ENCLOSURE 2

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-382/95-21

License: NPF-38

Licensee: Entergy Operations, Inc.
P.O. Box B
Killona, Louisiana 70066

Facility Name: Waterford Steam Electric Station, Unit 3

Inspection At: Taft, LA

Inspection Conducted: November 27 through December 7, 1995

Inspectors: T. W. Pruett, Resident Inspector
C. J. Paulk, Reactor Inspector, Division of Reactor Safety

Approved: Gregory A Pick for
P. H. Harrell, Acting Chief, Project Branch D

1/16/96
Date

Inspection Summary

Areas Inspected: Special, announced inspection of the failure of containment isolation valves to properly operate.

Results:

Engineering

- The inspectors identified that the licensee used an incorrect, and low, elastomer service temperature for normally energized solenoid valves. Using a higher, more appropriate, service temperature resulted in a 41-51 percent reduction in the environmental qualification (EQ) service life for 19 solenoid valves. The licensee's failure to account for the difference between internal and external service temperatures when determining the service life for normally energized solenoid valves was identified as a violation (Section 3).

Summary of Inspection Findings:

New Items

Violation 382/9521-01: Failure to determine correct elastomer service temperature for normally energized solenoid valves (Section 3).

Closed Items

None

Attachments:

- Persons Contacted and Exit Meeting

DETAILS

1 PLANT STATUS

During this inspection period, the plant operated at 100 percent power.

2 FAILURE OF CONTAINMENT ISOLATION VALVES (92903)

On June 14, 1995, during preparation for the performance of surveillance testing, air-operated Letdown Isolation Valve CVC-101 and Containment Isolation Valve CVC-109 failed to close and Containment Isolation Valve CVC-103 closed in 30 seconds, instead of the required 10 seconds. The valves failed to operate properly because the air-supply solenoids malfunctioned. The problems with the valves were identified when operations personnel attempted to secure the letdown system with the plant in cold shutdown, following the June 10, 1995, electrical fire. See NRC Inspection Report 50-382/95-15 for details of the fire and plant shutdown. The valve problems were not related to any deficiencies caused by the fire.

The licensee suspected that the solenoid failure mechanism was related to the high service temperature that each of the solenoids were subjected to; consequently, the licensee's immediate corrective actions included: (1) replacing the solenoids with solenoids manufactured in the 1993-1994 time frame, (2) adding a caution to the work instructions to minimize thread lubricant use, (3) installing a temporary alteration request to increase the air flow across the solenoids for Valves CVC-101 and CVC-103 to dissipate more of the coil heat, and (4) removing the solenoid vent port lines to preclude any potential restrictions. The licensee expected the solenoids to function properly until the end of Cycle 7 (September 1995) since they would only be in service for 3 months and because the resultant increased air flow from the temporary alteration should lower the service temperature. Details related to the environment of each valve/solenoid and the failure mechanisms are discussed below.

Valve CVC-101, located inside containment in the regenerative heat exchanger room, is a Fisher solenoid-operated valve, actuated by an Automatic Switch Company (ASCO) Series-206 solenoid. The solenoid was manufactured in 1988 and installed in 1992 during Refueling Outage 5. The solenoid failed and was replaced during Refueling Outages 4 and 5 and during Cycle 7 (June 1995). The continuously energized and seldom operated solenoid was located near a process line with an approximate temperature of 500°F and an ambient temperature of at least 127°F. Further, there was little or no air movement in the regenerative heat exchanger room; therefore, solenoid heat dissipation was minimal.

The licensee visually inspected the failed solenoid and noted the presence of a black, hardened dust inside the solenoid body and thread lubricant throughout the disk and stem. The licensee concluded that the solenoid failure may have resulted from excessive thread lubricant and the dust-like substance causing the solenoid internals to stick when exposed to high service

temperatures. A spectrogram of a swab of the internal solenoid components, performed on September 26, 1995, indicated the presence of a silicon-based lubricant in the plunger housing. The licensee stated that the origin of the silicon-based lubricant was unknown and that the vendor would be informed of engineering's findings.

Valve CVC-103, located inside containment in the regenerative heat exchanger room, has a Masoneilan valve operator actuated by an ASCO Series-8316 solenoid. The solenoid was manufactured in 1993 and installed in 1994 during Refueling Outage 6. Previously, the solenoid had failed and had been replaced during two forced outages in Cycle 4, during Refueling Outages 5 and 6, and during Cycle 7 (June 1995). The continuously energized and seldom operated solenoid was located near a process line at approximately 500°F and an ambient temperature of at least 127°F. There was little or no air movement in the regenerative heat exchanger room, therefore, solenoid heat dissipation was minimal.

Visual inspection of the failed solenoid determined that excessive thread lubricant may have migrated into the solenoid body. Heat aging of the solenoid was evident since it showed color changes resulting from high localized temperatures. Additionally, the solenoid diaphragm was wrinkled, which provided an additional indication of heat degradation. The licensee concluded that the solenoid failure may have resulted from excessive thread lubricant and high temperatures, which caused the internals to stick. A spectrogram of a swab of the internal solenoid components, performed on September 26, 1995, was inconclusive.

Valve CVC-109, located outside of containment in the letdown pipe chase, has a Masoneilan valve operator actuated by an ASCO Series-8316 solenoid. The solenoid was manufactured in 1983 and installed in 1988. The air-operated valve failed to close, and the solenoid was replaced during Refueling Outage 4 and during Cycle 7. The continuously energized and seldom operated solenoid was located near a process line with an approximate temperature of 240°F and an ambient temperature of less than 120°F.

The licensee's visual inspection of the failed solenoid determined that the valve diaphragm had hardened but retained some resilience. There was evidence of an unknown, mirror-like residue on the solenoid plunger and core assembly and a thread sealant throughout the body of the solenoid. The licensee concluded that the failure of the solenoid may have resulted from shelf-life aging, thermal aging of the elastomer, and excessive thread lubricant. A spectrogram of a swab of the internal solenoid components, performed on September 26, 1995, was inconclusive.

The licensee reviewed the history of ASCO Series-206 and -8316 solenoids in other systems and determined that a generic failure concern did not exist since there had not been a history of failure with other solenoids. The high failure rate of the three valve solenoids was attributed to the high environmental service temperatures.

When the licensee began experiencing a relatively high failure rate of the solenoids, engineers took action to establish the failure mechanism. After investigating the failure history, the engineers attributed the most probable cause to the solenoids exceeding their designated shelf life. The solenoids remained in the warehouse too long prior to being installed in the plant.

Consequently, during Refueling Outage 6, the licensee replaced the solenoids with recently manufactured solenoids in order to eliminate failures related to shelf life of the solenoids. However, when the solenoids failed again in June 1995, the engineers realized that the shelf life concern was not the actual root cause of the solenoid failures. The licensee performed additional reviews and determined that the relatively high rate of solenoid failures resulted from the high ambient temperatures where the solenoids were installed.

During Refueling Outage 7 (September - November 1995), the licensee implemented a design change that replaced the solenoids with a different model and relocated the solenoids for Valves CVC-101 and CVC-103, from the regenerative heat exchanger room, to a lower ambient temperature area inside containment. The inspectors reviewed the design change and concluded that the actions taken to relocate the solenoids to a lower ambient temperature area should address the frequent solenoid failures.

The inspectors reviewed the multiple failures of the solenoids to determine if the failures affected containment integrity. This issue was of concern since the solenoid failures would result in a failure to shut Containment Isolation Valves CVC-101 and CVC-109. These valves are the inside and outside containment isolation valves for the letdown line at the same penetration. A loss of containment integrity would result if both valves failed to operate at the same time.

The inspectors reviewed the failure history for Valves CVC-103 and CVC-109 and identified only one occasion when both valves failed to operated as designed, at the same time. On June 14, 1995, Valve CVC-109 failed to close, and Valve CVC-103 closed in 30 seconds, instead of the required 10 seconds. This resulted in a loss of containment integrity for 20 seconds. The licensee performed a calculation that assumed the line sheared and a fully open path existed out of the containment. The results of the calculation demonstrated that with this condition 10 CFR Part 100 radiological exposure limits would not be exceeded. The inspectors reviewed the calculation and noted no concerns.

Based on the short duration of the loss of containment integrity and the results of the 10 CFR Part 100 calculation, the licensee established and the inspectors' agreed there was no safety significance to this event.

3 REVIEW OF EQ REQUIREMENTS (92903)

The inspectors reviewed the results of EQ testing performed in October 1994 to determine if the appropriate service life had been calculated for normally

energized Series-206 and -8316 ASCO solenoid valves. The test required placing thermocouples at various locations on the solenoid, heating the solenoid in an oven over a range of ambient temperatures, energizing the coil, and measuring the temperatures with both the oven fan on and off. Based on the thermocouple temperature readings, the licensee calculated EQ service lives for the solenoid valves.

The engineers determined the elastomer service temperature using the median value for thermocouple readings taken on the exterior solenoid body with the oven fan on and off. The inspectors questioned if the correct elastomer service temperature had been determined since the solenoid coil heat would result in higher internal temperatures than those obtained using a thermocouple placed exterior to the body of the solenoid valve. Because of the inspectors' concern, the licensee performed an additional test on a Series-206 solenoid valve by drilling a hole in the body of the solenoid valve and placing a thermocouple adjacent to the body to bonnet gasket (elastomer). The licensee determined that the revised elastomer service temperature was 13.4 to 16.2°F greater than the originally determined elastomer service temperature.

Without correcting for refueling outage periods in which the solenoid valve would be deenergized, Primary System Sample Valve PSL-ISV-0105 exceeded its EQ service life replacement date of April 15, 1995. The end of EQ service life, with adjustments for periods of deenergization during outages, was September 30, 1995. Based on this adjustment, the licensee determined that the EQ service life for Valve PSL-ISV-0105 had not been exceeded. Fifteen solenoid valves had their EQ service life reduced from 26.4 to 12.94 years and 3 solenoid valves had their EQ service life reduced from 9.3 to 5.47 years. The remaining solenoid valves had a revised EQ service life date of greater than 40 years. The inspectors noted that the EQ replacement dates could have been exceeded had the incorrect elastomer service temperature not been identified. The inspectors concluded that, based on the revised elastomer service temperature, the EQ service life of normally energized ASCO solenoid valves was reduced to 41-51 percent of the initially determined EQ service life.

10 CFR 50.49(a) requires, in part, that the licensee establish a program for qualifying electrical equipment. Site Directive W4.103, "Equipment Qualification," Section 5.1.1.2.b states that detailed engineering analyses of specific elements are performed to establish and maintain qualification. The failure to determine the correct elastomer service temperature for normally energized solenoid valves resulted in a 41-51 percent reduction in the originally calculated EQ service life of 19 solenoid valves and is a violation of 10 CFR 50.49(a) (382/9521-01).