

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

December 19, 1996

**NRC INFORMATION NOTICE 96-67: VULNERABILITY OF EMERGENCY DIESEL
GENERATORS TO FUEL OIL/LUBRICATING OIL
INCOMPATIBILITY**

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 a recent finding involving degradation of the power block assembly of two emergency diesel generators caused by an incompatibility of the lubricating oil with fuel oil with a low sulfur content. It is expected that recipients will review the information for applicability and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

In December 1995, during preoperational testing of a new safety-related emergency diesel generator (EDG), test engineers for the licensee, Baltimore Gas and Electric Company (BGE), at the Calvert Cliffs Nuclear Power Plant, noted sporadic spikes in crankcase pressure and lubricating oil seeping out from the crankshaft seal. The engine was shut down and BGE conducted a boroscopic inspection of the unit. One cylinder showed indications of abnormal wear. The cylinder liner, piston, and piston rings were removed for analysis and replaced with a spare set. The testing program resumed, with normal crankcase parameters being indicated.

The test program for the safety-related EDG was completed on January 8, 1996. Several days later, during a scheduled 2-year maintenance inspection, BGE found four cylinders with heavy carbon-like deposits on the pistons and behind the piston rings and evidence of abnormal scuffing on the cylinder liners. On further inspection, all the cylinders exhibited some degree of similar degradation, including the replacement cylinder. BGE then inspected a second new EDG that had been installed as a backup power supply in 1995 for station blackout. One cylinder on the station blackout engine exhibited degradation similar to that of the safety-related EDG. Upon disassembly, excessive carbon deposition was found in all cylinders.

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PDR I&E Notice 96-067 961219

Discussion

Calvert Cliffs Nuclear Power Plant comprises two Combustion Engineering reactors with three EDGs, one dedicated to each unit and the third a "swing" EDG, that automatically loads onto the accident unit. In 1989, BGE initiated a modification to upgrade Calvert Cliff's emergency electrical system and meet the requirements of the station blackout rule. The modification included the installation of one safety-related EDG (giving each unit two dedicated EDGs) and one nonsafety-related EDG capable of powering any of the four safety-related 4-kV emergency electrical buses (for station blackout purposes). The new EDGs are basically identical, each with two engines in tandem with the generator between the engines. The EDGs were manufactured by Société Alsacienne de Constructions Mécaniques de Mulhouse (SACM) and have a nominal continuous rating of 5400 kW.

When the cylinder degradation was found, BGE assembled a root cause analysis team, which included persons with recognized industry expertise. The team developed three potential causes for the diesel power block degradation: components not to design specifications, improper operation of the engines, and lubricating oil/fuel oil incompatibility. The first possibility was ruled out by metallurgical and dimensional analysis and the second from discussions with SACM and other operators of SACM diesel generators. The team concluded that the lubricating oil used was incompatible with low sulfur content fuel.

The BGE team found that lubricating oil compatibility depends, in part, on the type of fuel being burned, as the lubricating oil contains an additive package that neutralizes the products of combustion, most importantly sulfuric acid, to prevent engine corrosion. The lubricating oil originally selected was an American Petroleum Institute (API) CD-grade synthetic oil. For the fuel oil used in the engines at that time, the specification was that the sulfur content was not to exceed 0.30 percent. In early 1995, the supplier of fuel oil to Calvert Cliffs switched to fuels with sulfur contents of 0.05 percent or less in order to meet new Environmental Protection Agency requirements intended to reduce sulfuric acid emissions. With the reduced amount of sulfur, there would be more unreacted additive in the lubricating oil, resulting in the formation of deposits when some of the oil was burned. These deposits built up behind the piston rings, forcing the rings to extrude and come into contact with the cylinder liner wall, resulting in scuffing.

After the problem was identified, BGE rebuilt the safety-related EDG with new cylinder liners, pistons, and piston rings. On the basis of the findings of the root cause analysis team, the safety-related EDG was supplied with a different lubricating oil, which is an API CG-4 grade mineral-based oil. A series of acceptance tests were then run to validate the root cause. The safety-related EDG was inspected after test runs totaling about 90 hours and no abnormal conditions were found. The station blackout EDG was then refurbished, tested, and inspected, and the results were identical to those for the safety-related EDG.

Another characteristic of synthetic lubricating oil was identified during the review of this event. Synthetic oils contain diester additives required to improve solubility of oil additives. In diesel

engines with low oil sump temperatures, water may accumulate in the sump because the temperature is too low to vaporize it. This water might cause hydrolysis of the diesters and the resulting acids would react with calcium in the additive to form insoluble compounds (soaps). These compounds may clog filters and degrade performance of a diesel engine.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please refer to the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.



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Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-66	Recent Misadministrations Caused by Incorrect Calibrations of Strontium-90 Eye Applicators	12/13/96	All U.S. Nuclear Regulatory Commission Medical Use Licensees authorized to use strontium-90 (Sr-90) eye applicators
96-65	Undetected Accumulation of Gas in Reactor Coolant System and Inaccurate Reactor Water Level Indication During Shutdown	12/11/96	All holders of OLs or CPs for nuclear power reactors
96-64	Modifications to Containment Blowout Panels Without Appropriate Design Controls	12/10/96	All holders of OLs or CPs for nuclear reactors
96-63	Potential Safety Issue Regarding the Shipment of Fissile Material	12/05/96	All U.S. Nuclear Regulatory Commission licensees authorized to possess special nuclear material in unsealed quantities greater than a critical mass
96-62	Potential Failure of the Instantaneous Trip Function of General Electric RMS-9 Programmers	11/20/96	All holders of OLs and CPs for nuclear power plants
96-61	Failure of a Main Steam Safety Valve to Reseat Caused by an Improperly Installed Release Nut	11/20/96	All holders of OLs or CPs for nuclear power reactors

OL = Operating License
 CP = Construction Permit

engines with low oil sump temperatures, water may accumulate in the sump because the temperature is too low to vaporize it. This water might cause hydrolysis of the diesters and the resulting acids would react with calcium in the additive to form insoluble compounds (soaps). These compounds may clog filters and degrade performance of a diesel engine.

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Tech Editor reviewed 11/13/96

Attachment filed in Jacket

DOCUMENT NAME: 96-67.IN

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OFFICE	Contacts	C/EMCB:DE	C/PECB:DRPM	D/DRPM
NAME	KLathrop* KParzewski*	JStrosnider*	AChaffee*	TMartin
DATE	11/21/96	11/21/96	12/12/96	12/13/96

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Another undesirable characteristic of synthetic lubricating oil was identified during the review of this event. Synthetic oils contain diester additives required to improve solubility of oil additives. In diesel engines with low oil sump temperatures, water may accumulate in the sump because the temperature is too low to vaporize it. This water may cause hydrolysis of the diesters and the resulting acids react with calcium in the additive to form insoluble compounds (soaps). These compounds may clog filters and degrade performance of a diesel engine.

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OFFICE	Contacts	C/EMCB:DE	C/PECB:DRPM	D/DRPM
NAME	KLathrop <i>for 117</i> KParzewski <i>117</i>	JStroszider <i>117</i>	AChaffee	TMartin
DATE	11/21/96	11/21/96	11/ /96	12/13/96

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