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

February 4, 1991

NRC INFORMATION NOTICE NO. 91-07: MAINTENANCE DEFICIENCY ASSOCIATED WITH GENERAL ELECTRIC HORIZONTAL CUSTOM 8000 INDUCTION MOTORS

Addressees:

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

Purpose:

This information notice is to alert addressees to a possible problem resulting from improper maintenance that may affect the operability of Horizontal Custom 8000 induction motors manufactured by the General Electric Company (GE). The problem relates to inadequate tightening of the bolts securing the air deflectors to the motor-end shield. 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:

On August 24, 1990, Northeast Utilities (NU), the licensee for the Millstone Nuclear Power Station, Unit 3, notified the U.S. Nuclear Regulatory Commission (NRC) that the lower fan shroud on the inboard side of one of the reactor plant component cooling water pump (RPCCW) motors had come loose and impacted the motor rotor causing a loud noise during its operation. The licensee inspected the motor and determined that the protective glass tape on the end turns of the drive-end winding had sustained damage; however, the mica insulation was not damaged. Additional observations indicated that the drive-end lower air deflector was loose and damaged with minor tears and cracks. The licensee evaluated the available evidence and determined that the cause of failure was the loosening of the clamps of the drive-end lower air deflector. The licensee believes that excessive vibration caused the clamping bolt to loosen and that a reduction in the metal contact grip of the clamps and the air deflector (because metal had been worn away at the corner) permitted the air deflector to loosen. GE repaired the damaged motor by welding the lower shroud clamping bracket. A licensee inspection of the other two RPCCW pump motors and additional motors of similar size and model identified loosened shrouds on six motors and one with cracked upper shrouds. The licensee tightened the loose bolts and repaired the cracks by welding.

IDAR-11C

Discussion:

Typically, the GE Horizontal Custom 8000 series motor models are assembled with split air deflectors at both ends of the motor. The circular air deflectors are cut through the center into two halves, and each half is secured to the motor-end shield with clamps, hex-head machine screws, and star-lock washers at the circumference of the air deflectors. Similar vertical motors are equipped with upper and lower air deflectors (constructed from one piece, instead of two halves). In both designs, the air deflectors direct incoming air to shaft-driven fans and cool the motor and stator. In the vertical motor, the upper deflector is mounted directly over the fan and is supported either by brackets or by 1/4-20 hex-head machine screws. If a bracket or screw(s) fails, it could fall into the rotating fan and be propelled into the winding end-turn, causing failure of the motor.

In General Electric Nuclear Energy (GENE) Service Information Letter (SIL) No. 484 of March 29, 1989, GENE discussed problems with air deflectors installed in vertical motors. This SIL summarized several other specific experiences and lessons learned from the use of similar GE alternating current (AC) induction motors in various applications in boiling water reactors (BWRs). In paragraph 8 of this SIL, GENE (1) described the purpose of air deflectors in vertical motors, (2) discussed the damage that may result if a bracket or screw loosens and falls into the rotating fan, (3) recommended that owners ensure that their procedures for motor disassembly and overhaul should include a provision to visually inspect the air deflector fasteners, and (4) recommended that the 1/4-20 hex-head screws securing the air deflector be replaced during each reassembly. On October 5, 1990, GENE issued Supplement 1 to SIL No. 484, which discussed several additional lessons learned from the application of the AC induction motors. In Paragraph 2 of this SIL, GENE discussed its experience with loose air deflectors on Horizontal Custom 8000 Motors and recommended that users ensure that the screws securing the air deflectors were tightened and maintained at the required torque. The SIL requested users to contact the GENE local representative for information pertaining to a design modification to prevent bolt loosening for some motor models.

Because the issues discussed in the SILs only reflected BWR experience, GENE only issued the SILs to BWR owners. Therefore, the NRC is concerned that non-BWR owners may not have received all of the information on these problems. Although GE normally sends service advisory letters (SALs) to other equipment manufacturers and non-BWR owners to communicate problems identified in GE products, GENE has informed the NRC that it had not issued SALs on this matter because the GE facility that manufactured these types of motors ceased to exist. Therefore, a copy of GENE SIL No. 484 and Supplement 1 to SIL 484 has been enclosed with this information notice for the benefit of non-BWR addressees.

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

Carl H. Berlinger for Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contact: Kamal R. Naidu, NRR
(301) 492-0980

Attachments:
1. SIL No. 484, March 29, 1989
2. Supplement 1 to SIL No. 484, October 5, 1990
3. List of Recently Issued NRC Information Notices

NUCLEAR SERVICES INFORMATION LETTER
SAN JOSE, CALIFORNIA

March 29, 1989
File Tab A

SIL No. 484
Category 3

EXPERIENCE WITH GE AC INDUCTION MOTORS

Introduction

This SIL summarizes specific experiences and lessons learned from applications of GE AC induction motors in BWRs. The information contained in this SIL has been collected from GE Nuclear Energy's own experience base as well as those of GE Service Shops and BWR owners. It concerns motors that either have failed, have exhibited abnormal running characteristics such as high temperature or vibration or have required replacement parts. Investigations that followed such motor performance problems led to the data and recommendations contained in this SIL.

The purpose of this SIL is to assist BWR owners in selecting applications, specifying refurbishment practices and performing field tests to improve the reliability of GE AC induction motors.

Recommended Action

GE Nuclear Energy recommends that BWR owners review the experiences and lessons learned that are summarized in Attachment 1 to this SIL for applicability to their plants. If a motor fails, a root cause evaluation should be undertaken so that appropriate repair can be made and information can be added to the experience base.

Please note that item 12, "Broken Or Cracked Surge Ring Brackets Should Be Replaced", is a folloup to RICSIL 016 issued by GE Nuclear Energy on April 11, 1988.

To receive additional information on this subject or for assistance in implementing a recommendation, please contact your local GE Nuclear Energy Service Representative.

Technical Source: J. S. Mokri

Issued by: J. G. Moore
Marketing Services Manager, Product Communications

Product Reference
A72: Plant Recommendations

SIL No. 484
Category 3

ATTACHMENT 1

FIELD EXPERIENCES AND LESSONS LEARNED FOR GE AC INDUCTION MOTORS

1. MOTOR OPERATION DURING BUS TRANSFERS MAY CAUSE DAMAGE:

Experience:

GE AC induction motors typically installed at BWRs are designed to operate at both rated and reduced voltage, to start and accelerate the standard NEMA MG1 load inertia and to start from zero speed from a single voltage source. As described in paragraph 15 of ANSI C50.41 (1977), motors are typically designed to withstand a maximum supply difference of 1.33 per unit volts per hertz during bus transfers.

If operating motors are transferred from one power source to another (e.g., bus transfers between plant transformer and startup transformer) and if the line voltage and frequency are significantly out of phase with the electromotive force (EMF) generated by the motor when the contactor is opened (e.g., outside the ANSI C50.41 criteria), the internal components of the motor may be stressed electrically and mechanically beyond design limits. This has been the postulated cause of motor damage at at least one BWR. Some motors at newer plants have been designed with additional end-turn support rings to carry the higher loads that may occur during fast bus transfers.

Recommended Action:

GE Nuclear Energy recommends that BWR owners review their plant design to determine how frequently motors may be subjected to fast bus transfers and how many redundant motors could be affected simultaneously by such transfers. If more than 10 fast bus transfers could occur during the life of the plant or if a number of safety related motors could be affected, the switching times should be investigated relative to ANSI C50.41 criteria.

2. ANTIFRICTION BEARING INTERNAL CLEARANCE SHOULD BE SPECIFIED:

Experience:

Motor shaft bearings are designed and specified to have certain internal clearances between the inner race, balls and outer race. This clearance is designed to be both large enough to permit radial thermal expansion of the shaft and the bearing components and small enough to prevent excessive shaft movement and vibration. If the shaft temperature is high relative to that of the bearing housing or if ambient temperatures are high, the internal clearance is reduced. The specified clearance allows the bearing to rotate without internal interference at high temperatures and to support the shaft when the motor is starting and at low temperature conditions.

Generally, manufacturers of commercial bearings do not distinguish between standard (designated "C0") and loose (C3) internal clearances. The C0 and C3 nomenclature is defined in the bearing standards of the Anti-Friction Bearing Manufacturers Association (AFBMA).

2. ANTIFRICTION BEARING INTERNAL CLEARANCE SHOULD BE SPECIFIED: (Cont'd.)

Recommended Action:

GE Nuclear Energy recommends that BWR owners specify the internal clearance class for bearings in procurement specifications and receiving inspection documentation. The class should be specified using the AFBMA nomenclature and should be consistent with the motor's design specification.

Motor maintenance practices and procurement dedication programs also should include requirements for measuring the internal clearance of bearings to assure that clearance specifications are met.

3. SPACE HEATERS SHOULD BE ENERGIZED WHEN A MOTOR IS IN THE STANDBY MODE:

Experience:

A motor's space heaters protect its internal components from moisture condensation if the temperature of the air around the motor is at or below the dew point. Stator windings impregnated with epoxy applied under a vacuum are not affected by moisture as much as randomly wound or polyester varnished windings are affected. In all cases, however, bearings, laminations, shafts and support components within a motor are affected adversely by moisture. Although most motors originally were provided with space heaters, some motors have been installed with no provisions for energizing the space heaters.

Recommended Action:

GE Nuclear Energy recommends that BWR owners assure that space heaters furnished with motors are energized when the motors are in the standby mode. The environmental qualification basis of some motors is contingent upon protecting the motors from moisture with space heaters. In such motors, the heaters must be energized to maintain the environmental qualification status.

To reduce the ambient heat load to motor, GE also recommends that BWR owners de-energize the space heaters when a motor is operating. The thermal life of a motor's insulation materials is reduced by a factor of about 2 for each 10 degrees centigrade increase in temperature. The heaters are sized to keep the temperature of the winding at least three degrees centigrade above the ambient temperature. Because the temperature of winding material near the heaters is more than three degrees above ambient, service life of the winding could be reduced significantly if the heaters remain energized during operation.

4. THE TEN YEAR INSPECTION RECOMMENDATION IS IMPORTANT:

Experience:

Experience and reliability data indicate that GE AC induction motors should be inspected at ten-year intervals. This inspection interval

4. THE TEN YEAR INSPECTION RECOMMENDATION IS IMPORTANT: (Cont'd.)

applies whether a motor is operated continuously, operated intermittently or stored. The environmental qualification status of some motors is contingent upon inspections at this interval.

Recommended Action:

GE Nuclear Energy recommends that BWR owners disassemble and inspect the internal components of safety related and non-safety related motors to confirm that none of a motor's functional components are degrading in service. This inspection should be documented and performed at approximately ten-year intervals regardless of the type of service to which the motor has been subjected.

5. MOTOR DRAIN PLUG O-RING AND SIGHT GLASS O-RINGS SHOULD BE REPLACED:

Experience:

Oil reservoir drain plugs typically have O-ring seals made of a low nitrile buna material. Oil and oil operating temperature eventually degrade this material, potentially reducing the effectiveness of the seals. Although GE motors are qualified for post-accident conditions, engineering studies have shown that high radiation and the typical 100-day, elevated temperature operating condition may accelerate the degradation of low nitrile buna material seals and lead to an oil leak.

Recommended Action:

GE Nuclear Energy recommends that BWR owners replace the low nitrile buna O-rings with medium nitrile buna-N O-rings containing at least 27% nitrile to improve seal reliability and increase the life of the seals. The O-rings should be replaced at every other oil change.

The sight glass O-rings are made of similar material. These also should be replaced with medium nitrile buna-N O-rings containing at least 27% nitrile when the motor is disassembled for overhauling or rewinding.

6. HIGH CYCLE FATIGUE HAS CAUSED CONDUIT BOX GASKET FAILURES:

Experience:

The gasket between the main conduit box and the motor frame is made of a 1/4 inch thick, resilient material. The purpose of the gasket is to support the lead cables from the frame and to provide a seal between the conduit box and the frame. The conduit box bolts compress the gasket. The compressed gasket is one of the components in the bolted joint that maintains a preload on the bolts. Over time, the gasket relaxes and the preload on the bolts diminishes. With a reduced preload, the bolts can loosen under normal operating conditions.

At some plants, vibratory loads have caused the bolts to fail from high cycle fatigue. It has been reported that this has occurred on three motors in safety related service. In one case the conduit box partially cut the lead cables when the box separated from the frame.

6. HIGH CYCLE FATIGUE HAS CAUSED CONDUIT BOX GASKET FAILURES: (Cont'd.)

Recommended Action:

A replacement gasket with metal inserts molded into the gasket is available. The inserts reduce the effect of gasket relaxation and the probability of bolt fatigue failure. GE Nuclear Energy recommends that BWR owners either install these replacement gaskets during the next periodic maintenance of the motors or contact GE Nuclear Energy for a recommended modification to the existing gaskets.

7. SLEEVE BEARINGS SHOULD BE INSPECTED FOR PLUGGED OIL PASSAGES:

Experience:

The upper bearing on high thrust motors uses a plate bearing for thrust loads and a sleeve bearing for radial loads. Lubricant for both bearings is metered through orifices and passages in the bearing housing casting.

During motor inspections at some plants, it has been discovered that chips and other debris in the oil have plugged the oil passages at their intersections with internal 90-degree holes. These internal passages are difficult to inspect and occasionally have been overlooked during motor overhauls. Under conditions of high ambient temperature and high side load, plugged passages could jeopardize the supply of lubricant to the bearing assembly.

Recommended Action:

GE Nuclear Energy recommends that BWR owners confirm that their motor disassembly and overhaul procedures require inspecting the internal oil passages and orifices for plugging and removing any plugging from this bearing assembly when the motor is disassembled and inspected.

8. AIR DEFLECTOR BRACKETS SHOULD BE INSPECTED FOR CRACKING:

Experience:

Vertical motors are equipped with upper and lower air deflectors to direct incoming air to shaft-driven fans. The upper deflector is mounted directly over the fan and is supported either by brackets or 1/4-20 hex head machine screws. If a bracket or screw fails, it could fall into the rotating fan, be propelled into the winding end-turn and cause motor failure.

One BWR owner reported a bent deflector bracket with cracks completely through its thickness. It is possible that a bracket in this condition could fail and fall into the motor windings.

Recommended Action:

GE Nuclear Energy recommends that BWR owners assure that their procedures for motor disassembly and overhaul require a visual inspection of the air deflector brackets. The 1/4-20 screws should be replaced during each

8. AIR DEFLECTOR BRACKETS SHOULD BE INSPECTED FOR CRACKING: (Cont'd.)

reassembly. These screws often have been overtorqued during a previous reassembly and, therefore, may be partially fractured.

9. TERMINAL LUGS SHOULD BE INSPECTED FOR CRACKING:

Experience:

As a result of NRC Bulletin 88-27, attention has been given recently to damaged feeder cable termination lugs. Some lugs have identification stamps near the transition which produce stress risers. On others, stiff cable splices require extra force to insert the termination into the conduit box. This contributes to mechanical failures of the lugs. At one plant, a motor had improperly crimped termination lugs which fell off the leads during an inspection. The lead was shortened and stripped to install a new lug, necessitating lead replacement.

Recommended Action:

GE Nuclear Energy recommends that BWR owners consider either increasing the length of motor lead cables to reduce mechanical stresses or installing oversized conduit boxes when motors are in the service shop.

10. SHAFT END-PLAY ADJUSTMENT IS CRITICAL TO BEARING LIFE:

Experience:

Shaft end-play is necessary to allow unrestrained thermal expansion of the rotor during transient conditions and to minimize axial shuttling of the rotor. At some plants, bearings, shaft sleeves and bearing housings have been damaged because of improper end-play adjustment.

Because motor instruction manuals are written in a general format for several different bearing configurations, the appropriate shaft end-play may not be evident from drawings in the manuals. For example, angular contact bearings mounted in the DF configuration do not require shaft end-play adjustment. However, the same bearings mounted in the DT configuration do require end-play adjustment of the top shaft nut.

Recommended Action:

GE Nuclear Energy recommends that BWR owners either consult the text of motor manuals to determine the types of bearing assemblies used on their motors and the methods of end-play adjustment that should be used for each bearing assembly when motors are reassembled or contact GE Nuclear Energy for guidance.

11. ANTIFRICTION BEARING INNER RACE TO BEARING CARRIER DIMENSION IS CRITICAL TO BEARING LIFE:

Experience:

Antifriction bearing life and load capability depend on specified close

11. ANTIFRICTION BEARING INNER RACE TO BEARING CARRIER DIMENSION IS CRITICAL TO BEARING LIFE: (Cont'd.)

tolerances. If the inner race is not mounted on the carrier with a tight fit, relative movement between the race and the carrier is possible. This can cause unacceptable wear. Bearing manufacturers discuss this failure mechanism in their commercial catalogs. Measurements of several vertical motors recently inspected in a GE Service Shop showed that the fit between the bearing inner race and the shaft was outside the design limit and required corrective action.

Recommended Action

GE Nuclear Energy recommends that when a motor is disassembled and available for dimensional inspection, BWR owners measure the bearing to bearing carrier dimensions to confirm that these dimensions are within specified design limits for the motor.

12. BROKEN OR CRACKED SURGE RING BRACKETS SHOULD BE REPLACED:

Experience:

A variety of methods has been used in GE motors to support end-turns against electromechanical loads that develop during starting transients and bus transfers. Surge ring brackets are used on some vertical motors. Cracks in surge ring brackets have been reported in NRC Information Notice 87-30 and in RICSIL 016, "ECCS Motor Bracket Failures", issued by GE Nuclear Energy on April 11, 1988.

Recommended Action:

GE Nuclear Energy recommends that BWR owners replace surge ring brackets on motors whose brackets are broken or missing. If motor inspections have confirmed that the bend radius of the brackets is no less than 1/4 inch or if a motor's original brackets have been replaced with brackets with no less than a 1/4 inch bend radius, no additional bracket inspections are necessary.

For motors whose bracket bend radii are less than 1/4 inch and for motors whose brackets cannot be inspected through the air vents, either inspections in accordance with NRC Information Notice 87-30 should be continued or plant unique justifications should be prepared for alternative actions.

13. HIGH VOLTAGE INSULATION TESTS OF INSERVICE MOTORS SHOULD BE AVOIDED:

Experience:

High voltage motor insulation testing at levels comparable to those used in the motor manufacturer's factory (e.g., NEMA MG1) usually should be avoided once the motor has been placed into service. However, after reassembling a motor in a service shop or power plant or if the condition of the winding is questionable, it may be appropriate to perform high voltage tests on the motor at a reduced voltage.

13. HIGH VOLTAGE INSULATION TESTS OF INSERVICE MOTORS SHOULD BE AVOIDED: (Cont'd.)

At some plants, test voltages approaching NEMA MG1 levels have resulted in damage to the windings, necessitating additional repair.

Recommended Action:

GE Nuclear Energy recommends that when high potential tests of GE AC induction motors are required, BWR owners conduct such tests in accordance with methods described in IEEE 95 to avoid damaging the winding. High voltage insulation testing of motors that have been in service should not be conducted at NEMA MG1 factory voltages.

14. PREDICTIVE MAINTENANCE METHODS HAVE PROVEN USEFUL IN TROUBLESHOOTING:

Experience:

Some BWR owners have found that the following methods have reduced the amount of motor troubleshooting required in certain situations and have been useful in diagnosing motor problems:

a. Devices for monitoring bearing shock pulse can be installed when the motor is disassembled. These devices measure antifriction bearing spike energy and can be trended to assist in predictive maintenance.

b. Samples of the oil reservoir lubricant can be analyzed periodically for contaminants and particles of bearing metal. Trending of the analysis results assists in predictive maintenance.

c. Techniques for rotor bar testing and stray field monitoring have been developed to assess a motor's condition by analyzing the frequency spectrum of the motor's current or stray magnetic fields. These data can be trended or compared with measurements from similar motors at the plant to determine the motor's condition.

Recommended Action:

GE Nuclear Energy recommends that BWR owners who have had problems with motors consider predictive maintenance methods both for troubleshooting problem motors and for predicting motor overhaul schedules.

End of Attachment 1

General Electric Company
175 Curtner Avenue, San Jose, CA 95125

SIL Services Information Letter

October 5, 1990

SIL No. 484 Supplement 1
Category 3

EXPERIENCE WITH GE AC INDUCTION MOTORS

Introduction

This Supplement 1 to SIL No. 484 summarizes specific experience and lessons learned from applications of GE AC induction motors. The information contained in this Supplement has been collected since SIL No. 484 was issued in March 1989 and is from GE Nuclear Energy's experience base as well as those of GE Service Shops and GE BWR owners. It concerns conditions identified as a result of investigating motor performance problems or in the course of performing routine motor inspections and maintenance.

The purpose of this Supplement is to inform GE BWR owners of motor operating and maintenance practices which can contribute to improved reliability of GE AC induction motors. These are identified in the attachment to this SIL.

To receive additional information on this subject or for assistance in implementing a recommendation, please contact your local GE Nuclear Energy Service Representative.

Technical Source

J. S. Mokri

Notice

This SIL pertains only to GE BWRs. GE Nuclear Energy prepared this SIL exclusively as a service for owners of GE BWRs. GE Nuclear Energy has not considered or evaluated the applicability, if any, of information contained in this SIL to any plant or facility other than GE BWRs. Determination of applicability of information contained in this SIL to a specific GE BWR and implementation of recommended action are the responsibilities of the owner of that GE BWR.

No warranty or representation expressed or implied is made with respect to the accuracy, completeness or usefulness of this information. General Electric Company assumes no responsibility for liability or damage which may result from the use of this information.

Issued by

J. G. Moore
Customer Service Communications Manager

Product Reference

A72 - Plant Recommendations

Attachment **Experience with GE AC Induction Motors**

Experience **1. Motor Fan Bolt Engagement**

Many GE AC induction motors installed at GE BWRs are designed with fan mounting bolts which also are used to secure rotor balancing weights. Thread engagement of the mounting bolt in the rotor is a nominal 5/8 inch for 1/2"-13 bolts. At a GE BWR/4 it was discovered that a pump motor in service had one of twelve fan mounting bolts, also used to secure balancing weights, engaged only 1/4 inch in the threaded hole in the rotor spider subassembly.

Recommended Action GE Nuclear Energy recommends that when motors are disassembled for rotor maintenance or inspection GE BWR owners verify the amount of thread engagement of motor fan/spider subassembly bolts which also secure rotor balancing weights.

One at a time, remove all bolts that secure rotor balancing weights. If bolt engagement is less than 5/8 inch, replace the original bolt with an SAE Grade 5 safety related bolt of sufficient length to satisfy the 5/8 inch engagement requirement. Replace balancing weights as necessary, tighten the 1/2 inch bolts to 70 to 75 ft-lbs and rebalance the rotor.

Experience **2. Loose Air Deflector on Horizontal Custom 8000 Motors**

Horizontal Custom 8000 series motor models are typically assembled with split type air deflectors at both ends of the motor. The circular air deflectors are cut through the center into two halves and are secured to the motor end shield with three clamps, bolts and star lock washers at the circumference of the air deflectors. Loose air deflectors have damaged motor stator windings and rotor cooling fins.

Recommended Action GE Nuclear Energy recommends that GE BWR owners take appropriate action to assure that the bolts securing air deflectors on Custom 8000 motors are tightened and maintained at the required torque. A design modification is available for some motor models to prevent bolt loosening. Information about the modification is available from local GE Nuclear Energy Service Representatives.

Experience **3. Maintenance of Cooling Water Flow Rates and Temperatures**

Motors with oil cooling coils require that the cooling water flow rate be greater than a minimum value and that cooling water inlet temperature be less than a maximum value to control bearing oil temperature during transient or accident conditions. Oil temperature usually can be maintained within operating limits with less than the minimum cooling water flow rate during normal operation if

both the cooling water and ambient air temperatures are relatively low. However, a low flow rate risks motor availability during abnormal operating conditions. Measurements of actual cooling water flow rates at some plants have identified motors operating with substantially less than the required minimum flow rate. Furthermore, corrosion product buildup or biological growth can degrade the flow rate. USNRC Generic Letter 89-13 contains more information on this.

Recommended Action GE Nuclear Energy recommends that GE BWR owners verify that all motors, particularly motors in the Emergency Core Cooling System, are supplied with at least the minimum recommended cooling water flow rate. Cooling water temperatures also should be maintained within recommended limits.

Experience **4. Motor Oil Cooling Coil Corrosion**

GE AC induction motors equipped with oil reservoir cooling coils often contain untreated water in the coils. A cooling water leak in the upper oil cooling coil of a pump motor at a GE BWR/4 caused the oil reservoir to overflow onto motor internals, rendering the motor inoperable. Inspections of motor oil coolers on other motors at the same plant revealed three more cooling coils with corrosion sufficiently advanced that failure could have occurred at any time. For more information on this event, please refer to SIL No. 523, "Motor Oil Cooling Coil Corrosion," issued August 29, 1990.

Recommended Action Severe corrosion leading to failure can develop in cooling coils where water chemistry, coil materials and operating conditions combine to create an adverse environment. GE Nuclear Energy recommends that GE BWR owners investigate for the presence of corrosion in oil cooling coils. SIL No. 523 provides specific guidelines which may be useful in this effort. If oil level monitors have been installed, verify that the high and low level alarms are operable.

Experience **5. Space Heater Electrical Lead Replacement**

Motor space heaters are installed with the heater electrical leads enclosed in protective sleeves. Motor inspections at some plants have revealed that the protective sleeves were degraded.

Recommended Action GE Nuclear Energy recommends that GE BWR owners include inspection of space heater leads and sleeves as part of motor 10-year inspection plans. Degraded sleeves should be replaced with class F-A-1 fiberglass-acrylic sleeves.

Experience **6. Maintenance of Bearing Insulation**

Motor bearing housings generally are designed and installed to be insulated

electrically from the motor frame. If the electrical isolation is violated, stray electric current can flow through the bearing, significantly reducing bearing life.

At some plants, proximity probes have been mounted on motor bearing housings. Grounding paths can be created unintentionally through the probe mounting fixture, through a conductive sheath on the instrument cable or through a grounding connection integral to the instrument.

Recommended Action

GE Nuclear Energy recommends that GE BWR owners be aware of the significance of the insulated bearing assembly and the potential for reduced bearing life if the electrical isolation is not maintained. Provisions for electrical insulation between any instrument mounted on the bearing housing and the motor frame must be included in any installation. After installing any instrumentation on an insulated bearing assembly, verify that the bearing assembly is electrically isolated from the motor frame.

Experience

7. Precautions for Tandem Angular Contact Bearing Applications

Motors in high thrust and reversing thrust applications generally use angular contact bearings in duplex configurations. Tandem configurations increase the axial load (thrust) capability of the motor in one direction by distributing the load between multiple bearings. Face-to-face configurations provide for thrust capability in both axial directions. For load sharing to occur as designed, individual bearing dimensions must be compatible. If bearing dimensions are not compatible within a bearing pair, one of the bearings can take a disproportionate share of the load. This causes accelerated wear and can lead to early bearing failure. Both types of duplex bearing applications require the inner and outer bearing races to be ground to specific, close dimensional tolerances to avoid both excessive preload and endplay.

Recommended Action

GE Nuclear Energy recommends that GE BWR owners be aware of the need for tighter dimensional tolerances for duplex bearing applications.

Experience

8. Bearing Wiping During Initial Motor Operation

Recirculation pump motor guide bearing wiping occurred recently on two GE BWR motors. In both cases the motors were forced to operate outside the design limits (low oil level after receiving a low level alarm in one case and no cooling water in the other case). An oil sample from the reservoir of the failed bearing of one of the motors was analyzed and although the Direct Reading Ferrography result showed an increase in particles, the operator concluded that the motor was normal. Low oil level caused a rapid increase in bearing temperature which led to the bearing wiping.

At two other GE BWRs with similar motors, a combination of factors also caused upper guide bearing wiping. These factors included differential thermal

expansion which reduced the running clearance and caused the bearing wiping.

Oil temperature increased rapidly when the motor was restarted following bearing replacement. There was evidence that the motors may have been operating in this condition for a long time with no adverse consequences under normal operating conditions. Operability of motors with wiped bearings may be questionable under abnormal conditions.

Recommended Action

If increased bearing oil temperature is observed after motor start-up or if the motor has been operated with lower than the recommended oil level, a bearing may have been wiped and, unless analysis of the oil shows no change in oil properties, bearing inspections should be planned and implemented. Minor changes in oil properties, even though otherwise acceptable, may indicate that the bearing has wiped. If shaft proximity probes indicate increasing clearance or if there are other indications of a wiped bearing, justification for continued operation of the motor should include an evaluation of its ability to operate in abnormal conditions. Bearing design changes have been installed on some motors that have experienced wiped bearings to improve lubricant flow and avoid wiping caused by differential thermal expansion.

Experience

9. Motor Lead Bushing and Conduit Box Gasket

The original SIL No. 484 recommended replacement of original conduit box gaskets with gaskets of an improved design during the next periodic maintenance because of gasket relaxation and subsequent bolt loosening and fatigue failure. The bolts securing the conduit box to the motor frame are safety related for Class 1E motors and should be replaced with new safety grade bolts when the conduit box gasket is replaced.

Recommended Action

GE Nuclear Energy recommends that GE BWR owners be aware of the safety related function of the conduit box bolts for Class 1E applications. Complete kits including the new gasket design, metal inserts and bolts for both safety and non-safety applications are available through local GE Nuclear Energy Service Representatives.

Experience

10. Cooling Coil Damage During Motor Installation

At some GE BWRs, motor cooling coils have been damaged inadvertently when cooling water supply piping was connected to motors. If excessive torque is applied to the cooling coil tube, brazed connections inside the motor can be damaged and potentially cause a coil to leak cooling water into the oil reservoir. GE vertical AC induction motors of recent design are equipped with special cooling water fittings which do not transmit torque to the cooling coil.

Recommended Action

GE Nuclear Energy recommends that GE BWR owners include appropriate precautions in motor maintenance procedures to prevent excessive torque from

being applied when cooling water piping is installed. A replacement fitting of the new design is available through local GE Nuclear Energy Service Representatives.

Experience

11. Motor Oil Cooling Coil Removal

Motor oil cooling coil reliability and maintenance problems may be avoided by replacing water cooled coils with air cooling on some motors where the normal and accident ambient temperatures remain below 140 degrees Fahrenheit.

Recommended Action

GE Nuclear Energy recommends that GE BWR owners consider converting certain oil cooled motors to air cooling. Information on such conversions is available through local GE Nuclear Energy Service Representatives.

Experience

12. Motor Improvements and Upgrades

Before performing major maintenance on motors, it may be appropriate to consider adding motor upgrades and improvements during the maintenance project. Available improvements include the following:

- o Insulation upgrading from Class B to Class F
- o Bearing spike energy probe installation
- o Internally mounted stator and rotor condition monitors
- o Temperature detector installation, if not originally installed
- o Oil reservoir conversion to air cooling
- o Dirt resistant coating application for motor windings
- o Motor stator cooling improvements
- o Oil level monitor

Recommended Action

GE Nuclear Energy recommends that GE BWR owners consider motor improvements and upgrades for improved motor reliability, ease of maintenance and/or added performance monitoring capability. Information about such improvements is available from local GE Nuclear Energy Service Representatives.

End of Attachment

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
91-06	Lock-up of Emergency Diesel Generator and Load Sequencer Control Circuits Preventing Restart of Tripped Emergency Diesel Generator	1/31/91	All holders of OLs or CPs for nuclear power reactors.
91-05	Intergranular Stress Corrosion Cracking in Pressurized Water Reactor Safety Injection Accumulator Nozzles	1/30/91	All holders of OLs or CPs for pressurized water reactors (PWRs).
91-04	Reactor Scram Following Control Rod Withdrawal Associated with Low Power Turbine Testing	01/28/91	All holders of OLs or CPs for nuclear power reactors.
91-03	Management of Wastes Contaminated with Radioactive Materials ("Red Bag" Waste and Ordinary Trash)	01/07/91	All medical licensees.
91-02	Brachytherapy Source Management	01/07/91	All Nuclear Regulatory Commission (NRC) medical licensees authorized to use byproduct material for medical purposes.
91-01	Supplier of Misrepresented Resistors	01/04/91	All holders of OLs or CPs for nuclear power reactors.
90-82	Requirements for Use of Nuclear Regulatory Commission-(NRC-)Approved Transport Packages for Shipment of Type A Quantities of Radioactive Materials.	12/31/90	All registered users of NRC-approved packages.
90-81	Fitness for Duty	12/24/90	All U.S. Nuclear Regulatory Commission (NRC) material and non-power reactor licensees.

OL = Operating License
CP = Construction Permit

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

Carl H. Berlinger

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

Technical Contact: Kamal R. Naidu, NRR
(301) 492-0980

Attachments:
1. SIL No. 484, March 29, 1989
2. Supplement 1 to SIL No. 484, October 5, 1990
3. List of Recently Issued NRC Information Notices

*See previous concurrences.

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Division of Operational Events Assessment
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(301) 492-0980

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