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Docket No. 50-397

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 Allegation Program Manager
Division of Reactor Inspection
and Safeguards, NRR

SUBJECT: FACT FINDING VISIT TO WASHINGTON NUCLEAR PROJECT, UNIT 2

While conducting our special review assignment, we visited Washington Nuclear Project, Unit 2 on November 6 and 7, 1991 to obtain 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 noted concerns regarding compliance with Appendix R to 10 CFR Part 50, and weaknesses in the licensee's vendor interface and procurement programs. We recommend that these concerns be referred to Region V for detailed review.

/S/

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

/S/

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

Enclosures:
As stated

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ENCLOSURE 1

SUMMARY OF ISSUES

Facility: Washington Nuclear Project, Unit 2
Licensee: Washington Public Power Supply System
Docket No.: 50-397
Trip dates: November 6 and 7, 1991
Task Force: Loren Plisco, NRR and Steven West, NRR

Issue	Status
1. The licensee is using ampacity derating factors that may not be conservative. (Page 2.)	1. Ampacity derating test methods and the use of ampacity test results for plant design are generic concerns and are being reviewed by the task force.
2. The licensee did not review the vendor's October 26, 1986 Mailgram regarding ampacity derating for applicability to WNP2. This may be a weakness in the licensee's vendor interface program (Generic Letter 83-28, July 8, 1983). (Page 3.)	2. The task force recommends referral to Region V for review.
3. The Thermo-Lag portion of the Interam/Thermo-Lag interface failed a fire test conducted by 3M, but passed a subsequent test conducted by TSI. (Page 3.)	3. See Item 5, below. (NRC follow up action may be required after the generic resolution is determined.)
4. [redacted] the licensee may have used a failed fire test to justify the installation of 1-hour Thermo-Lag barriers on cable trays. (Page 5.)	4. The licensee did not use the test to justify Thermo-Lag installations. [redacted]
5. The licensee may not have adequate technical basis for installing Thermo-Lag fire barriers at WNP2. (Page 5.)	5. The adequacy and validity of fire endurance tests and lack of analyses to substantiate installations are generic concerns and are being reviewed by the task force.

6.	The licensee did not perform tests or analyses to justify the Appendix R fire barrier separating the radwaste building from the turbine buildings. (Page 6.)	6. The task force recommends referral of this issue to Region V for review.
7.	There are weaknesses in the licensee's procurement program. (Page 6.)	7. The task force recommends referral to Region V for review.
8.	Some of the licensee's fire barriers appear to deviate from the construction specification and the vendor's installation recommendations. (Page 7.)	8. Installation deficiencies are a generic concern. Will be tracked by review team. (Information Notice 91-79, which addressed installation problems was issued December 6, 1991.)

ENCLOSURE 2

TRIP REPORT

Facility: Washington Nuclear Project, Unit 2
Licensee: Washington Public Power Supply System
Docket No.: 50-397
Trip dates: November 6 and 7, 1991
Task Force: Loren Plisco, NRR and Steven West, NRR

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 vendor claimed fire ratings of 1 and 3 hours. The licensees use this fire barrier system at more than 100 commercial nuclear power plants to satisfy the U.S. Nuclear regulatory Commission's (NRC's) requirements for protecting safe shutdown capability 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 a Thermo-Lag fire barrier to pass a 3-hour fire endurance test conducted at Southwest Research Institute (SwRI) by Gulf States Utilities (GSU), the licensee for RBS. These reports prompted the NRC's Office of Nuclear Reactor Regulation (NRR) 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 the vendor and intended by the licensees, 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 has visited RBS and Comanche Peak Steam Electric Station to obtain additional information on the use of Thermo-Lag by the nuclear power industry. On November 6 and 7, 1991 Loren Plisco and Steven West visited Washington Nuclear Project, Unit 2 (WNP2).

The task force reviewed purchase orders and receipt inspection reports for Thermo-Lag fire barrier materials, reviewed installation and quality control inspection documents, inspected Thermo-Lag prefabricated panels in the WNP2 warehouse, conducted walkdowns in the reactor building 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 Washington Public Power Supply System (WPPSS), the licensee. Ms. Jeannie Kittler, Principal Fire Protection Engineer, was the licensee's representative for the task force.

The task forces's activities and findings are documented below. The Attachment is a list of the WPPSS employees interviewed by the task force.

AMPACITY DERATING

By 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 obtained from the UL tests (UL Project 86NK23826, File R6802, January 1987), which the vendor claimed to have sent to each of its customers, exceeded those previously reported by the vendor (for example, ITL Reports 82-355-C, 82-355-F, and 82-355-F1).

Before the task force visited the site, the licensee informed the task force that the ampacity derating factors reported in ITL Reports 82-355-C, 82-355-F, and 82-355-F1 were used at WNP2 and that it had no record of having received the Mailgram. The task force sent the Mailgram to the licensee before the site visit to provide background information for discussions of ampacity derating during the visit. During the site visit, the licensee stated that the vendor had informed the licensee that it had sent the Mailgram to the licensee's purchasing organization. Apparently, the Mailgram was never forwarded to the WNP2 architect-engineer, Burns and Rowe, Incorporated. Therefore, the licensee had not determined if the derating factors derived from the UL test applied to the WNP2 design. After receiving the Mailgram from the task force, the licensee performed a minimal review of the UL test results and compared the ampacity derating factors derived from the UL test with those experimentally derived from the ITL 82-355 series tests, which are currently used for WNP2.

The following are some of the factors that affect ampacity: cable temperature rating, cable jacket material, conductor material and size, cable loading, the number of cables in a group, raceway components, fire barrier materials, and the ambient temperature. ITL performed the 82-355 series tests using plant-specific components such as WNP2 cables, raceway components, and fire barrier materials. The licensee informed the task force that the 82-355 series tests were more conservative than the UL test because of the tray configuration, the type of cable conductor used, and other factors. The licensee also stated that the baseline ampacity deratings derived from the 82-355 series tests were close to those reported by National Electrical Manufacturers Association[1] (NEMA), whereas those derived from the UL tests were almost two times greater than the NEMA baseline data. The licensee concluded that (1) the NEMA data validated the 82-355 series tests, (2) the derating factors derived from the 82-355 series tests were valid for WNP2 and (3) the factors derived from UL Project 86NK23826 do not apply to WNP2. The licensee also informed the task force that the WNP2 design does not include sufficient margin to accept additional cable derating without adversely effecting cable performance.

The task force has identified ampacity derating as a generic concern. The task force is continuing to review this concern, including reviewing ampacity derating test methods and analyzing and using ampacity derating test results for plant design. The licensee need not take further action at this time. However, Generic Letter 83-28, "Required Actions Based on Generic Implications

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[1] IPCEA-NEMA Standard Publication entitled "Ampacities - Cables in Open-top Cable Trays," (IPCEA Publication P-54-440, Second Edition; NEMA Publication WC 51-1975)

of Salem ATWS Events," of July 8, 1983 requires that the licensee maintain a program to review the vendor's Mailgram for applicability to WNP2. Lack of documentation to indicate that the licensee had done so indicates a weakness in the licensee's vendor interface program.

QUALIFICATION FIRE TESTING

The licensee provided a copy of its internal response (licensee document OER 82042G) to Information Notice 91-47 to the task force for information. This document stated that the licensee had identified all issues regarding Thermo-Lag qualification tests and field installations in 1987 and had resolved them by May 1988. The licensee concluded that it need not respond further to the information notice. The task force reviewed OER 82042G, made observations during the site visit, and concluded that the licensee's review lacked the depth and breadth needed to identify problems associated with the use of Thermo-Lag at WNP2.

While reviewing fire endurance tests involving Thermo-Lag, the task force reviewed Twin Cities Testing Corporation Report 414186-1119 (3M Fire Test 86-92) of October 1986. On August 19, 1986, the Minnesota Mining and Manufacturing Company (3M) performed this test for the licensee to qualify a method for joining the 3M Interam E-50D series flexible 3-hour fire wrap system with the 3-hour rated Thermo-Lag 330-1 fire barrier system. The Thermo-Lag portion of the test assembly failed the test. Specifically, temperatures inside the conduit sections protected by Thermo-Lag exceeded 325 °F and cables enclosed in the conduit sections protected by Thermo-Lag were damaged by fire. On May 7, 1987, TSI repeated the Interam/Thermo-Lag interface qualification test for the licensee at the TSI facility. The Thermo-Lag appeared to meet the NRC acceptance criteria during this test, which is documented in ITL Report 87-5-76, June 1987.

During the site visit, the licensee informed the task force that TSI advised it that the Thermo-Lag failed the 3M test because the test specimen had not cured for 30 days before the test. The licensee concluded that the 3M test was not valid. The task force confirmed that the Thermo-Lag cured for only 13 days before the 3M test. However, the task force could not determine the cure time for the specimen tested by TSI. The task force reviewed other ITL test reports and observed that the vendor has successfully tested other assemblies that had not cured for 30 days[2]. The task force concluded that the reason the Thermo-Lag failed the 3M test could not be determined. The task force is reviewing the effects of cure time on Thermo-Lag fire performance.

On March 31, 1987, the licensee conducted a 3-hour fire endurance test of steel conduits 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 performed this test at the vendor's facility. The results are documented in ITL Report 87-3-606 of April 1987. During the test, temperatures inside the conduits

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[2] Reference for example, CTL Report 240056 824-63, Revision 1, October 1989.

exceeded 325 °F after 1 hour and 12 minutes. The cause of the failure was not documented in the ITL report. However, the licensee informed the task force that the failure was attributed to voids created in the Thermo-Lag material by the injection process.

The licensee informed the task force that the subcontract installer, Brand Industrial Services (Bisco), developed this application method, "low pressure extrusion," to meet the divisional separation requirements in Regulatory Guide 1.75, "Physical Independence of Electric Systems." Bisco later used the technique to install fire barriers[3]. The licensee stated that the vendor's field engineer may have helped develop the extrusion technique. Moreover, the vendor's field engineer observed, but never questioned the use of this technique to install fire barriers. Bechtel Construction, Incorporated, the WNP2 constructor, helped to install and test these barriers.

On April 1, 1987, the licensee performed a 1-hour fire endurance test on conduits protected by a 1/2-inch layer of Thermo-Lag installed using the low pressure extrusion process. This test, which is documented in ITL Report 87-4-3, April 1987, appear to have passed NRC acceptance criteria. However, the fire endurance tests conducted by the vendor may not be valid if the test facility and equipment and the qualifications of ITL are not adequate. The task force is reviewing these concerns.

Following the site visit, the task force received copies of reports from the licensee that document two original 3-hour fire endurance tests of Thermo-Lag fire barriers installed by the low pressure extrusion process. The first test, which was conducted at TSI on August 1, 1986, is documented in ITL Report 86-7-472. The second test was conducted on December 4, 1986, at the Weyerhaeuser Fire Technology Laboratory. Both tests failed on temperature rise. The Weyerhaeuser test may also have included a conduit protected with prefabricated Thermo-Lag panels. This test assembly also appeared to have failed the test. However, the test report lacks the clarity needed for making a final conclusion about this assembly.

[redacted]censee may have used the results of a fire endurance test conducted at SwRI by Pennsylvania Power & Light (PP&L) to justify the installation of Thermo-Lag barriers on cable trays at WNP2. The report (SwRI Report 01-7163, August 1982), which PP&L traded to WPPSS for a report owned by WPPSS, documented the failure of the Thermo-Lag configurations to provide a 1-hour fire resistance rating for cable tray barriers. The report, therefore, was not an acceptable basis for installing such barrier designs to comply with NRC requirements for protecting the safe shutdown capability from fire. During the site visit, the licensee confirmed that SwRI Report 01-7163 was not used as the technical basis for installing Thermo-Lag

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[3] Following the WNP2 site visit, the task force visited Perry Nuclear Power Plant and learned that the low pressure extrusion technique was used by Bisco to install 1-hour Thermo-Lag fire barriers at Perry.

barriers at WNP2. [redacted] This issue is closed.

DIFFERENCES BETWEEN TESTED AND AS-BUILT CONFIGURATIONS

Licensees must substantiate the fire resistance ratings of all fire barrier designs used to satisfy NRC requirements for the fire protection of safe shutdown capability by subjecting test specimens representative of the construction for which classification is desired to a standard fire endurance test[4]. To ensure that the 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 analysis, that barriers that deviate from the tested configurations provide an equivalent level of protection. Generic Letter 86-10, "Implementation of Fire Protection Requirements," dated April 24, 1986, provided NRC guidance on the acceptance criteria for qualification fire tests and the technical analyses to support deviations between tested and field configurations.

Before the site visit, the licensee provided the task force with copies of seven fire endurance test reports held by WPPSS. Following the site visit, the licensee provided three more test reports. The licensee apparently conducted several of the fire tests, for example, those documented in ITL Reports 87-5-76, 83-5-472, 87-4-3, and 87-3-606, to establish the technical bases for installing Thermo-Lag fire barriers at WNP2. However, during the site visit, the licensee could not provide its specific design bases. The licensee could neither identify the specific fire tests used to establish the technical basis nor provide the evaluations performed to verify that the Thermo-Lag fire barriers installed at WNP2 either replicate the tested configurations or provide an equivalent level of protection.

Qualification fire testing is a generic concern and includes the use of fire test results to justify field installations, and the evaluation of deviations between tested and field configurations. Information obtained and observations made by the task force during the subject site visit substantiated this concern. Although there is no regulatory requirement that the licensee take specific action, the licensee stated that it would review its fire barrier design basis and advise the task force of its findings.

During the plant tour, the task force observed one Appendix R fire barrier that the licensee indicated was not substantiated by either fire test or engineering analysis. This barrier, the wall separating the radwaste building from the turbine building at elevation 471, which the licensee stated needs a 3-hour fire rating to meet Appendix R commitments, is constructed of concrete blocks and is coated on one side with a layer of Thermo-Lag material that was applied by spray. The task force is not aware of any ASTM E-119 fire endurance test on this wall configuration and recommends that this issue be referred to Region V for detailed review.

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[4] American Society of Testing and Materials (ASTM) Standard E-119, "Standard Methods of Fire Tests of Building Construction and Materials."

FIRE BARRIER SYSTEM MATERIALS

The licensee does not have a purchase specification for Thermo-Lag, which is purchased as a commercial grade material. The licensee does not impose Title 10 of the Code of Federal Regulations (10 CFR) Appendix B or 10 CFR Part 21 requirements on the vendor and, therefore, does not conduct either quality assurance (QA) audits or source inspections at the vendor's site.

The licensee's quality control (QC) inspectors inspect Thermo-Lag materials received at WNP2 and document their findings on a standard (generic) receipt inspection report form in accordance with a generic inspection procedure (QAI 10-3, Revision 8, "Program and Audits Quality Assurance Instruction - Receiving Inspection," October 17, 1991). This procedure does not apply specifically to Thermo-Lag. The task force reviewed Purchase Orders 218915, 096492, 85732, and 071963 and their associated documentation, including receipt inspection reports. The task force found that the licensee does not have any procedures or guidance concerning specific inspection attributes important to Thermo-Lag, such as shelf life requirements, temperature limitations, and thickness tolerances. The licensee informed the task force that it includes in the receipt inspection only special requirements explicitly stated in the purchase order. However, although the purchase orders for trowel-grade material listed shelf life requirements, shelf life was not included as an inspection attribute in the receipt inspection report. The licensee could not explain this discrepancy.

The task force reviewed Procurement Requirements Evaluation 615 of July 9, 1991, and found it inconsistent with its associated purchase order (P.O. 218915, July 9, 1991). For example, the purchase order included a provision covering shelf life requirements. However, the evaluation indicated that there were no shelf life requirements for the material. The licensee could not explain this discrepancy.

These observations indicate weaknesses in the licensee's procurement process. The task force recommends that this issue be referred to Region V for resolution.

FIRE BARRIER INSTALLATION

Bechtel participated in installing the Thermo-Lag fire barriers at WNP2. Bisco was Bechtel's subcontractor for the installation and quality control of the installations. Burns and Roe, Incorporated, Specification 2808-215, Section 15S, "Fire Insulation Barrier for Electrical Cable Trays, Conduit, Junction Box Assemblies, Structural Steel Members, and Instrumentation Tubing and Devices - Technical Provisions," set forth the construction requirements for fire barriers. The vendor also provided a field engineer. Specification 2808-215, Paragraph 1.3, identified the scope of the field engineer's responsibilities. The licensee informed the task force that this individual [redacted] was on site throughout most of the time that the Thermo-Lag barriers were being constructed, provided the vendor's certification training, reviewed field installations, and provided technical assistance, including reviewing and approving fire barrier designs and deviations from procedures.

Bechtel continues to participate in work control at WNP2 and, therefore, continues to help install and maintain the Thermo-Lag barriers. The licensee's employees provide installation and quality control.

The construction specification, 2808-215, appeared to meet the intent of the vendor's installation procedures and contained detailed installation drawings and requirements. After construction was complete, the licensee replaced the construction specification with WNP2 Plant Procedure 10.25.89, "One Hour - Three Hour Fire Barrier Installation." The licensee issued the current version, Revision 8, on October 21, 1991. The task force reviewed this specification and concluded that it is inadequate to ensure proper installation and QC inspection of Thermo-Lag fire barriers. For example, it does not include all of the sequential steps involved in applying the Thermo-Lag system and provides less detail than is provided in the vendor's installation procedures documents.

The licensee informed the task force that most field installations are constructed of prefabricated panels and preshaped conduit sections. However, some of the original spray on applications remain. The licensee butters joints for prefabricated panels and preshaped conduits sections before assembling individual panel sections. The task force could not identify the specific installation techniques employed for some of the field installations reviewed. However, it appeared that the licensee does not use edge guards and uses tie wires instead of banding straps.

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

- Three-hour fire rated (1-inch thick) preshaped conduit sections assembled around conduits with separations at least 1-inch wide along the edges on both sides of the conduit. The gaps appeared to be filled with trowel grade Thermo-Lag material. Stress skin was not placed across the separations.

- Cable trays protected by two layers of 1-hour (1/2-inch thick) fire-rated prefabricated panels with the stress skin of both layers installed toward the tray. The licensee stated that this design is intended to provide a 3-hour fire resistance rating. This configuration was permitted by the construction specification (Paragraph 4.1.5). However, it is a deviation from the vendor's installation procedures and may not have been qualified by fire test.

- Stress skin, or what the licensee referred to as "hardware cloth," wrapped around and fastened to completed barriers with tie wires. The stress skin or hardware cloth was not affixed to the barrier with trowel-grade Thermo-Lag material. The use of the hardware cloth appeared to be a deviation from Paragraph 3.4, "Materials," of Construction Specification 2808-215, Section 15S, which prohibited the use of

alternates or substitutions for stress skin. The use of hardware cloth has not been qualified by testing and it does not appear to be acceptable as a substitute for stress skin by the vendor.

During the October 17, 1991, meeting with the vendor, the vendor stated that the structural ribs formed into the prefabricated panels are required for seismic stability. The vendor did not inform the task force that prefabricated panels are available without ribs. However, during the site visit, the task force observed prefabricated panels received by the licensee from the vendor without ribs formed into the panels. The licensee informed the task force that these panels are used to make repairs and to install barriers around junction boxes and similar components where a flush fit between the Thermo-Lag panel and the component eases installation. However, the licensee's installation specification does not state the time or method for using panels without structural ribs. The task force is concerned that fire barriers constructed of panels without structural ribs or barriers applied by direct spray over stress skin without ribs may not be able to withstand a seismic event. The task force will obtain additional information on this issue from the vendor.

The task force found that weaknesses in the installation procedures and practices of the vendor and the licensee are a generic concern. Thus, the task force is addressing the installation problems generically. The staff addressed these problems in Information Notice 91-79, "Deficiencies in the Procedures for Installing Thermo-Lag Fire Barrier Materials," of December 6, 1991.

CONCLUSIONS

During this site visit, the task force obtained additional information to indicate that the following issues should be treated as generic concerns:

- Ampacity derating test methods and the use of ampacity test results for plant design.
- The adequacy and validity of fire endurance tests.
- Lack of analyses by licensees to substantiate that fire barrier installations either replicate the tested configurations or provide an equivalent level of protection.
- Installation problems ranging from the adequacy of installation specifications and procedures, to adherence to installation procedures, to the adequacy of QC inspections.

ATTACHMENT

PERSONS CONTACTED

Facility: Washington Nuclear Project, Unit 2
Licensee: Washington Public Power Supply System
Docket No.: 50-397
Trip dates: November 6 and 7, 1991
Task Force: Loren Plisco, NRR and Steven West, NRR

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