	YES	YES

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NAME	MMEJAC*		JEROSSI*	GMARCUS	BKGRIMES
DATE	6/16/93	/ /93	7/23/93 9/3/93	9/ /93	9/ /93
COPY	NO	NO	YES NO	YES NO	YES NO

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DATE	6/17/93	6/24/93	7/23/93	7/23/93	6/28/93
COPY	YES	YES	YES	YES	YES

OFFICE	TECHED	OGCB/DORS	D/DRIL/NRR	BC/OGCB/DORS	D/DORS/NRR
NAME	MMEJAC*	N CAMPBELL	CEROSSI*	GMARCUS	BKGRIMES
DATE	6/16/93	10/15/93 M.E.C.	7/23/93	10/ /93	10/ /93
COPY	NO	NO	YES	YES NO	YES NO

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DATE	6/17/93	6/24/93	7/23/93	7/ /93	7/ /93
COPY	YES	YES	YES NO	YES NO	YES NO

OFFICE	TECHED	DD/DRIL/NRR	D/DRIL/NRR	BC/OGCB/DORS	D/DORS/NRR
NAME	MMEJAC*	~~RZIMMERMAN~~	CEROSSI	GMARCUS	BKGRIMES
DATE	6/16/93	7/ /93	7/ /93	7/ /93	7/ /93
COPY	NO	YES NO	YES NO	YES NO	YES NO

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DATE	6/17/93	6/24/93	6/ /93	6/ /93	6/28/93
COPY	YES NO	YES NO	YES NO	YES NO	YES NO

OFFICE	TECHED	DD/DRIL/NRR	D/DRIL/NRR	BC/OGCB/DORS	D/DORS/NRR
NAME	MMEJAC*	RZIMMERMAN	CEROSSI	GMARCUS	BKGRIMES
DATE	6/16/93	6/ /93	6/ /93	6/ /93	6/ /93
COPY	YES NO	YES NO	YES NO	YES NO	YES NO

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DATE	6/ /93	6/ /93	6/ /93	6/ /93	6/ /93
COPY	YES NO	YES NO	YES NO	YES NO	YES NO

OFFICE	TECHED	DD/DRIL/NRR	D/DRIL/NRR	BC/OGCB/DORS	D/DORS/NRR
NAME	~~JMAIN~~ MMEJAC	RZIMMERMAN	CEROSSI	GMARCUS	BKGRIMES
DATE	6/16/93	6/ /93	6/ /93	6/ /93	6/ /93
COPY	YES NO	YES NO	YES NO	YES NO	YES NO

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