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Potential Deficiency in Qualifition of Okonite Single-Conductor Electrical Control Cables

December 26, 2000

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.

TOP

INTENT

The U.S. Nuclear Regulatory Commission (NRC) is issuing this regulatory issue summary (RIS) to notify addressees of a potential deficiency in the environmental qualification (EQ) of certain single-conductor Okonite electrical cables used for instrumentation and control (I&C) applications in nuclear power plants. The NRC is continuing to work with the nuclear power industry to reach closure in this matter. Consequently, this RIS only presents the current status of the NRC/industry effort; a supplement to this RIS will be issued when a satisfactory basis for closure is identified. This RIS does not transmit any new requirements or staff positions. No specific action or written response is required.

BACKGROUND INFORMATION

The Brookhaven National Laboratory (BNL), under contract to the NRC, has been conducting research on low-voltage I&C cables to support the resolution of Generic Safety Issue (GSI) 168, "Environmental Qualification of Electric Equipment." As part of this research, in late 1999, a loss-of-coolant-accident (LOCA) test (Test #5) was conducted on I&C cables having ethylene propylene rubber (EPR) insulation and covered with a bonded chlorosulfonated polyethylene (CSPE) outer jacket. The purpose of the test was to determine whether cables with bonded jackets would experience a failure mechanism that is unique, that is, a failure mechanism other than what unbonded jacketed cables have shown under postulated LOCA conditions. The testing was performed at the Wyle Laboratories in Huntsville, Alabama, using cable samples obtained from several manufacturers, including Okonite. The Okonite samples were single conductor, #12 American wire gauge (AWG) cable, with the insulation and bonded jacket covering noted above. For the test, the cable samples were first subjected to accelerated thermal and radiation aging, and then exposed to simulated LOCA conditions.

The accelerated thermal and radiation aging parameters were selected on the basis of each vendor's original EQ test report. For the Okonite cable samples, preaging was conducted to demonstrate 20-year and 40-year qualification. The parameters for demonstrating 40-year qualification of Okonite cable included elevated temperature exposure for 504 hours at 150 ° C (302 ° F), followed by exposure to 500 kGy (50 Mrads) of gamma radiation at a dose rate of 6.5 kGy/hr (0.65 Mrad/hr).

The simulated LOCA test consisted of exposing the cable samples to 1500 kGy (150 Mrads) of gamma radiation at a dose rate of 7.5 kGy/hr (0.75 Mrad/hr), followed by exposure to a double-peak steam profile, as described in Institute of Electrical and Electronic Engineers (IEEE) Standard 323-1974. The peak temperature and pressure conditions of the steam profile were, respectively, 174 ° C (346 ° F) and 779.1 kPa (113 psig). A boric-acid based chemical spray was initiated when the test chamber pressure decreased to 220.6 kPa (32 psig), and was continued for twenty-four hours. The duration of the steam exposure was 10 days.

Following the exposure of the cable samples to the simulated LOCA conditions, the specimens were submerged in water and subjected to voltage-withstand testing at a test voltage of 2400 volts ac

(equivalent to 80 v/mil ac), as described in IEEE Standard 383-1974. All three Okonite specimens that underwent 40-year equivalent preaging, and one of two Okonite specimens that underwent 20-year equivalent preaging, failed instantaneously. The artificial aging is believed to have contributed to the failure mechanism since circumferential cracks were observed following cable preaging. Longitudinal splits were observed on the cable jackets following exposure to the simulated LOCA conditions. The details of this test are discussed in a letter report from Robert Lofaro, BNL, to Satish Aggarwal, NRC, "Results of Test 5 on Bonded Jacket Electric Cables," dated March 6, 2000 (ADAMS accession number ML003709449).

SUMMARY OF ISSUE

Following receipt of the test results from BNL, the NRC held meetings with representatives from Okonite and the nuclear industry on February 8, and 16, 2000, respectively. It was determined that the composite EPR with CSPE jacket in Okonite's original qualification test report NQRN-1 is a bonded jacket system that is almost identical to the specimens tested by BNL. Okonite single-conductor, #12 AWG cables with EPR insulation and bonded CSPE jacket are used in electrical equipment important to safety, which are located in areas of nuclear power plants that are exposed to harsh environments. Okonite test report NQRN-1 is the basis for environmental qualification of this cable under 10 CFR 50.49, "Environmental Qualification of Electric Equipment Important to Safety for Nuclear Power Plants."

On June 22, 2000, the NRC staff met with representatives of the Nuclear Energy Institute (NEI), the Okonite Company (Okonite), and licensees to discuss the BNL LOCA test (Test #5) results. The industry noted that the BNL test, which duplicated the original Okonite qualification test, may have been conservative, and presented data from other documented EPR test reports to support this contention. These reports, according to the industry representative, show that EPR insulated cables consistently passed LOCA tests where the cables were preaged to a 40-year equivalent at 60 ° C (140 ° F). NEI has since issued a survey to licensees asking them to identify any Okonite single conductor cables (conductor size 8 AWG and smaller) in 10 CFR 50.49 applications that may be exposed to average service conditions more severe than 60 ° C (140 ° F) and to provide the average temperature, service duration, and safety function supported

by the cable. By letter dated July 14, 2000, Okonite informed the NRC staff that it will develop revised aging parameters that are based on the results of the NEI survey to requalify Okonite single-conductor cable. On October 12, 2000, NRC staff met with representatives of NEI and the Okonite Company to discuss NEI's preliminary survey results. By letter dated November 9, 2000 (ADAMS accession number ML003769561), NEI transmitted to the NRC its report titled "NEI Survey Results on Okonite Okolon Single-Conductor Cables," dated November 1, 2000. The staff is considering further evaluations to validate the 60 ° C (140 ° F) threshold that was the focus of the survey questions. Based on the NEI survey, 30 of the 103 operating reactors use Okonite Okolon single-conductor cable in 10 CFR 50.49 applications. Four units have the cable installed in environments that are 60 ° C (140 ° F) or greater, which may affect the service life of the cable. One unit has a 0.76 mm (30 mil) Jacket on the cable, which is thicker than that on the tested cable. One unit will replace the cable and another unit may replace it following an inspection in 2001. The fourth unit will determine a course of action following issuance of this RIS.

In addressing this matter, the staff identified concerns regarding the comprehensiveness of the NEI survey request and the summary results. In particular, the Okonite Okolon cables that are routed in localized adverse environments (hot spots) at reactor facilities were not identified and the technical basis for the threshold temperature of 60 ° C (140 ° F) used in the survey requires further evaluation. The staff plans to articulate its concerns in a letter to NEI following issuance of this RIS. The staff will determine whether further regulatory action is necessary after it has received the Okonite report on the subject cable.

The basis for allowing continued operation of nuclear power plants pending the NRC's efforts to reach closure in this matter was addressed in an NRC memorandum from Brian W. Sheron to Samuel J. Collins, "Action Plan to Address Failures of Bonded-Jacket Okonite Single-Conductor Cables During Loss-of-Coolant-Accident Testing by the Office of Nuclear Regulatory Research," dated May 9, 2000 (ADAMS accession number ML003711726). In essence, continued operation of nuclear power plants is warranted while the staff, in conjunction with the industry, continues to evaluate the potential deficiency of the subject cables. This assessment is based on industry statements regarding the limited application of single conductor EPR/Hypalon bonded-jacket cables in harsh environments and staff acknowledgment that most of these cables would not be in an operating environment as severe as that simulated during pre-test aging. In addition, the

staff is not aware of any installed cables that yet experienced the same thermal and radiation aging that was used for the LOCA qualification test.

The generic implications of similar Okonite cable of different wire gage size, similar cable of other manufacturers, and similar multi-conductor cable of all manufacturers are outside the scope of this RIS. They are, however, being considered in the resolution of GSI 168.

BACKFIT DISCUSSION

This RIS requests no action or written response. Consequently, the staff did not perform a backfit analysis.

FEDERAL REGISTER NOTIFICATION

A notice of opportunity for public comment was not published in the *Federal Register* because this RIS is informational.

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PAPERWORK REDUCTION ACT STATEMENT

This RIS does not request any information collection.

If there are any questions concerning this RIS, please contact the person listed below.

/RA/D. B. Matthews

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Attachment: List of Recently Issued NRC Regulatory Issue Summaries
(ADAMS Accession Number ML003749767)