



UNITED STATES
NUCLEAR REGULATORY COMMISSION
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MEMORANDUM FOR: Chairman Palladino
Commissioner Gilinsky
Commissioner Bradford
Commissioner Ahearne
Commissioner Roberts

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FROM: William J. Dircks
Executive Director for Operations

SUBJECT: BIMONTHLY REPORT ON CONFIRMATORY TESTS FOR ELECTRICAL
CONNECTORS AND REPLICATION TESTS FOR FIRE PROTECTION
SYSTEMS

The Commission Memorandum and Order (CLI-80-21) dated May 23, 1980, requested that the staff provide bimonthly progress reports on the RES research LOCA confirmatory tests for electrical connectors and the replication tests of fire protection systems. This report covers the period from June 24, 1981 to August 31, 1981.

LOCA Confirmatory Tests for Electrical Connectors

The Commission-directed environmental qualification test on connectors qualified to the environmental requirements of IEEE-323 (1974) was completed on June 21, 1981, using connectors obtained from the Cawtaba Nuclear Plant (used also in the McGuire Plant) of the Duke Power Company. Three of the 208 conductors in the 16 D. G. O'Brien Type K electrical penetration connector assemblies exhibited a short circuit during the LOCA simulation phase of the test. The conductors were connected electrically in series (or pairs) to provide 104 circuits for electrical monitoring. During the LOCA simulation test, 12 circuits (including the three short circuits mentioned above) exhibited a resistance to ground below the 5 megohm minimum acceptance level. At the conclusion of the test and following cooldown, 89 of the circuits exhibited a low resistance. During disassembly of the test chamber and examination of the connectors late in June, it was found that short circuit failure (electrical grounding) and low insulation resistance were caused by the extrusion of the cable grommet sealing material used inside the connectors which, in the process of extrusion, stripped insulation from many of the conductor wires where they pass through the metal connector plug. The wires, in the case of the conductors exhibiting a short circuit, were touching the metal plug. At the end of the test, during cooldown, the silicone grommet

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probably contracted providing a path for steam into the connector where it subsequently condensed and caused the significant number of low resistance measurements listed above. The largest part of the extrusion probably occurred during the accelerated thermal aging of the connectors which was performed by holding them in an assembled mode, with the grommet seal under load, at an elevated temperature of 150°C for 168 hours. Differential thermal expansion between the metallic assembly housing and the silicone grommet would occur during thermal aging because of the large bulk modulus of expansion of the silicone. An elevated temperature is used during thermal aging to accelerate the polymer aging process to obtain the equivalent property changes one would anticipate from a 40-year plant life. The method of thermal aging in the assembled state (the Duke Power Company's recommended qualification procedure) was probably questionable and, hence, results of the confirmatory qualification test of the connectors are inconclusive.

On July 6, 1981, the NRC staff met with representatives from Duke Power Company, D. G. O'Brien, Inc., and Life Cycle Engineering (a Duke Power consultant) to discuss the above tests of D. G. O'Brien connectors and, in particular, their use in the McGuire Plant. The McGuire Plant's D. G. O'Brien connectors had, according to Duke Power Company, successfully passed previous LOCA qualification tests but without thermal aging of the silicone RTV grommet. Test results were presented by the D. G. O'Brien Company which indicated that failures, similar to the Sandia Laboratories' results, had occurred when the O'Brien connector design had been thermally aged in the assembled state prior to LOCA testing.

The Duke Power Company agreed, at the July 6, 1981 meeting, to have additional testing performed to verify the adequacy of the D. G. O'Brien connectors when thermally aged and develop a further understanding of the failure mechanism observed in the Sandia Laboratories' test. The Duke Power Company has proposed that the silicone grommet in this test be thermally aged as a separate component. RES expects to review the results of this test to further assess the Sandia Laboratories' results.

It was necessary during the Sandia tests of the connectors to retorquer the connector and reestablish the load on the RTV silicone grommet seal after each sequential experimental step. A load must be maintained on the seal to prevent the entrance of water into the connector and possible grounding in the event of an accident. Retorquing the seal in the Sandia tests probably contributed to the connector failure by extruding the grommet. If the RTV silicone extrudes with time under load, periodic retorquing might be necessary during plant life to maintain a seal. A separate effects test is planned at Sandia in which several connectors will be maintained at slightly elevated plant temperature over a period of time to simulate aging, and the behavior of the RTV silicone grommet will be observed under conditions in which the seal load is maintained by periodic retorquing simulating maintenance. The properties of the silicone will also be investigated to see if reversion takes place when the material is heated in a confined space. These tests will help to clarify whether connector

failure from grommet extrusion could be expected in the normal aging process should maintenance retorquing be required to maintain load on the seal or the failure in the Sandia tests is solely attributable to the method used in the accelerated aging step.

Preliminary information on the test failures of the D. G. O'Brien electrical penetration assemblies was distributed publicly by IE Information Notice No. 81-20 on July 10, 1981. The Atomic Safety and Licensing Appeal Board for McGuire Nuclear Station, Units 1 and 2, was notified of the Sandia test results by memorandum from NRR on July 8. An RES detailed test report is in preparation.

Fire Protection Replication Test

The first Browns Ferry replication test was performed on July 17, 1981, at the Northbrook, Illinois, facilities of Underwriters Laboratories, Inc. The objective of the test was to demonstrate the ability of certain fire protection modifications made at Browns Ferry to protect one of two redundant trains of safe shutdown cables located in the same area from damage by a single fire. The test replica consisted of four vertical cable trays and three adjacent vertical conduits. One of the trays contained cables for Safety Train II. One conduit contained cables for Safety Train I and a second conduit contained cables for Safety Train II. The other three trays and the third conduit contained other than safety related cables. The cables in all four cable trays were damaged, however, functional capability was not lost since the cables in all three conduits (one of which contained cables for a redundant train) were undamaged by the test fire.

Since the test was conservative; i.e., run without any automatic or manual fire suppression efforts attempted, the staff feels that the original objective of this test, to verify the survivability of one redundant train, has been satisfied.

Details of the test and initial results were distributed by memo from Notley dated August 11, 1981. The staff's conclusion that the intent of the replication test program has been satisfied and its recommendation that the remainder of the replication test program be cancelled are contained in my memo of September 17, 1981 to Commissioner Bradford, Subject: Browns Ferry Replication Test (copy enclosed). The remainder of the Browns Ferry replication tests and all of the Brunswick replication tests will, therefore, be cancelled and those fire protection research efforts will be redirected towards a series of separate effects tests which will provide maximum useful information for NRR in its licensing reviews. This will, accordingly, be the final bimonthly report on this topic.

The environmental qualification test of the D. G. O'Brien electrical connectors to be conducted early next year by Duke Power Company will be followed by the NRC and Sandia. This test, along with the separate effects

tests at Sandia Laboratories on the aging characteristics of the silicone grommet, should provide further data on the connector qualification. It is proposed that further bimonthly reports on the electrical connectors be discontinued and a final report summarizing conclusions from the connector test results be issued when Duke Power and Sandia complete their additional testing next year.

(Signed) William J. Dircks

William J. Dircks
Executive Director for Operations

Enclosure: Memo fm Dircks to
Bradford dtd 9/17/81

cc: OGC
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