UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SUPPLEMENTAL SAFETY EVALUATION

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

AMPACITY ISSUES RELATED TO THERMO-LAG FIRE BARRIERS

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT, UNIT 1

DOCKET NO. 50-390

1.0 INTRODUCTION

In June 1991, the U.S. Nuclear Regulatory Commission (NRC) established a Special Review Team (SRT) to review the safety significance and generic applicability of the technical issues regarding the use of Thermo-Lag materials. One area of concern was the validity of the ampacity derating parameters previously established for Thermo-Lag fire barriers. The NRC issued Generic Letter 92-08, "Thermo-Lag 330-1 Fire Barriers," on December 17, 1992, to provide further information on staff concerns related to this subject. In light of the concerns raised by the SRT and the status of construction activities at Watts Bar Nuclear Plant, Unit 1 (WBN 1), Tennessee Valley Authority (TVA), the licensee, initiated a technical program to test Thermo-Lag 330-1 for intended WBN 1 applications and thereby to demonstrate the qualification of the material for intended service.

TVA has conducted extensive ampacity derating testing of various Thermo-Lag fire barrier configurations at its Central Laboratories Services Department (denoted as Phase 1 tests) in Chattanooga, Tennessee, from March 9 through April 6, 1993; April 30 through May 10, 1993; and June 1 - 22, 1993; and at Omega Point Laboratories (OPL) (denoted as Phase 2 tests) in San Antonio, Texas, from August 16 - August 26, 1994; September 14 to October 6, 1994; November 15 to December 3, 1994; and January 4 - January 23, 1995. TVA's Thermo-Lag 330-1 Phase 1 and 2 tests were submitted to the staff on July 9, 1993, and April 25, 1995, respectively. A new Thermo-Lag fire barrier material 770-1 for 3-hour rated electrical raceway application was tested at OPL as part of an upgrade to the basic Thermo-Lag 330-1 barrier system for a single tray (denoted as Phase 3 tests). The Phase 3 tests were documented in an OPL report dated June 30, 1995. Lastly, a 3-hour fire barrier system nominally similar to that of the Phase 3 cable tray was tested for one 1-inch and one 4-inch conduit enclosure (denoted Phase 4 tests). The Phase 4 tests were documented in an OPL report dated August 21, 1996.

The licensee ampacity derating test methodology followed the guidance in draft of Institute of Electrical and Electronics Engineers (IEEE) Standard P848, "Procedure for the Determination of the Ampacity Derating of Fire Protected Cables," Revisions 11, 12, and 14, dated April 6, 1992; February 24, 1993; and April 15, 1994 respectively, except for changes as identified in individual test plans. The staff identified concerns as documented in its request for additional

information (RAI) dated May, 5 1993, before the start of testing. After issuance of the licensee test report, "Testing to Determine Ampacity Derating Factors for Fire Protected Cables for Watts Bar Nuclear Plant" (Phase 1 Tests), with the licensee's submittal of July 9, 1993, the staff also identified concerns as documented in its RAI provided during a meeting between licensee representatives and the NRC staff on October 13, 1993. In addition, a meeting was also held between licensee representatives and the NRC staff on August 30, 1994. The licensee submitted responses to the staff's questions regarding WBN Unit 1 by letters dated June 30, 1993; November 26, 1993; and December 23, 1994.

After completion of the interim evaluation on Phase 1 and 2 tests, the staff stated that a final review of the licensee's ampacity test program and results could be completed after the licensee had submitted its final test reports. The licensee submitted the test reports for Phase 3 and 4 tests for the staff's review on September 14, 1995. The licensee responded to the staff's questions on the test program results as documented in the staff's RAI of August 29, 1996, by letter dated October 24, 1996.

The staff's evaluation of the final ampacity derating test program results for WBN Unit 1 follows.

2.0 EVALUATION

After reviewing the licensee's submittals and the Sandia National Laboratories (SNL) technical letter reports (see Attachments 1 and 3) and technical evaluation report (Attachment 2), the staff agrees with SNL's analyses and conclusions. Attachment 2 gives details of SNL's input on the test review questions. Attachment 3 provides additional SNL input on Question 3 and Open Item A.3. The ampacity test review questions, the licensee responses, and the staff's evaluation of the responses and open items follows.

Ampacity Test Review

- Question 1

  For Test Item 7.1 (single 24-inch X 4-inch tray with solid sheet top cover and 5/8-inch (nominal) 330-1 fire barrier), a steel cover was used as a part of the fire barrier system. The licensee should verify that the subject cover plate was not in place during the baseline ampacity derating test for Test Item 7.1 or used as a part of the fire barrier system for Test Item 7.2.

  Licensee's Response

  In its submittal of October 24, 1996, the licensee provided explicit descriptions documenting where and when the referenced tray covers were installed in the applicable test specimens. In all of the baseline ampacity tests, the licensee stated that tray covers were not installed during the conduct of these tests.

Staff's Evaluation

The clarification by the licensee fully resolves the staff's concerns.

- Question 2

The licensee plan required that a 30-day fire barrier cure period be obtained prior to the performance of the clad or wrapped ampacity tests. This cure period was not achieved in the case of Test Item 7.3 (three stacked 24-inch x 4-inch trays, spaced on 12-inch centers, in a common 5/8-inch 330-1 fire barrier enclosure). Furthermore, there was no indication of barrier moisture level measurements after the subject test. The licensee should provide an assessment of the impact of apparent shortened cure time on the test results for Test Item 7.3.

Licensee's Response

In its submittal of October 24, 1996, the licensee clarified the time line associated with Test Item 7.3. The licensee stated that after the initial completion of the barrier construction, it found it necessary to remove the bottom from the barrier and reinstall the bottom panel using some additional panel material, stress skin, and skin coating by trowel-grade material. The licensee's timeline indicates that even with the reconstruction of the bottom of the barrier for the subject test article; a minimum cure time of 27 days was achieved for the entire article however, the bulk of the test article was cured for the required 30-day period. The licensee contends that the failure to strictly adhere to the 30- day cure time period would not affect the test results because (1) a significant portion of the cure time was achieved and (2) only a small fraction of the test article surface area was affected by the subject test deficiency.

Staff's Evaluation

The information provided by the licensee addresses the staff's concerns, which are considered resolved.

- Question 3

The licensee test procedures specified the testing of two different test articles simultaneously in the same test enclosure. This practice, while not specifically prohibited IEEE P848 draft standard, "Procedure for the Determination of Ampacity Derating of Fire Protected Cables," may have influenced some of the temperature responses by the test articles.

For the subject tests, the surface temperatures of the tests are significantly higher than that of the surrounding (i.e, the air and walls of the test enclosure). This situation may lead to the direct interchange of radiant energy between test articles when more than one article is tested at the same time. The intent of the draft test standard is to ensure that the test articles exchange energy only with the ambient surroundings. Hence, the

practice of simultaneous testing may introduce an unanticipated thermal effect which could impact the test results.

To illustrate the possible effects, consider that Test Items 7.1 and 7.4 (three 1-inch diameter steel conduits in a horizontal row surrounded by a common rectangular 5/8-inch 330-1 fire barrier) were tested at the same time. For the clad test, it was also noted that the left conduit of the Test Item 7.4 configuration was the hottest specimen of the three conduits in the configuration. This result is atypical because one would expect the test configuration to exhibit symmetric heat transfer behavior such that the center conduit would exhibit the highest temperature. One possible explanation for this behavior would be the presence of Test Item 7.1, the cable tray specimen, in the test enclosure.

The licensee is requested to describe further, the physical separations (i.e., three dimensional depictions) between test articles and any measures taken to ensure direct radiative heat transfer did not occur between specimens test data. The licensee should also provide an assessment of the impact on the applicable test results due to any non-symmetric heating behavior which would be associated with the simultaneous testing of multiple test articles.

Licensee's Response

In its submittal of October 24, 1996, the licensee responded as follows:

The simultaneous testing of more than one specimen is implied by Figure 4-4 of the draft of IEEE P-848 used by the TVA test program (IEEE P-848 has since been approved by the IEEE Standards Board). Figure 4-4 shows a tray and a conduit within a common test chamber and specifies a minimum lateral separation of 36 inches. The staff expressed a concern that radiant energy from one specimen may have resulted in a temperature rise on the adjacent specimen. The contribution of energy from an external source could thereby influence the test results.

The staff cited the simultaneous testing of Thermo-Lag protected Assemblies 7.1 and 7.4 as one possible example of its concern. The thermocouple data in Appendix D to the subject report (See Table below) shows that after cladding, the cables in the "left-most" conduit in Assembly 7.4 experienced the hottest average maximum temperatures (left - 90.42 °C; center - 85.13° C; right - 86.04 °C). The staff hypothesized that this condition was the result of the heat contribution from the adjacent tray.

TVA does not believe that the non-symmetrical temperatures are the result of simultaneous testing for the following reasons:

- The hottest conduit during the wrapped test of Assembly 7.4 was on the side of the enclosure away from Assembly 7.1.

- The thermocouple data shown below also establish that the side-to-side delta T of Assembly 7.4 was much lower than the difference between the center and left

conduits mentioned above (0.2 °C versus 5.29 °C). The fact that the side of the Electrical Raceway Fire Barrier Systems (ERFBS) enclosure that faced the "cold" wall of the test chamber is at almost the same temperature as the side facing Assembly 7.1 further confirms that the differential was not externally generated.

TABLE 1

Average Data During the Final 60 Minutes of the Ampacity Test
All temperatures in Degrees C

POSITION	ASSEMBLY 7.1	ASSEMBLY 7.4
"Left" Side	46.6	45.5
"Right" Side	46.8	45.3

Finally, we note that the subject of simultaneous testing was discussed with the IEEE P-848 Working Group at the IEEE Insulated Conductor Committee Spring 1996 Meeting in Houston, Texas. The group consensus was that no change to the IEEE P-848 draft was warranted, given the above considerations.

Staff's Evaluation

The information provided by the licensee addresses the staff's concerns, which are considered resolved.

- Question 4

Given the completion of the ampacity derating tests (Phases I, II, III) for the Thermo-Lag fire barriers that are installed at WBN Unit 1, the licensee should confirm that the existing ampacity design margins are adequate and sufficient for each installed fire barrier configuration. The licensee should delineate the minimum excess ampacity derating margins for the various electrical distribution circuits (e.g., 4 kV, 480 V) enclosed by the Thermo-Lag fire barrier material at the Watts Bar Nuclear Plant.

Licensee's Response

In its submittal of October 24, 1996, the licensee stated that upon completion of the ampacity test program, its Corporate Engineering organization evaluated the results and established conservative ampacity correction factors for the various Thermo-Lag fire barrier enclosed electrical raceway configurations.

Staff's Evaluation

Although the licensee's response did not provide the minimum excess ampacity margins requested, this information is available for onsite review. The confirmation that

the ampacity derating margins are adequate and sufficient for each fire barrier resolves the staff's concerns.

Open Items

Item A.1

This item involves the completion of the Phase III ampacity derating tests for the Thermo-Lag 770-1 fire barriers to be installed at WBN Unit 1. The licensee should confirm in writing that the existing ampacity design margins are adequate and sufficient for each installed fire barrier configuration.

Staff's Evaluation

The licensee's response to Question 4 above resolves Open Item A.1.

Item A.2

This item pertains to the Phase I and II ampacity derating tests for the Thermo-Lag 330 -1 and 330-660 fire barriers to be installed at WBN, Unit 1. The licensee should confirm in writing that the existing ampacity design margins are adequate and sufficient for each installed fire barrier configuration.

Staff's Evaluation

The licensee's response to Question 4 above resolves Open Item A.2.

Item A.3

This item pertains to the question whether ampacity test results using IEEE Standard P848 will bound nominally different conduit sizes. The licensee did not test the 3/4-inch and 5-inch conduit fire barrier configuration which are installed at WBN Unit 1.

Staff's Evaluation

The staff has examined the industry ampacity test data provided by Texas Utilities Electric Company and Florida Power Corporation in conjunction with the licensee's test results. Although the 3/4-inch and 5-inch conduits were not specifically tested by the licensee, the increase in heat dissipation evident in some negative ampacity test results indicates that there would not be significant variation or spread in ampacity derating values because of conduit size only. Given the fact that additional margin is included in the final ampacity correction factor (ACF) values in excess of the test results, the ampacity derating values selected should not be a significant safety hazard at WBN Unit 1 on the basis of conduit size. Therefore, this issue is considered resolved with respect to the review of the licensee ampacity derating test program.

3.0 CONCLUSION

From the above evaluation, the staff concludes that no significant safety hazards are introduced with the use of ampacity test program results for cables enclosed by the subject Thermo-Lag fire barrier configurations at WBN Unit 1.

Attachments: As stated (3)

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Dated: January 6, 1998