

Docket No. 50-440

December 18, 1991

MEMORANDUM FOR: Frank J. Miraglia, Jr., Deputy Director
Office of Nuclear Reactor Regulation

FROM: Loren R. Plisco, Section Chief
Performance and Quality Evaluation
Branch, NRR

K. Steven West, NRC Allegations Program Manager
Division of Reactor Inspection and
Safeguards, NRR

SUBJECT: FACT FINDING VISIT TO PERRY NUCLEAR POWER PLANT

While conducting our special review assignment, we visited Perry Nuclear Power Plant on November 19, 1991 to obtain additional information on the use of Thermo-Lag fire barriers. Enclosure 1 is a summary of technical issues. Enclosure 2 is our trip report.

During our visit, we observed a degraded Thermo-Lag fire barrier in the division 1 cable spreading room. We recommend referral of this observation to Region III for possible followup of the licensee's corrective action. We also observed a minor weakness in the licensee's receipt inspections. We recommend that this observation be referred to the Vendor Inspection Branch and Region III for possible followup during a future procurement inspection.

LS
Loren R. Plisco, Section Chief
Performance and Quality Evaluation
Branch, NRR

LS
K. Steven West, NRC Allegations Program
Manager
Division of Reactor Inspection and
Safeguards, NRR

Enclosures:
As stated

cc w/enclosures:
~~_____~~
~~_____~~

b:pnpptrip.rpt

DISTRIBUTION:
TSI File
SWest/LPlisco

NRR *SW*
SWest
12/18/91

NRR *SW*
LPlisco
12/18/91

SUMMARY OF ISSUES

Facility: Perry Nuclear Power Plant
 Licensee: Cleveland Electric Illuminating Company
 Docket No.: 50-440
 Trip dates: November 19, 1991
 Task Force: Loren Plisco, NRR and Steven West, NRR

<u>Issue</u>	<u>Status</u>
1. The licensee may not have an adequate technical basis for installing Thermo-Lag fire barriers at PNPP. (Page 2.)	1. The adequacy and validity of fire endurance tests and the lack of analyses to substantiate installations is a generic concern. This issue is being reviewed by the task force.
2. The licensee may not have an adequate technical basis for deviating from the vendor's 18-inch rule for raceway support protection. (Page 3.)	2. The adequacy and validity of fire endurance tests and the lack of analyses to substantiate installations is a generic concern. This issue is being reviewed by the task force.
3. The licensee's receipt inspection procedures do not include an inspection attribute for temperature limitations (for trowel-grade materials). (Page 5).	3. The licensee stated that it would revise its receipt inspection procedures. Advise Vendor Inspection Branch and Region III for possible followup.
4. The task force observed a split in a Thermo-Lag barrier on a conduit in the control complex. (Page 8.)	4. Advise Vendor Inspection Branch and Region III for possible followup of the licensee's corrective action.

TRIP REPORT

Facility: Perry Nuclear Power Plant
Licensee: Cleveland Electric Illuminating Company
Docket No.: 50-440
Trip dates: November 19, 1991
Task Force: Loren Plisco, NRR and Steven West, NRR

BACKGROUND

Section 50.48, "Fire protection," of Title 10 of the Code of Federal Regulations (10 CFR 50.48) contains the U.S. Nuclear Regulatory Commission's (NRC's) regulations for nuclear power plant fire protection. Section 50.48 requires that each nuclear power plant licensed to operate before January 1, 1979, meet the requirements of Section III.G, "Fire protection of safe shutdown capability," of Appendix R, "Fire Protection Program for Nuclear Power Facilities Operating Prior to January 1, 1979," to 10 CFR Part 50. In a separate action the Commission required that all plants to receive their operating license after January 1, 1979, also satisfy the requirements of Section III.G of Appendix R. The NRC provided further guidance in Generic Letter (GL) 86-10, "Implementation of Fire Protection Requirements," April 24, 1986. These requirements and guidance, if properly implemented, provide reasonable assurance that at least one means of achieving and maintaining safe shutdown conditions will remain available during and after any postulated fire in the plant.

One means of complying with Section III.G of Appendix R to 10 CFR Part 50 is to separate one safe shutdown train from its redundant train with fire-rated barriers. The level of fire resistance required of the barrier, either 1 or 3 hours, depends on the other fire protection features provided in the fire area. Licensees use the Thermo-Lag 330-1 fire barrier system at more than 100 nuclear power plants to meet the Appendix R requirements for separation. The Thermo-Lag system is available from its manufacturer and supplier, Thermal Science, Incorporated (TSI, the vendor), St. Louis, Missouri. The vendor claims that Thermo-Lag fire barriers are available with both 1-hour and 3-hour fire resistance ratings.

In a letter of December 20, 1989, Gulf States Utilities (GSU), the licensee for the River Bend Station (RBS), reported the failure of an "as-designed" Thermo-Lag fire barrier to pass a 3-hour fire endurance test conducted by the Southwest Research Institute for GSU. In Licensee Event Report (LER) 90-003 of March 8, 1990, GSU reported discrepancies in the installation of Thermo-Lag fire barriers at RBS. These reports, which indicated that the Thermo-Lag fire barrier system may not provide the level of fire

protection claimed by the vendor and intended by the licensees, prompted the NRC's Office of Nuclear Reactor Regulation (NRR) to establish a technical task force to assess the safety significance and generic applicability of issues regarding the use of Thermo-Lag. On August 6, 1991, NRR issued Information Notice (IN) 91-47, "Failure of Thermo-Lag Fire Barrier Material To Pass Fire Endurance Test." The notice alerted NRC licensees to problems that could result from using or improperly installing Thermo-Lag fire barriers.

On October 7, 1991 the Cleveland Electric Illuminating Company (CEI), the licensee for the Perry Nuclear Power Plant (PNPP), found discrepancies in the installation of Thermo-Lag fire barriers that could adversely affect the safe shutdown capability at PNPP. While conducting its review of Information Notice 91-47, the licensee found that spaces between mechanical fasteners exceeded the vendor's tested configuration. On November 4, 1991, the licensee reported the installation discrepancies in LER 91-020. On November 19, 1991, Loren Plisco and Steven West visited PNPP to review with the licensee the event reported in the LER.

The task force reviewed purchase orders and receipt inspection reports for Thermo-Lag fire barrier materials, reviewed installation and quality control (QC) documents, inspected Thermo-Lag prefabricated panels and Thermo-Lag fire barrier mockups in a PNPP training facility, conducted walkdown inspections to review field installations of Thermo-Lag fire barriers, and discussed generic and plant-specific safety and technical issues regarding Thermo-Lag fire barriers with the licensee. Ms. Mary Makar, Lead Fire Protection Engineer, was the licensee's representative for the task force. The task force's activities and findings are documented below. The attachment is a list of the CEI employees interviewed by the task force.

QUALIFICATION FIRE TESTING AND APPLICATION OF TEST RESULTS

The licensees must substantiate the fire resistance ratings of all fire barriers used to satisfy NRC requirements. The licensee must have the following documentation to verify the fire resistance rating of each fire barrier: (1) the design description of the barrier and (2) the report that documented that a test assembly passed a standard fire endurance test¹. This assembly must represent materials, method of assembly, dimensions, and configuration for which a fire resistance rating is desired. Construction variations may substantially change the performance

¹ American Society of Testing and Materials (ASTM) Standard E-119, "Standard Methods of Fire Tests of Building Construction and Materials." (This standard was adopted by the National Fire Protection Association (NFPA) as NFPA Standard 251.)

characteristics of the assembly. Therefore, to ensure that the fire barriers can provide the level of fire protection required, the licensee must either (1) install barriers that replicate the configurations that were tested or (2) justify, by engineering evaluation, that fire barriers that deviate from the tested configurations provide an equivalent level of protection. The NRC issued guidance in GL 86-10 on the acceptance criteria for qualification fire tests and on the review of deviations between tested and field configurations.

During the site visit, the licensee informed the task force that it had established as its technical bases for installing Thermo-Lag fire barriers at PNPP to meet the requirements of Appendix R to 10 CFR Part 50 the fire tests identified in TSI Technical Note 20684², "Thermo-Lag 330 Fire Barrier System Installation Procedures Manual - Power Generating Plant Applications." The licensee did not evaluate (1) fire test reports to validate the fire resistance ratings of Thermo-Lag and their applicability to the PNPP design or (2) the fire barrier designs installed at PNPP to ensure that they either replicated the tested configurations or provided an equivalent level of protection. The licensee stated that the problems identified in IN 91-47 had prompted it to plan to establish and document its technical basis. This will include performing technical evaluations of the fire test reports to ensure that they are valid and apply to PNPP, finding any deviations between the tested configurations and the field installations, and evaluating any identified deviations for acceptability.

The licensee deviated from the vendor's recommendation that raceway supports be protected with a 1/2-inch dry film thickness of Thermo-Lag. The licensee protects raceway supports with a 1/4-inch dry film thickness of trowel-grade Thermo-Lag material. The licensee applied the material to each support from the point of attachment to the raceway to a point 18 inches away from the point of attachment. This is commonly called the "18-inch rule." To assess the performance of its raceway supports during fire exposure, the licensee performed a small-scale 1-hour ASTM E-119 fire test at Construction Technology Laboratories (CTL) on September 28, 1986. The test results are documented in Bisco Fire Test Report 748-218 of September 28, 1986. The licensee provided a copy of the report to the task force for information. The licensee constructed the test assembly in accordance with Brand Industrial Services, Incorporated (Bisco) Procedure SP-116 to represent a typical PNPP installation. The cable tray test assembly was covered with a 1/2-inch layer of Thermo-Lag

² Section IX of TSI Technical Note 20684 contains ANI "Acceptance of Testing" forms for ITL Test Reports 85-2-382, 85-5-314, 85-6-283, 82-11-80, 82-11-81, 82-11-241, 83-5-472A, and 84-12-294.

(prefabricated panels). Each of the two cable tray supports were covered with a 1/4-inch dry film thickness of trowel-grade Thermo-Lag material for a distance of 18 inches from the point of tray attachment. Portions of the unprotected supports were exposed to the fire. The Thermo-Lag failed to provide 1 hour of fire protection when the temperature inside the cable tray exceeded 325 °F after 50 minutes of exposure to the ASTM E-119 standard test fire. The task force concluded that the fire test could not be used to determine the fire resistance rating of Thermo-Lag. Specifically, the Thermo-Lag test assembly was not cured for 30 days before the fire test and the test report lacked the information and detail needed to reach a conclusion about the fire performance of the Thermo-Lag test assembly. Furthermore, the task force could not determine if the temperatures inside the protective envelope exceeded 325 °F because of a failure of the Thermo-Lag fire barrier or as a result of heat transmission through the support system. In a letter of December 15, 1986, the licensee asked the vendor to review the test report. In a June 29, 1987 letter, the vendor provided its comments on the test results to the licensee. The vendor discussed the lack of cables in the test assembly, the placement of the thermocouples, and the cure time, but did not state a conclusion as to the acceptability of the test results. The licensee informed the task force that it continued to protect raceway supports with a 1/4-inch thick layer of Thermo-Lag rather than a 1/2-inch thick layer on the basis of the vendor's review of the test report and its analysis of the test report and the vendor's comments. The licensee's analysis was not available during the site visit.

While reviewing fire endurance tests of Thermo-Lag, the task force reviewed Minnesota Mining and Manufacturing (3M) Company's March 21, 1986, test report for Fire Tests 86-42 and 86-43. The task force also reviewed 3M Company's October 10, 1986, proposal (PJ-24) and October 22, 1986, test data for Fire Test 86-112. 3M Company conducted the three fire tests to qualify a method for joining the 3M Interam E-50D series flexible 1-hour fire wrap system with the 1-hour-rated Thermo-Lag 330-1 fire barrier system. In all three tests, the Thermo-Lag failed to provide 1 hour of fire protection because the temperatures inside the conduit sections protected by Thermo-Lag exceeded 325 °F after less than 1 hour of exposure to the ASTM E-119 standard test fire. During the site visit, the licensee informed the task force that it had no record of having requested 3M Company perform the aforementioned fire tests. The licensee believed that 3M Company performed the tests on its own initiative in an attempt to market its fire barrier products to the licensee.

The Thermo-Lag test assemblies for 3M Company Fire Tests 86-42 and 86-43 were not (1) constructed by TSI certified installers, (2) constructed in accordance with TSI's installation procedures, (3) cured for 30 days before the fire tests, or (4) inspected by TSI-certified QC inspectors. The task force concluded that the test

results did not establish the fire resistance rating of Thermo-Lag. A test report was not prepared for Fire Test 86-112. The task force reviewed 3M Company's notes and data from the test and concluded that this information lacked the clarity and detail needed to reach a conclusion about the fire performance of Thermo-Lag.

The licensee has used the 3M Interam E-50D series flexible fire wrap system to meet Appendix R requirements. However, no 3M TSI fire barrier interfaces are installed at PNPP.

The task force has not resolved technical issues regarding the validity of fire endurance tests involving Thermo-Lag based, for example, on adequacy of the test facility and equipment, the qualifications of the test personnel, and the quality of the test documentation and reports. The task force did not obtain any new information on these issues during the site visit. However, the 3M Company tests provide further evidence that most of the fire tests conducted to substantiate the fire resistance rating of Thermo-Lag are not valid. Using fire test results to justify field installations and evaluating deviations between tested and field configurations are also generic concerns. The task force obtained information and made observations during the site visit that substantiated these concerns.

FIRE BARRIER SYSTEM MATERIALS

The licensee purchases Thermo-Lag as a commercial grade material. The licensee does not impose 10 CFR Part 21 or 10 CFR Appendix B requirements on the vendor. The licensee does not conduct source inspections at the vendor's site, but conducts annual quality assurance (QA) audits. Instead of conducting the annual QA audit, the licensee may obtain the results of an annual audit performed by another licensee and assess those results for applicability to its QA program. In this case, if the licensee finds that the third party audit satisfies its requirements, it does not conduct an independent audit of the vendor's program that year.

The licensee's QC inspectors inspect Thermo-Lag materials received at PNPP and document their findings on a standard receipt inspection report form in accordance with a generic inspection procedure. This procedure does not apply specifically to Thermo-Lag. The task force reviewed several purchase orders and their associated receipt inspection reports. The task force found that the licensee's receipt inspection procedure did not provide guidance regarding temperature limitations for trowel-grade Thermo-Lag materials. The task force found that the licensee included the temperature strip charts in the receipt inspection file but did not check the temperature data against inspection acceptance criteria or record the data in the receipt inspection report. The licensee stated that this was a flaw in its receipt inspection procedures and that it would revise the procedures to

ensure that the temperature limits are included in future receipt inspections of the trowel-grade material. The task force found this response acceptable and does not recommend specific regulatory action on the licensee's procurement program. The task force recommends advising NRR's Vendor Inspection Branch and Region III of this issue for followup during a future procurement inspection.

PNPP Installation Standard Specification SP-2100, "Detailed Specification for Penetration Seals, Raceway Fire Barriers and Radiant Heat Energy Shields," identified the thickness acceptance criterion for 1-hour prefabricated Thermo-Lag panels as 0.50, +0.25, and -0.00 inches. The task force inspected several 1-hour panels in a PNPP training facility and found one panel with thickness ranging from 0.375 to 1.25 inches along an exposed edge. (Interior measurements could not be taken.) The licensee responded to the task force's concern by stating that the acceptance criteria specified in SP-2100 control how fire barriers are installed on PNPP electrical raceways. If the licensee receives a Thermo-Lag panel that does not meet the acceptance criteria, the licensee rejects the nonconforming areas of the panel when it is cut into sections for installation on a raceway. Therefore, the licensee would not install in the plant any panel sections that do not meet the acceptance criteria. The task force also observed two Thermo-Lag fire barrier training mockup assemblies in the training facility. These assemblies consisted of cable tray sections that had been covered with 1-hour fire rated (1/2-inch thick) Thermo-Lag panels during training sessions in which students performed the installations. The panel sections installed on the cable trays appeared to meet the licensee's thickness acceptance criteria.

FIRE BARRIER INSTALLATION AND INSPECTION

Gilbert Associates, Incorporated (GAI) was the PNPP architect-engineer. Bisco was GAI's contractor for installing and performing QC for the Thermo-lag fire barriers at PNPP. Bisco Procedures SP-116, "Fire Barrier Installation Procedure," and QCP-116, "Inspection of Thermo-Lag Fire Barriers," set forth the construction requirements for the Thermo-Lag fire barriers. TSI provided certification training for the Bisco installers.

After the plant was completed, the licensee replaced the Bisco procedures with PNPP Installation Standard Specification SP-2100. On December 5, 1989, the licensee issued the current version, Revision 2. Several former Bisco employees, who are now employed by the licensee's maintenance contractor, install and provide QC for the PNPP fire barriers. The licensee performs periodic surveillance inspections of the PNPP Thermo-Lag fire barriers using PTI-P54-P0075, "Appendix R Wrap Inspection."

The licensee does not have a QC inspection procedure specifically for fire barriers. The licensee informed the task force that QC inspectors compare installations, which generally consist of repairs and modifications, against the procedures and acceptance criteria specified in SP-2100, the vendor's installation procedure, and inspection attributes identified by a quality control engineer on a sign-off sheet that is included with the work package.

The licensee informed the task force that only steel cable trays and conduits are installed at PNPP. Except for one 2-inch diameter conduit in the control complex that is protected by 3-hour fire rated Thermo-Lag, all Thermo-Lag installations have 1-hour fire ratings. Most of the Thermo-Lag fire barrier installations are constructed of prefabricated panels and preshaped conduit sections. The licensee buttered the edges for these barriers before assembling the individual panel sections. The licensee uses tie wires and banding straps as mechanical fasteners and does not use edge guards. The banding straps have crushed small portions of the edge of the panel which the licensee covered with trowel-grade material after applying the straps.

Several conduits are protected by Thermo-Lag that had been applied by injecting trowel grade material into an annular space between the conduit and a layer of stress skin installed circumferentially around the conduit. The licensee stated that Bisco developed this "low pressure extrusion" technique because of the difficulties of trowelling the trowel-grade Thermo-Lag directly to the conduits.

While reviewing of IN 91-47, the licensee found that the spaces between some mechanical fasteners (banding straps) exceeded the vendor's tested configuration without technical justification. The licensee concluded that this discrepancy in the installation of the Thermo-Lag fire barriers was caused by inadequate design, could adversely affect the ability to meet the safe shutdown requirements, and was reportable as a defect under 10 CFR Part 21. The licensee reported the installation discrepancies in LER 91-020 of November 4, 1991.

After finding the deviations the licensee verified that the fire detection systems were operable and established fire watches in each of the affected areas. The licensee committed in the LER to revise its installation specification (SP-2100), design drawings, and periodic inspection procedure (PTI-P54-P0075) to reflect the vendor's recommended band spacing, and to improve all affected cable tray raceways to the required band spacing. According to the LER, the licensee will complete all corrective actions by January 31, 1992. The task force reviewed the proposed corrective actions with the licensee during the site visit, but did not verify the detector's operability or the fire watches. Upon reviewing the information provided by the licensee and its

observations made during the site visit, the task force concluded that the licensee's corrective actions will bring the Thermo-Lag fire barriers installed at PNPP up to the vendor's recommended installation specifications for band spacing.

During the site visit, the licensee informed the task force that after it submitted LER 91-020, it found raceway supports with dry film thicknesses of less than 1/4-inch. The licensee attributed this deviation from its acceptance criteria to the failure to apply sufficient wet film thicknesses of trowel-grade Thermo-Lag during construction to allow for material shrinkage during curing. The task force observed the licensee's maintenance contract installers improving some of the affected raceway supports by applying more trowel-grade material to the supports. The installers were not wearing protective equipment such as gloves or respirators. One of the installers informed the task force that this was his common practice and that he had never experienced any adverse health effects. The installers were meticulous and precise in their work and did not appear to have any Thermo-lag material on either their skin or their clothing. After the site visit, the licensee informed the task force that it planned to report this deviation through either a supplement to LER 91-020 or a new LER.

While performing the plant walkdown inspections, the task force observed a split in a Thermo-Lag fire barrier on a conduit at the 638-foot elevation of the control complex division 1 cable spreading room. This split was the full depth of a joint between preshaped conduit sections. This damage appeared to have been caused by individuals stepping or walking on the conduit. On December 17, 1991, the licensee informed the task force that it had issued a work order to repair the conduit fire barrier. Fire watches have been established in the cable spreading room because of the banding strap spacing deviations reported in LER 91-020. The split will be repaired when the banding strap spacing is improved.

NRR issued IN 91-79, "Deficiencies in the Procedures for Installing Thermo-Lag Fire Barrier Materials," of December 6, 1991, to alert the licensee to installation problems that the task force had found, including those that the licensee had identified in LER 91-020. However, NRR cannot determine the fire protection provided by the Thermo-Lag fire barrier system because of the unresolved technical issues and questions. Therefore, even those Thermo-Lag fire barriers installed in accordance with the vendor's specifications may not provide the level of fire protection claimed by the vendor and intended by the licensees. The task force is reviewing the outstanding issues.

AMPACITY DERATING

In a Mailgram of October 26, 1986, the vendor informed the NRC of the results of ampacity derating tests performed at the Underwriters Laboratories (UL). The ampacity derating factors derived from the UL tests (UL Project 86NK23826, File R6802, January 1987) exceeded those previously reported by the vendor (for example, ITL Reports 82-355-C, 82-355-F, and 82-355-F1). The vendor claimed to have sent the Mailgram to each of its customers.

The licensee was not prepared to discuss ampacity derating during the site visit, but stated that it would determine if it received the Mailgram and, if so, the manner in which it had handled this information. On December 4, 1991, the licensee informed the task force that its purchasing department had received the vendor's Mailgram during October 1986 and forwarded it to the quality department. The licensee subsequently reassessed the PNPP ampacity derating based on the information provided in the Mailgram. The licensee stated that it would provide copies of letters that detail the results of its assessment to the task force for information.

Ampacity derating is a generic concern. The task force is reviewing ampacity derating test methods and the analysis and use of ampacity derating test results for plant design.

CONCLUSIONS

During the PNPP site visit, the task force obtained information to justify treating the following issues as generic concerns: (1) The licensees failed to review and evaluate fire endurance test results to determine the validity of the tests and the applicability of the test results to the plant derating. (2) the licensees failed to substantiate that their fire barrier installations either replicate the tested configurations or provide an equivalent level of protection, (3) the installation specifications and procedures are incomplete and contain weaknesses, and (4) the licensees failed to install the fire barriers in accordance with the installation procedures.

PERSONS CONTACTED

Facility: Perry Nuclear Power Plant
Licensee: Cleveland Electric Illuminating Company
Docket No.: 50-440
Trip dates: November 19, 1991
Task Force: Loren Plisco, NRR and Steven West, NRR

J. Bowser, QC Inspector
L. Erbacher, Receipt Inspector
J. Hashim, Fire Protection Engineer
T. Hogan, Compliance Engineer
M. Makar, Lead Fire Protection Engineer
G. Tilisky, Quality Engineer