

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

April 12, 1988

NRC INFORMATION NOTICE NO. 88-12: OVERGREASING OF ELECTRIC MOTOR BEARINGS

Addressees:

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

Purpose:

This information notice is being provided to alert addressees to problems caused by accumulation of grease on electric motors used to drive rotating equipment in nuclear power plants. 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:

NRC personnel observed accumulations of grease on the air vent screens of electric motors used for driving such rotating equipment as fans and pumps at the Millstone and Calvert Cliffs nuclear power plants. The grease appeared to have come from overgreasing of the electric motor bearings. Grease was forced out of the bearing seals, onto the stator windings and rotor, from where it either fell or was thrown onto the inside of the motor housing. Because of these observations, the NRC began an investigation into problems that have been caused in the past, or could be caused in the future, by the overgreasing of electric motor bearings.

Several electric motor overgreasing events were identified that have led to failures of nuclear plant components:

- At a nuclear plant in 1975, overgreasing of the motor bearings caused the failure of the containment cooler fans when a bearing failed and seized.
- At Susquehanna Unit 1, on July 24, 1984, excessive grease buildup in the electric motor of a motor generator set caused the set to shut down and resulted in the spurious emergency actuations of the standby gas treatment system and the control room emergency outside air system (LER 387/84-036).

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- At Palisades Unit 1, overgreasing of the motor bearings caused the containment cooler fans to fail on three different occasions: On July 7, 1986, overgreasing of the motor shaft bearings caused the bearings to skid instead of roll. This caused the motor to overheat and automatically shut down. On August 8, 1986, and again on August 11, 1986, overgreasing caused the motor bearings to deteriorate which, in turn, caused the motor and fan to vibrate, and bolts on the equipment to loosen and fail (LER 255/86-031).

In addition to these overgreasing events, a number of cases have been reported in which excessive motor bearing grease caused problems that were caught before the systems actually failed. For example, at a nuclear plant in 1978, excessive grease in a motor bearing in the service-water system caused the bearing to become abnormally hot and noisy. At another nuclear plant in 1986, grease from a bearing in the component cooling pump motor ran into the motor, causing it to smoke.

Discussion:

The NRC staff has solicited technical information and operating experience on the problems caused by the overgreasing of electric motor bearings from motor and bearing manufacturers, as well as from other licensees. Their responses are summarized in this discussion.

Two basic mechanisms involving overgreasing of bearings can lead to the failure of electric motors:

- (1) The excess grease will leak out from the bearing seal and be deposited on the stator and rotor windings. The grease deposits create a thermal barrier between the windings and their cooling air, leading to an increase in motor temperature. For motors designed to use outside air to cool the windings, the temperature is increased still more by the buildup of dirt, dust, and other foreign materials that adhere to the grease. It is estimated that for every 10°F rise in motor temperature, the insulation life of the windings is reduced by half. The deterioration of the winding insulation then causes the motor to "short out".
- (2) The excess grease causes a "churning" action of the ball bearings within their housing, increasing the temperature of the grease and bearings. As the temperature approaches the upper functional design limit of the grease, viscous or hard residues form, causing a breakdown of the lubricating characteristics of the grease. The bearing temperature then rises higher, and eventually causes a reduction in bearing hardness and a subsequent breakdown of the bearing. A rule of thumb, based on certain

manufacturers' tests, is that grease life is halved for every 25°F increase in temperature and is doubled for every 25°F decrease in temperature.

High bearing temperature may also cause the inner race of the bearing to expand and slip on the rotor shaft. The expansion and slippage of the bearing's inner race leads to a misalignment between the rotor shaft and the bearing; this misalignment can cause contact between the rotor and stator. Once contact occurs, the windings short and burn out.

One frequent cause of excess grease problems is the failure to provide an exit path for the displaced grease when new grease is added. This can result from the failure to remove the grease drain plug, or from failure to unblock drain lines that have become plugged by hardened grease or dirt. Another frequent cause is the addition of too much grease. The correct amount must be determined for each situation. Bearing manufacturers generally recommend filling the motor bearing void space from one-third to one-half full of grease. However, the optimum amount can vary from 20% to 80% full, depending on such factors as the application of the motor, the environment of the motor, the retainer design, and the type of grease.

The following actions can be taken to correct or prevent motor overgreasing and related problems:

- (1) Review motor lubrication procedures to ensure that they identify the type and quantity of grease to use, the specific fill and drain nozzles to uncap, and the length of time motors should be run with drain plugs off after greasing the bearings.
- (2) To prevent foreign materials from contaminating the grease, ensure that grease containers are covered during periods of storage and that nozzles and grease fittings are cleaned.
- (3) Determine the optimum quantity and correct type of grease required for each motor by examining the manufacturer's recommendations and by monitoring the behavior of grease added to motors.
- (4) Consider using prelubricated sealed bearings in applications where re-lubrication is difficult, where contaminants can adulterate the grease, or where overgreasing might damage safety systems.

It should be noted that the vast majority of the reported lubrication-related incidents have been the result of underlubrication rather than overlubrication. This notice is not intended to discourage the adequate lubrication of motor bearings, but to prevent overgreasing problems by encouraging a thorough understanding of correct lubrication procedures.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the technical contact 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: James A. Prell, RI
(215) 337-5108

Donald C. Kirkpatrick, NRR
(301) 492-1152

Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
88-11	Potential Loss of Motor Control Center and/or Switchboard Function Due to Faulty Tie Bolts	4/7/88	All holders of OLs or CPs for nuclear power reactors.
88-10	Materials Licensees: Lack of Management Controls Over Licensed Programs	3/28/88	All NRC licensees authorized to use byproduct material.
87-44, Supp. 1	Thimble Tube Thinning in Westinghouse Reactors	3/28/88	All holders of OLs or CPs for nuclear power reactors that employ a Westinghouse NSSS.
88-09	Reduced Reliability of Steam-Driven Auxiliary Feedwater Pumps Caused by Instability of Woodward PG-PL Governors	3/18/88	All holders of OLs or CPs for nuclear power reactors.
88-08	Chemical Reactions with Radioactive Waste Solidification Agents	3/14/88	All NRC licensees generating or processing low level radioactive waste.
88-07	Inadvertent Transfer of Licensed Material to Uncontrolled Locations	3/7/88	All NRC broad licensees and licensees authorized to possess byproduct material as sealed sources in teletherapy units or "self-contained" irradiators.
88-06	Foreign Objects in Steam Generators	2/29/88	All holders of OLs or CPs for PWRs.
88-05	Fire in Annunciator Control Cabinets	2/11/88	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
 CP = Construction Permit

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