

UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
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NRC INFORMATION NOTICE 2006-22: NEW ULTRA-LOW-SULFUR DIESEL FUEL OIL  
COULD ADVERSELY IMPACT DIESEL ENGINE  
PERFORMANCE

## ADDRESSEES

All holders of operating licenses for nuclear power reactors, except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

## PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert licensees to the potential for new ultra-low-sulfur diesel (ULSD) fuel oil to adversely impact engine performance. 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 IN are not NRC requirements; therefore, no specific action or written response is required.

## DESCRIPTION OF CIRCUMSTANCES

In January 2001 and in June 2004, the U.S. Environmental Protection Agency (EPA) finalized the Clean Diesel Trucks and Buses Rule and the Clean Nonroad Diesel Rule, respectively, with more stringent standards for new diesel engines and fuels (<http://www.epa.gov/oms/reggs/fuels/diesel/diesel.htm>). The EPA rules require a reduction in the sulfur content of highway diesel fuel from its current level of 500 parts per million (ppm) (low sulfur diesel, or LSD) to 15 ppm (ULSD). Refiners were required to start producing the cleaner-burning diesel fuel ULSD, for use in highway vehicles beginning June 1, 2006. The EPA requires sulfur reductions for land-based nonroad diesel fuel to be accomplished in two steps, with an interim step from currently uncontrolled levels to a 500 ppm cap starting in June 2007 and the final step to 15 ppm in June 2010. Although the EPA requirements for the 15 ppm ULSD do not take effect until 2010 for nonroad diesel fuel, several nuclear power plant licensees have received shipments of ULSD. The California Air Resources Board regulations require that all California users of diesel fuel oil transition to ULSD fuel oil by June 1, 2006.

Some licensees have already received (and all licensees will eventually receive) ULSD fuel oil from petroleum product refiners, distributors, and wholesalers and may have started using this fuel in diesel engines that provide functions important to safety. Examples of diesel engines

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providing functions important to safety include: Emergency diesel generators (EDGs), diesel-driven fire pumps, diesel-driven auxiliary feedwater pumps, diesel-driven essential service water makeup pumps, diesel-driven instrument air compressors, security diesel generators, safe shutdown facility diesel generators, diesel generators for emergency preparedness and response functions, and station blackout diesel generators.

There are several diesel fuel properties other than sulfur concentration that change as a result of moving to ULSD that may adversely effect the engine performance including:

#### Energy Content

In general, the processing required to reduce sulfur to 15 ppm also reduces the aromatics content and density of diesel fuel, resulting in a reduction in volumetric energy content (BTU/gallon). The expected reduction in energy content is 1.2 percent or more. Less energy content of the fuel can reduce the instantaneous output rating of the diesel engine. The reduced output rating may be less than the value specified in the plant's design and licensing basis, potentially rendering the diesel inoperable.

The reduced energy capacity of the ULSD may result in increased fuel consumption such that the onsite diesel fuel storage capacity for the emergency diesel generators may be insufficient to satisfy the plant's design and licensing basis for diesel operation duration before offsite replenishment is needed.

The reduced energy capacity may also lengthen the amount of time needed for the emergency diesel generators to reach the required speed and voltage.

#### Fuel Particulate Build-up Increases

Additives to increase lubricity and to inhibit corrosion used by different refineries and wholesale suppliers can react or become unstable in storage, which can result in increased fuel particulates that may foul or plug filters and fuel injection equipment, and can affect suitability of some testing methods. Some nuclear plant licensees using ULSD have observed an increase in the rate of particulate buildup in samples from their diesel fuel oil storage tanks.

#### Fuel System Seal Leaks

Non-nuclear industry operating experience using ULSD shows an increased incidence of fuel system leaks at points where elastomers (O-rings) are used to seal joints, with most leaks occurring at the fuel pump and injectors. The evidence to date suggests the problem is linked to a reduction in the aromatics content of the ULSD which affects seal swelling, as does seal material and age of the material.

#### Compatibility with Lubricating Oil

As discussed in NRC IN 96-67, "Vulnerability of Emergency Diesel Generators to Fuel Oil/Lubricating Oil Incompatibility," lubricating oil contains an additive package that neutralizes the products of combustion, most importantly sulfuric acid, to prevent engine corrosion. With a

reduced amount of sulfur, there is more unreacted additive in the lubricating oil, which may result in the formation of deposits when some of the oil is burned. These deposits can build up behind the piston rings, forcing the rings to extrude and come into contact with the cylinder liner wall, resulting in scuffing.

#### Microbial Growth

Diesel fuel that was desulfured at the refinery through hydrocracking (versus hydrotreatment) may have a greater propensity for microbial growth due to an increased concentration of n-alkanes (linear molecules).

#### Incompatible Metals

There are no known compatibility issues with aluminum, carbon steel, stainless steel, and bronze. However, copper and zinc are incompatible with ULSD because both are oxidative catalysts that will accelerate the formation of sediments, gels, and soaps (American Society for Testing and Materials (ASTM) D975, Appendix X2.7.2).

#### Lubricity

Lubricity is a measure of the fuel's ability to lubricate and protect the various parts of the engine's fuel injection system from wear. The processing required to reduce sulfur to 15 ppm also removes naturally-occurring lubricity agents in diesel fuel. Rotary and distributor type fuel pumps are completely fuel lubricated resulting in high sensitivity to fuel lubricity. Refiners treat the diesel fuel with additives on a batch to batch basis to ensure adequate lubricity. Therefore, receipt of ULSD with inadequate lubricity is possible but unlikely.

## **BACKGROUND**

#### Applicable Regulatory Documents

General Design Criterion (GDC) 17, "Electric Power Systems," of Appendix A, "General Design Criteria for Nuclear Power Plants," to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that an onsite electric power system and an offsite electric power system be provided to permit functioning of structures, systems, and components important to safety. In addition, GDC 17 contains requirements concerning system capacity, capability, independence, redundancy, availability, testability, and reliability. Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 establishes overall quality assurance requirements for the design, construction, and operation of structures, systems, and components important to safety.

Regulatory Guide (RG) 1.137, Revision 1, "Fuel Oil Systems for Standby Diesel Generators" dated October 1979, describes a method acceptable to the NRC staff for complying with the Commission's regulations regarding diesel fuel oil systems for standby diesel generators and assurance of adequate diesel fuel oil quality. RG 1.137 states that Appendix B to American National Standards Institute (ANSI) N195-1976 should be used as a basis for a program to ensure the initial and continuing quality of diesel fuel oil as supplemented by eight additional provisions described in the RG for maintaining the properties and quality of diesel fuel oil.

#### Related NRC Generic Communications

NRC IN 96-67, "Vulnerability of Emergency Diesel Generators to Fuel Oil/Lubricating Oil Incompatibility," dated December 19, 1996. This IN alerted addressees to a finding involving degradation of the power block assembly of two EDGs caused by an incompatibility of the lubricating oil with a low-sulfur-content diesel fuel oil.

NRC IN 91-46, "Degradation of Emergency Diesel Generator Fuel Oil Delivery Systems," dated July 18, 1991. This IN alerted addressees to potential inoperability of multiple EDGs resulting from common cause degradations: (1) degraded diesel fuel oil delivery systems and (2) failure to meet technical specification (TS) testing requirements intended to detect potentially-degraded quality of the diesel fuel oil stored onsite.

NRC Generic Letter (GL) 83-26, "Clarification of Surveillance Requirements for Diesel Fuel Impurity Level Tests." This GL provided licensees revised surveillance provisions for diesel fuel oil impurity level tests to clearly reflect the relationship between the Standard TS testing requirements for diesel fuel oil impurity levels; guidance given in RG 1.137, Revision 1, and ANSI N195-1976 (ASTM D270, ASTM D975 and ASTM D2274); and the NRC staff review performed in accordance with Standard Review Plan Sections 9.5.4 through 9.5.8.

#### **DISCUSSION**

In January 2001 and in June 2004, the EPA finalized the Clean Diesel Trucks and Buses Rule and the Clean Nonroad Diesel Rule, respectively, with more stringent standards for new diesel engines and fuels that require a reduction in diesel fuel sulfur content to 15 ppm. Some licensees have already received, and all will eventually receive, this ULSD. As described above, the ULSD has a number of properties that have the potential to degrade or render inoperable the associated diesel engine or may create a condition that is inconsistent with current plant design and licensing bases. This ULSD issue is of particular concern because it affects all licensee diesel generators that are safety-related and/or important to safety, thereby, presenting a possible common mode failure. Licensees can evaluate the potential impacts of ULSD and can take measures to ensure the plant is consistent with the current design and licensing basis and prevent the diesels from being rendered inoperable or significantly degraded.

## CONTACT

This information notice requires no specific action or written response. Please direct any questions about this matter to the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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Note: NRC generic communications may be found on the NRC public Web site, <http://www.nrc.gov>, under Electronic Reading Room/Document Collections.