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NUCLEAR REGULATORY COMMISSION
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Docket No. 50-445

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

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SUBJECT: FACT FINDING VISIT TO COMANCHE PEAK, UNIT 1

While conducting our special review assignment, we visited the Comanche Peak Steam Electric Station (CPSES) on November 4 and 5, 1991, to obtain facts on the use of Thermo-Lag fire barriers. Enclosure 1 is a summary of technical issues. Enclosure 2 is our full trip report.

During our visit, we did not identify any plant-specific concerns regarding Appendix R compliance to be forwarded to Region IV.

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Enclosures:
As stated

cc w/enclosures:

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SUMMARY OF ISSUES

Facility: Comanche Peak Steam Electric Station, Unit 1
 Licensee: Texas Utilities Electric
 Docket No.: 50-445
 Trip dates: November 4 and 5, 1991
 Task force: Loren Plisco and Steven West, NRR

<u>Issue</u>	<u>Status</u>
1. The licensing bases may not support installing Thermo-Lay fire barriers at CPSES. The design basis test did not represent the plant configuration.	1. The task force will track this issue since it may apply generically. This issue may be referred to Region IV following NIST review of the ITL 82-11-80 test report.
2. The installation procedure, specifications, and practices for the fire barrier system differ from the vendor manual.	2. The task force will track this generic issue. (The spacing between the bands differs from the vendor's recommended spacing at CPSES.)
3. The licensee uses topcoat on all installations of Thermo-Lag. Topcoat has not been fire tested.	3. The task force will track this issue, which is related to Issue 1.
4. The licensee has not performed tests or analyses to justify the acceptance criteria it uses in the receipt inspection. These acceptance criteria are based on panel weight.	4. The task force will track this issue. The NRC has not fully reviewed the supplementary information provided by the vendor. This issue may be referred to Region IV at a later date.
5. The licensee is installing in the plant panels without structural ribs. These panels are not discussed in the vendor's manual.	5. The task force will track this issue and will request the vendor to respond to the issue of seismic capability.

TRIP REPORT

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Licensee: Texas Utilities Electric
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Background

The Thermo-Lag 330-1 fire barrier system is available from its manufacturer and supplier, Thermal Science, Incorporated (TSI, the vendor), St. Louis, Missouri, with fire resistance ratings of 1 hour and 3 hours. The licensees use this material at more than 100 commercial nuclear power plants to satisfy the U.S. Nuclear Regulatory Commission's (NRC's) requirements for protecting safe shutdown equipment from fire. The NRC received reports of discrepancies in the installation of Thermo-Lag fire barriers at the River Bend Station (RBS) and the failure of Thermo-Lag to pass a 3 hour fire endurance test conducted at the Southwest Research Institute (SWRI) by Gulf States Utilities (GSU). These reports prompted the NRC to issue Information Notice 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. Upon learning that the system may not provide the fire protection claimed by TSI and intended by the licensees, the Office of Nuclear Reactor Regulation (NRR) established a technical task force to assess the safety significance and generic applicability of issues regarding the use of Thermo-Lag. To support this effort, the task force visited several facilities to obtain additional information on the use of Thermo-Lag by the nuclear power industry.

On November 4 and 5, 1991, Loren Plisco and Steven West visited Comanche Peak Steam Electric Station, Unit 1 (CPSES). The task force reviewed the purchase orders and the receipt inspections issued by the Texas Utilities Electric Company (TU) reports for Thermo-Lag fire barrier materials, inspected Thermo-Lag prefabricated panels and preshaped conduit sections in the CPSES warehouse, reviewed installation and quality control inspection documents, conducted walkdown inspections to review field installations of Thermo-Lag fire barriers, and discussed with the licensee generic and plant-specific safety and technical issues regarding Thermo-Lag fire barriers. Mr. Obaid Bhatti, Licensing 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 TU employees interviewed by the task force.

Ampacity Derating

In a Mailgram of October 2, 1986, TSI informed the NRC of the results of ampacity derating tests performed at the Underwriters Laboratories (UL). The ampacity derating factors obtained from the UL tests (UL Project 86NK23826, File R6802, January 1987), significantly differed from those previously reported by TSI (ITL Report 82-355-C, 82-355-F, and 82-355-F1). TSI claimed to have sent the new test data to all TSI customers.

During the site visit, the licensee provided the task force with a letter of March 4, 1987, from Stone and Webster to TU Electric, that directed use of the revised TSI ampacity derating factors. The licensee currently uses a 31-percent derating for single cable trays and a 20-percent derating for single conduits that have been enclosed with more than 2 feet of Thermo-Lag. These deratings are consistent with, or more conservative than, the UL test results, and appear to be adequate. Although only 1-hour Thermo-Lag fire barriers are installed at CPSES, Stone and Webster conservatively applied the 3-hour barrier derating factors since the maximum thickness in the CPSES specification exceeded the panel thickness used in the UL test. Before the UL test, an ampacity derating of 10 percent was used at CPSES based on a Gibbs and Hill calculation.

The NRR technical task force has identified ampacity derating as a generic concern since a number of facilities have not used the revised figures. Although CPSES properly implemented the revised deratings from TSI, the task force is continuing to review this concern including reviewing the ampacity derating test methods and the analysis and use of ampacity derating test results for plant design.

Differences Between Tested and As-Built Configurations

The licensee must qualify the fire resistance ratings of all fire barrier designs used to satisfy NRC requirements by subjecting test specimens that represent the as-built installation to a standard fire endurance test (ASTM E-119 or NFPA 251). To ensure that the barriers can provide the level of fire protection required during a fire, the installed barriers should replicate the tested configurations unless they are justified by an engineering analysis. The NRC issued Generic Letter 86-10, "Implementation of Fire Protection Requirements," to provide NRC guidance on the acceptance criteria for qualification fire tests and the technical analyses needed to support deviations between tested and field configurations.

During a telephone call in September 1991, the Office of the Inspector General (OIG) referred a possible health and safety issue to the NRR technical task force for review. The concern was whether the licensee was using the results of a September 1981 SwRI fire endurance test to justify the current installation of Thermo-Lag barriers at CPSES. The report (SwRI Report 03-6491, October 27, 1981) documented the successful 1-hour test of spray-on Thermo-Lag configurations. The SwRI report would not be an acceptable basis on which to satisfy the NRC criteria for the fire protection of the safe shutdown capability at CPSES since spray-on applications are no longer installed at CPSES. In 1989, the licensee removed all of the CPSES Thermo-Lag barriers installed by spray-on application and replaced them with barriers constructed with prefabricated panels and preshaped conduit sections manufactured by TSI. The methods for installing the spray-on and prefabricated panels differ significantly.

During the site visit, the licensee fire protection engineer, Gene Beckett, stated that the licensee was using the 1981 SwRI test as the design basis for using Thermo-Lag. The licensee provided to the task force a list of 16 other fire endurance test reports that it had received from the vendor as backup information. However, during the site visit, the licensee could neither identify the specific fire tests used for the design basis nor provide any evaluations performed to verify that the Thermo-Lag fire barrier configurations installed at CPSES either replicate the tested configurations or provide an equivalent level of protection.

After the site visit, the licensee provided a copy of Impell Calculation 0210-063-0046, "Review of TSI Protective Envelope Fire Test," November 13, 1987. Impell developed this calculation for evaluating the SwRI Project 03-6491 and ITL 82-11-80 test reports. This analysis included verifying that (1) the test assembly and materials represented the as-built installation, (2) the test was conducted in accordance with ASTM E-119, and (3) proper test methods were followed. Impell found that the material configuration described in SwRI Project 03-6491 did not represent the materials installed at CPSES and therefore could make no conclusion as to the fire resistance of the material installed at CPSES. Impell found that the Thermo-Lag system in this report contained fiberglass armoring (Thermo-Lag 330-71), which is not installed at the plant. Impell also found that the thermocouples were placed within the cable bundle instead of on the interior surface. However, ITL test report 82-11-80 was found by Impell to be acceptable as evidence of a 1-hour rated fire barrier envelope system at CPSES.

The licensee's specification 2323-MS-38H, Revision 2, "Cable Raceway Fire Barrier Materials," June 23, 1988, states that fire tests shall be performed and documented by a "recognized" testing laboratory to establish the fire resistance rating of the cable raceway fire barrier system. This specification also requires

that the vendor supply documented tests of product performance referencing the materials used, the type of installation and the method of application as a basis for meeting the specified requirements.

The task force has identified fire endurance qualification testing as a generic concern, including applying fire test results to justify field installations and evaluating deviations between tested and field configurations. The task force obtained information during the site visit that substantiated this concern. The task force will track this issue.

Fire Barrier System Materials

The task force reviewed the licensee's material procurement and receipt inspection process for Thermo-Lag. While CPSES was being constructed, the licensee purchased the Thermo-Lag fire barrier materials from TSI as safety-related materials. However, recent licensee purchase orders stated that the material is "non-safety related augmented quality." The licensee stated during the site visit that it did not consider fire protection equipment as safety-related, but specified some quality assurance requirements on the vendor. The licensee imposes on the vendor Appendix B to Part 50 of Title 10 of the Code of Federal Regulations (10 CFR Part 50) and 10 CFR Part 21, but specifically informed the task force during the site visit that its QA program did not require the vendor to meet these requirements. The licensee imposes Appendix B to 10 CFR Part 50 on the vendor only because the licensee knows that the vendor has a QA program and does not object to using the program for TU's purchase orders. However, licensee specification 2323-MS-38H, Revision 2 states that 10 CFR Part 21 shall apply to the procurement of materials for cable raceway fire barriers.

The licensee conducts triennial vendor audits. The licensee also stated during the site visit that it conducts source inspections at the vendor's site before the vendor ships orders using detailed verification plans. The licensee's inspection procedure used panel density and moisture content as acceptance criteria. Moisture content is checked by the licensee using a moisture meter if the panel has not cured for at least 30 days. The licensee stated during the site visit that during the construction phase some panels were still wet (uncured) when received from the vendor, but the problem was corrected. The density is calculated by dividing the panel weight by the panel area (length x width). The licensee established maximum and minimum acceptance criteria for the density. The task force has requested technical justification from the vendor for the acceptance criteria. This method of determining the proper curing of the panels using density does not appear valid because of the number of variables involved: thickness, void content, moisture content, and material composition.

Until September 1987, the Thermo-Lag panels used at CPSES were fabricated on site. In July 1989, the licensee found that these panels were not of sufficient thickness. In August 1989, the licensee removed and replaced all the panels fabricated at the site with panels manufactured by TSI. In November 1989, the licensee found problems with the thickness of the prefabricated panels received from TSI. While performing receipt inspections, the licensee found 1 hour panels (1/2 inch nominal thickness) from 3/8 to 1 1/4 inches thick (NCR 89-11142). The licensee took field measurements in response to the NCR and found panels that exceeded the maximum specified thickness of 3/4 inch. The NCR was subsequently closed out, when a TSI letter to Impell of October 26, 1989, was received. The letter stated that "Local variations in thickness are negated by the average effects of the total mass of subliming materials and subliming gas produced as a result of energy exchange between the fire barrier and the flame itself." TSI stated that it scans the entire surface of each panel and measures the thickness at a minimum of 18 preselected locations on each panel. TSI also stated that it understood the areas of the panels at CPSES less than 1/2-inch thick to be less than 2 percent of the total surface area of the panel and that "small statistical variances have no impact on the fire resistive response of the panels." These comments prompted the licensee to close out the NCR and accept the panels as 1-hour rated barriers. NRC Region IV reviewed the TSI correspondence and closed out the issue in a letter to the licensee of July 20, 1990.

The licensee's specifications allow Thermo-Lag panels to exceed a 3/4-inch thickness as long as they do not exceed a density of 5.25 pounds per square foot, which is the maximum density allowed by the seismic design. The licensee's program lists the cable raceway fire barriers as Seismic Category II. The minimum density specification is 3.0 pounds per square foot. Upon reviewing the letter from TSI, the licensee attempted to use an acceptance criteria of less than 1/2 inch in assessing the thickness of panels during receipt inspections. However, the receipt inspectors found impractical the amount of effort needed to verify that less than 2 percent of the surface area of a panel was thinner than 1/2 inch. This difficulty prompted the licensee to establish the density criteria. The licensee relies on the vendor's thickness measurements made before shipment to verify the nominal thickness.

The licensee's installation specification allows surface cracks or pinholes of less than 0.05 inches in width. The specification also states that the voids resulting from the manufacturing process noted during receipt inspections are acceptable. The task force has not established the technical basis for these specifications and may need to request further information from the vendor.

The licensee has purchased Thermo-Lag panels without "V" stiffener ribs. These panels have been observed by the task force at several sites, but are not discussed in the vendor's procedures. The task force could not determine if these panels have been qualified for fire endurance or seismic events. In the meeting on October 17, 1991, the vendor stated that the ribs were needed for support during a seismic event. The licensee stated that these panels were used only for junction boxes and repair procedures. This issue will be followed up by the task force with the vendor.

Deficiencies in the Procedures for Installing Fire Barriers

Comanche Peak was the first nuclear facility to conduct independent fire endurance testing on the Thermo-Lag fire barrier materials. The licensee constructed the test assembly by applying the fire barriers using the spray-on application method. When beginning to install the barriers in 1987, the licensee decided to prefabricate its panels locally and continued this practice until September 1987. However, the licensee found problems with these panels and removed them.

Brown and Root, as the constructor, supervised the installation of the Thermo-Lag fire barriers at CPSES. A TSI field technical representative, Mr. Kenneth McKay, was contracted to provide installation training and technical support during construction. The licensee informed the task force that the TSI representative was on the site throughout most of the Thermo-Lag barrier installation process. He provided the vendor's installation certification training, reviewed field installations, and provided technical assistance, including reviewing and approving fire barrier designs and deviations from procedures.

The task force reviewed the training records for a 2 day training session that the licensee conducted in September 1989 after identifying many installation errors. The training was conducted in groups of up to 60 installers at a time. The licensee also stated that the installers were not skilled insulators, but consisted of roofers, framers, and drywall hangers that spoke very little English. A translator was used for the training sessions. Quality control inspectors received the same training. The list of items covered in the training indicates that it could not have included a significant amount hands-on training.

TU Electric Engineering Construction Construction Department Procedure (ECC) 10.07, "Application of Fire Protection Materials" states that Thermo-Lag should be applied in accordance with the vendor's approved manuals. The task force found that the licensee did not use vendor's manuals for installation. However, the licensee's procedures either incorporated the necessary requirements, or were more conservative.

While performing a walkdown inspection of the plant, the task force observed the following installation details that deviated from TSI Technical Note 20684, "Thermo-Lag 330 Fire Barrier System Installation Procedures Manual - Power Generating Plant Applications;" TSI's August 23, 1991, letter to licensees regarding Information Notice (IN) 91-47; and information provided verbally during NRC's October 17, 1991, meeting with TSI:

- Banding straps are installed within 2 inches of each panel joint. This technique is more conservative than the current TSI manual but is consistent with the special TSI installation manual for aluminum cable trays (TSI Technical Note 20689-AL). The task force's concern is that this strap location may be necessary for all installations, but the TSI procedures do not require them. The licensee could not recall the reason for requiring this installation detail.
- For cable trays greater than 24-inches wide, the licensee's procedure requires installing banding straps around the tray before installing the panels. These bands support the top layer of Thermo-Lag and prevent sagging into the tray.
- The panel joints are all prebuttered with approximately 1/4 to 1/2 inch of Thermo-Lag trowel grade material, although this detail is not listed as an option in the TSI manual. The licensee stated that TSI informed it during training sessions that this was an essential step of the installation process.
- The raceway supports were covered with 1/2 to 3/4 inch of Thermo-Lag trowel grade based on a "9-inch rule," which the licensee derived from a calculation. The vendor manual recommends covering the first 18 inches of each penetration into the fire barrier system, and all structural steel supports. On October 4, 1983, the licensee submitted a position paper to the NRC providing an engineering basis for not protecting cable tray supports. In 1988, the NRC approved this installation.
- The licensee applied topcoat to all Thermo-Lag installations but could not provide qualification test documentation that demonstrated acceptability of this product.
- The licensee's installation procedures specify that all seams, joints, and scored edges shall be filled with Thermo-Lag trowel grade to slightly above the level of the surrounding prefabricated sections to ensure 1/2-inch minimum thickness is maintained after the trowel grade material shrinks approximately 25 percent during curing. Although this appears to be a good practice it is not in the TSI procedures manual and has not been observed during other site visits.

- The licensee's installation specification required that the prefabricated panel "V" stiffener ribs be oriented perpendicular to the cable tray on the top section to prevent sagging, and parallel with the tray on the bottom section to ensure the joints are tight. The task force is not aware of any guidance from the vendor that requires this technique, but will follow up with the vendor. The task force is concerned that this may be necessary for seismic considerations, but has not been communicated to the licensees by the vendor.

Weaknesses in vendor and plant-specific installation procedures and practices are a generic concern and have been identified at each facility visited by the team. Installation problems are, therefore, being addressed by the task force, and were discussed in IN 91-79, issued on December 6, 1991.

Conclusions

The licensee reviewed IN 91-47 and concluded that the Thermo-Lag problems do not apply to Comanche Peak because they prebuttered their joints and the SwRI test failed at the Promat/TSI interface.

Although the licensee has had a long history of problems with Thermo-Lag materials and installation, the licensee has not fully recognized the scope and depth of the Thermo-Lag fire barrier problems at CPSES. The licensee only briefly reviewed IN 91-47 and they did not appear to understand the problems. The site visit confirmed that the generic areas of concern, except for those regarding ampacity, also apply to Comanche Peak.

PERSONS CONTACTED

Facility: Comanche Peak Steam Electric Station
Licensee: Texas Utilities Electric
Docket No.: 50-445
Trip dates: November 4 and 5, 1991
Task force: Loren Plisco and Steven West, NRR

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