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

July 18, 1991

NRC INFORMATION NOTICE NO. 91-46: DEGRADATION OF EMERGENCY DIESEL GENERATOR FUEL OIL DELIVERY SYSTEMS

Addressees:

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

Purpose:

This information notice is intended to alert addressees to potential inoperability of multiple emergency diesel generators (EDGs) resulting from common cause degradations: (1) degraded fuel oil delivery systems and (2) failure to meet Technical Specification (TS) testing requirements intended to detect potentially degraded quality of the fuel oil stored on site. 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:

Over the past four years, several licensees have submitted licensee event reports (LERs) describing degradations in EDG operability or other safety-related equipment attributable to problems with the fuel oil system. Descriptions of selected LERs are presented below to illustrate three classes of problems.

I. Inappropriate painting of fuel injection assemblies

McGuire Unit 1: On June 25, 1990, while the unit was operating at full power, the licensee, Duke Power, declared two EDGs inoperable on discovery that paint had been inappropriately sprayed on the exciter commutator rings and on the back side of the fuel rack pivot points. This condition prevented the EDG output from attaining the TS-required 4160 volts in the allotted time (11 seconds). (LER 50-369/90-17-01)

Palo Verde Unit 3: On March 28, 1990, while the unit was operating at full power, the licensee, Arizona Public Service, discovered paint in the ports for the EDG fuel pump fuel oil metering rods, making the EDG inoperable, because the paint would most likely have prevented operation of the fuel oil injection system. (LER 50-530/90-03)

Byron Unit 1: On March 28, 1989, while the unit was operating at 80 percent of full power, the licensee, Commonwealth Edison, discovered that an EDG failed to start during the monthly surveillance test because inappropriately applied paint was binding the fuel oil metering rods and thus preventing the EDG from getting enough fuel oil to start. (LER 50-327/89-25)

II. Fouling of fuel oil filters or strainers

Dresden Unit 2: On December 24, 1988, while the unit was shut down, with all the reactor fuel removed from the reactor vessel, and with both reactor protection system (RPS) buses being powered from one EDG, the EDG frequency decreased below the setpoint of the underfrequency relays associated with the motor-generator sets. When the relays actuated, the RPS buses were deenergized, resulting in a scram signal on both RPS channels. The standby gas treatment system was automatically initiated and the reactor building ventilation system was automatically isolated. The licensee, Commonwealth Edison, determined the root cause to be a fouled fuel oil filter. (LER 50-237/88-20)

Turkey Point Unit 3: On September 20, 1988, while the unit was operating at full power, the licensee, Florida Power and Light, declared its B EDG inoperable due to high fuel oil pressure. At the time of the event, Unit 4 was shut down and the A EDG was out of service for maintenance. The licensee determined the root cause to be an excessive interval between fuel oil filter replacements that allowed gradual accumulation of particulate matter in the filter. (LER 50-250/88-22)

Ginna: On February 20, 1987, while the unit was shut down and with all station electrical power being supplied by the EDGs, the licensee, Rochester Gas and Electric, discovered low fuel oil levels in both day tanks because the fuel oil transfer pump suction strainers were partially plugged. The particulate contamination was analyzed as weld flux from plant construction activities and fibrous material from either cleaning rags or filter media. The licensee had to drain and flush the fuel transfer pump suction piping several times to prevent plugging of the strainers when the fuel oil from the storage tanks was recirculated. (LER 50-244/87-01)

III. Potential degradation of fuel oil quality, as measured by licensees' TS

Susquehanna Unit 1: On July 26, 1990, with both units operating at full power, the licensee, Pennsylvania Power and Light, declared an EDG inoperable because a sample of fuel oil from a storage tank exceeded its TS limit for the concentration of insoluble matter (2 mg/100 ml, using the ASTM-D2274-70 oxygen accelerated stability test), indicating a loss of stability of the stored fuel oil. (LER 50-387/90-15)

Perry Unit 1: On April 5, 1990 (LER 50-440/90-05-01), and on January 11, 1989 (LER 50-440/89-01-01), the licensee, Cleveland Electric Illumination, declared safety-related equipment inoperable because a sample of fuel oil from a storage tank exceeded its TS limit for the

concentration of insoluble matter (2 mg/100 ml, using the ASTM-D2274-70 test). In April 1990, the licensee declared its high-pressure core spray system inoperable while the unit was operating at full power and in January 1989, the licensee declared an EDG inoperable while the unit was operating at 70 percent of full power. In the April 1990 event, the licensee attributed the degradation to a contaminant found in the biocide additive and to degradation of the material coating the storage tank. In January 1989, the licensee believed the fuel oil aging was accelerated by the addition of new fuel oil a few days before the event.

WNP Unit 2: On January 3, 1990, while the unit was operating at full power, the licensee, Washington Public Power Supply, declared all three of its EDGs inoperable, because an EDG fuel oil test of samples drawn on December 27, 1989, indicated that the fuel oil in all three storage tanks did not meet the oxygen accelerated stability criterion, and entered the limiting condition of operation (LCO) for TS 3.0.3. At the time of this report, the licensee's TS required that EDG fuel oil be tested in accordance with the standard ASTM-D2274-70, with particulate contamination not exceeding 2 mg/100 ml. The licensee reviewed past surveillance results, which were typically half the TS limit, found no discernible trends, and consulted two fuel oil experts, who indicated that no reason existed for a step increase in the stability measure.

The licensee believes the root cause of this event to be the fuel oil analysis method. The licensee submitted an emergency amendment, which included the substitution of a filter cleanliness test based on the standard ASTM-D2276-78, Method A, with particulate contamination not exceeding 10 mg/l, for the oxygen accelerated stability test based on ASTM-D2274-70. On March 30, 1990, the NRC temporarily approved the amendment. On June 4, 1990, the NRC permanently approved a revision of the amendment that included changes in addition to this test substitution. The filter cleanliness test is designed to measure particulate contamination existing in the fuel oil whereas the oxygen accelerated stability test is designed to measure the potential of the fuel oil for forming gums, varnishes, and tars in the future. The filter cleanliness test results for the samples of fuel oil drawn on December 27, 1989, were acceptable. Results of both the oxygen accelerated stability test and the filter cleanliness test for samples drawn from both tank bottoms and transfer pump discharges on January 2, 1990, and on January 3, 1990, were acceptable. (LER 50-397/90-01)

Diablo Canyon Unit 1: On May 5, 1988, while the unit was shut down, the licensee, Pacific Gas and Electric, observed the power output of an EDG to decrease below the licensee's acceptance criterion for a 24-hour load test. The licensee determined that the primary fuel oil filter had become clogged with a fungus growing in the day tank supplying that EDG. The licensee also found fungus and spores in the other day tanks and in the fuel oil storage tanks. The licensee added a biocide and filtered the fuel oil in the day tanks until its acceptance criteria were met for flash point, gravity, viscosity, and particulate contamination (10 mg/l, using the ASTM-D2276-78, Method A, particulate contamination test).
(LER 50-275/88-14)

Discussion:

The lessons to be learned from the LERs that deal with inappropriate painting incidents are self-evident. Similarly, the LERs that deal with partially plugged fuel oil filters or strainers show that regular and careful maintenance of these components is important to reliable EDG operation. In particular, these LERs show that the period of time between replacement of filters and strainers should not be excessive and that cleanliness of maintenance operations performed on the fuel delivery system is important. The subject of filter maintenance was previously discussed in NRC Information Notice No. 87-04, "Diesel Generator Fails Test Because of Degraded Fuel." Some of the LERs on TS testing problems are concerned with actual degradations of fuel oil quality but primarily address the particular test used in the TS.

The main concern with degraded EDG fuel oil (particulate contamination) lies in its potential for clogging filters, strainers, and fuel injection equipment through which the fuel oil must flow and thus causing engine failure. All fuel oil tends to degrade in two general ways during extended storage. The first way is oxidation and polymerization of the fuel oil to yield soluble and insoluble gums. The second way is clustered microbiological growth of bacteria, fungi, or yeasts at the interface of the fuel oil and water present at the bottom of the storage tank. Through chemical processes, the bacteria produce solids and additional water. The bacterial solids may accumulate in the bottom of the fuel storage tank and not pose a problem for EDG operability until the fuel transfer pump draws them into its suction pipe. All these solid materials, the gums, the microbiological growth, and the bacterial sludge, as well as foreign debris, are collectively called particulate contamination.

Focusing on the question of degraded fuel oil quality, note that several standards are used in individual plant TS requirements for testing EDG fuel oil. Most plants use the American Society for Testing and Materials (ASTM) "Standard Specification for Diesel Fuel Oils," ASTM-D975-XX, where XX represents the year of the modification used, for testing the quality of fuel oil, both freshly delivered and stored. It includes tests for a number of fuel properties, including flash point, cloud point, distillation temperature, water and sediment content, carbon residue, ash content, sulfur content, viscosity, corrosive potential, and Cetane number (ignition quality). Some plants' TS only require the water, sediment, and viscosity tests. Some plants' TS contain a requirement for the oxygen accelerated stability test described in "Standard Test Method for Oxidation Stability of Distillate Fuel Oil (Accelerated Method)," ASTM-D2274-XX, and some plants' TS contain a requirement for the particulate contamination test described in "Standard Test Methods for Particulate Contaminant in Aviation Turbine Fuels," ASTM-D2276-XX. The American Nuclear Society (ANS), in its standard approved by the American National Standards Institute (ANSI), "Fuel Oil Systems for Emergency Diesel Generators," ANSI/ANS-59.51-1989, recommends in Appendix C the ASTM-D2276-XX particulate contamination test.

The ASTM-D975 standard is intended as a statement of permissible limits of significant fuel properties used for specifying the wide variety of commercially available diesel fuel oils. As such, it most readily applies to determination of the quality of new fuel oil, but does not readily apply to the question of

particulate contamination in stored fuel oil. The oxygen accelerated stability test of the ASTM-D2274 standard predicts the potential for future degradation of fuel oil but does not show the existing state of degradation. On the other hand, the particulate contamination test of the ASTM-D2276 standard readily applies to the question of particulate contamination in stored fuel oil.

Revision 4A of the Westinghouse Standard TS (STS) contains comprehensive requirements on testing and monitoring the condition of stored EDG fuel oil, in which the salient features are (1) use of the ASTM-D2276 particulate contamination test and (2) testing for and removal of water. Some nuclear power plants, such as McGuire Units 1 and 2, Wolf Creek, Limerick Units 1 and 2, and WNP Unit 2, have voluntarily adopted this revision of the STS in their individual plant TS. In the LER for WNP 2 (above), the licensee determined that incorporation of this total program in its plant TS was an effective corrective action for its problems in determining the quality of its stored fuel oil. The Electric Power Research Institute (EPRI) has provided additional guidance on this point in "Storage and Handling of Fuel Oil for Standby Diesel Generator Systems," EPRI NP-63140, August 1988.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please call one of the technical contacts listed below or the appropriate 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
91-45	Possible Malfunction of Westinghouse ARD, BFD, and NBFD Relays, and A200 DC and DPC 250 Magnetic Contactors	07/05/91	All holders of OLs or CPs for nuclear power reactors.
91-44	Improper Control of Chemicals in Nuclear Fuel Fabrication	07/08/91	All nuclear fuel facilities.
91-43	Recent Incidents Involving Rapid Increases in Primary-to-Secondary Leak Rate	07/05/91	All holders of OLs or CPs for pressurized-water reactors (PWRs).
91-42	Plant Outage Events Involving Poor Coordination Between Operations and Maintenance Personnel During Valve Testing and Manipulations	06/27/91	All holders of OLs or CPs for nuclear power reactors.
91-41	Potential Problems with The Use of Freeze Seals	06/27/91	All holders of OLs or CPs for nuclear power reactors.
88-63, Supp. 2	High Radiation Hazards from Irradiated Incore Detectors and Cables	06/25/91	All holders of OLs or CPs for nuclear power reactors, research reactors, and test reactors.
91-40	Contamination of Non-radioactive System and Resulting Possibility for Unmonitored, Uncontrolled Release to the Environment	06/19/91	All holders of OLs or CPs for nuclear power reactors.
91-39	Compliance with 10 CFR Part 21, "Reporting of Defects and Noncompliance"	06/17/91	All Nuclear Regulatory Commission (NRC) material licensees.
91-38	Thermal Stratification in Feedwater System Piping	06/13/91	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit