UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
OFFICE OF NUCLEAR REACTOR REGULATION
OFFICE OF NEW REACTORS
WASHINGTON, DC 20555-0001

February 26, 2010

NRC INFORMATION NOTICE 2010-04: DIESEL GENERATOR VOLTAGE REGULATION SYSTEM COMPONENT DUE TO LATENT MANUFACTURING DEFECT

ADDRESSEES

All holders of an operating license or construction permit for a nuclear power reactor issued under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," except those who have permanently ceased operations and have certified that fuel has been permanently removed from the reactor vessel.

All holders of or applicants for an early site permit, standard design certification, standard design approval, manufacturing license, or combined license issued under 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

All holders of or applicants for a license for a fuel cycle facility issued pursuant to 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material."

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to possible latent manufacturing defects in emergency diesel generator (EDG) voltage regulation components. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. Suggestions contained in this IN are not NRC requirements; therefore, no specific action or written response is required.

DESCRIPTION OF CIRCUMSTANCES

On November 12, 2008, during the performance of a monthly surveillance test at Palo Verde Nuclear Generating Station Unit 2, the train 'A' EDG tripped on a generator differential protective relay trip shortly after paralleling it to offsite power. The licensee declared the EDG inoperable.

Licensee troubleshooting revealed damage to the excitation control system for the generator on one of the three phase alternating current voltage inputs to the rectifier bridge. The damaged electrical component was found to be the 'C' phase linear power reactor. A linear power reactor is an electrical component consisting of a magnetic coil (inductor). The linear power reactor function is to limit the magnitude of the current through the excitation bridge, which supplies the generator field during operation. The licensee inspection of the failed magnetic coil found burnt

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and charred copper conductors and insulation materials. No additional electrical components in the cabinet were found damaged or operating out of specifications. Troubleshooting also revealed that the failure was isolated to this component and not caused by any other component in the voltage regulation system.

The licensee sent the failed linear power reactor to an external laboratory for an equipment failure analysis. The analysis determined the cause of the component failure to be a latent manufacturing defect. An iron core lamination was slightly out of alignment with the other laminations in the transformer's 'E' core assembly. The slight misalignment created a sharp, thin metal edge that, coincident with existing lamination vibration, slowly cut into and degraded the internal insulation around the coil wire. The internal insulation was found to be cut/worn below the required voltage withstand level resulting in a winding-to-winding fault. The high fault current caused very high temperatures and melting of the copper windings. Due to the relatively small amount of run time (approximately 3000 hours) on the EDG, the insulation degradation developed slowly over a period of approximately 25 years. Manufacturing defects normally manifest as an early failure, however the limited actual in-service energized time of the EDG delayed the appearance of the defect. However, once a coil winding-to-winding fault develops, it is postulated that it grows quickly, resulting in sudden component failure in a relatively short period of time.

Palo Verde licensee corrective actions include the following:

- Adding a preventive maintenance task for thermography of EDG excitation system silicon controlled bridge rectifiers, power diode bridge rectifiers, current transformers, power transformers, and linear reactors. Additionally, performing these new thermography surveys may necessitate a plant modification to install new viewing ports for safely performing thermography in difficult locations similar to the cabinet housing the linear power reactors.

- Using a data recorder to capture various EDG parameters during startup and provide trending for troubleshooting can enhance the licensee's corrective action program.

- Inspecting linear power reactors for signs of defects such as observing splits in the laminated windings of the transformer's 'E' core and by performing surge/meggar testing to detect degrading insulation integrity.

- Periodically replacing some power magnetic components based on service time. Availability of spares for the excitation system components can increase EDG availability.

Other actions to be considered by licensees may include:

- Performing visual inspections for burn marks on the linear power reactors, conductors, cabinet and electrical connections.

- Incorporating into plant maintenance procedures the industry's preventive maintenance recommendations contained in Technical Report/Maintenance Guide for the individual voltage regulator model.

DISCUSSION

This IN describes the failure of a linear power reactor in an EDG voltage regulation system at plant where the licensee’s preventive maintenance program did not address the EDG excitation system magnetic components that can be subject to deterioration with age or time in service. The licensee's preventive maintenance strategy included a visual inspection and cleaning at a frequency of once every three fuel cycles. The visual inspection was non-intrusive and would not reveal latent manufacturing defects. There are no vendor recommendations that specify predictive maintenance to identify degrading magnetic components prior to failure. Thermography, surge testing, or other maintenance practices may reveal a potential fault developing after the insulation sufficiently degrades, but it might not be enough in advance to prevent an equipment failure in-service.

Reviews by the licensee and the NRC revealed past industry experience with degraded voltage regulation magnetic components. However, these prior events did not conduct detailed laboratory analyses to determine the failure mechanisms. In most cases, the failures were attributed to age related degradation. However, the DuPont Nomex insulation material used for the linear reactor coils was found to be rated for an extended life while in service up to 428 degrees Fahrenheit (220 degrees Celsius). In this case, the manufacturing defect was attributed to poor workmanship and assembly techniques during original component construction. The failed component was originally assembled in the 1970s and installed in the 1980s. The defect went undetected until its ultimate failure under loaded conditions. The relatively small amount of run time on the EDGs, over several years, facilitates characterizing these types of defects as age related failures whereas latent component manufacturing defects can actually result in failures earlier than what is their expected service life.

CONTACTS

This IN 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 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.

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