PREDECISIONAL INFORMATION

June 8, 1992

Docket No. 50-445
and 50-446

MEMORANDUM FOR: Conrad E. McCracken, Chief
Plant Systems Branch

THROUGH: Ralph Architzel, Section Chief

FROM: Malcolm Widmann, SPLB
K. Steven West, DRIS

SUBJECT: TRIP TO OMEGA POINT LABORATORIES, SAN ANTONIO, TEXAS, REGARDING THERMO-LAG FIRE BARRIER TEST PROGRAM, COMANCHE PEAK UNIT 2

As a result of an invitation by Texas Utilities (TU) Electric Company by letter dated May 1, 1992, Malcolm Widmann and Steven West visited Omega Point Laboratories Incorporated (OPL), San Antonio, Texas, on May 6 through May 8, 1992. The purpose of the visit was to observe the construction of Thermo-Lag fire barrier test specimens to be tested by TU Electric against 1-hour fire endurance criteria. Our trip report is enclosed.

During our visit we identified concerns to Mr. Calvin Banning, TU Electric's Project Manager for the fire test program, and Mr. Deggary Priest, President of Omega Point Laboratories (OPL), regarding the construction of the fire test specimens. Comparisons were also made to previous Thermo-Lag fire endurance tests. A staff Special Review Team for the Evaluation of Thermo-Lag Fire Barrier Performance identified deficiencies in these previous tests.

PREDECISIONAL INFORMATION

The Plant Systems Branch will monitor the manner that TU Electric addresses the concerns identified in the construction of the test specimens and in the documentation of the final report. In addition Plant Systems Branch will witness some or all of the fire tests, which are tentatively scheduled for June 17 through June 26, 1992.

Original signed by
Malcolm Widmann, Reactor Systems Engineer
Plant Systems Branch, NRR

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

Enclosure:
As stated

cc w/enclosures:
R. Architzel
P. Madden
K. Walker
E. Pawlik

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[G:TRPOMEGA.MTW]

Enclosure

TRIP REPORT

Facility: Comanche Peak Steam Electric Station Units 1 and 2
Licensee: Texas Utilities Electric Company
Docket Nos.: 50-445 and 50-446
Trip Dates: May 6 through May 8, 1992
Review Team: K. Steven West, NRR, and Malcolm Widmann, NRR

Background

As a result of concerns identified by a staff review team with Thermo-Lag fire barriers during meetings at NRC offices in Rockville, Maryland, on February 12, 1992, Texas Utilities Electric Company (TU Electric, the licensee) has initiated a confirmatory test program to assess the overall adequacy of the Thermo-Lag fire barrier program at Comanche Peak Steam Electric Station (CPSES). TU Electric has contracted with Omega Point Laboratories (OPL) San Antonio, Texas, to conduct the test program, perform quality assurance check point inspections, and write the final test report. CPSES stock Thermo-Lag fire barrier materials will be utilized in the fabrication of the fire test specimens. Site craft personnel (contractors) will install the Thermo-Lag materials in accordance with CPSES installation procedures. The specimens will be inspected by CPSES QC inspectors. As a result of the concerns identified in the February 12, 1992 meeting, TU Electric has conducted a review of their installation and inspection controls as implemented by the Thermo-Lag specifications and applicable procedures, and concluded that the program implemented at CPSES is satisfactory.

According to Mr. Calvin Banning, TU Electric Project manager, Thermal Science, Incorporated (TSI), has a limited role in the TU Electric fire test program. Ben Evans, Quality Control Manager for TSI, will witness installation of the Thermo-Lag to the fire test assembly raceways. TSI's involvement is limited to QC inspections of Thermo-Lag installation of specific hold points. TSI has no authority or input over test assembly configurations, thermocouple placement, banding, materials installed, or procedures to be utilized by CPSES craft personnel to install fire barrier material.

Review Items

Attachment 1 is a comprehensive list of documents submitted by TU Electric on May 4, 1992. Prior to meeting with TU Electric and OPL personnel, we conducted a preliminary review of these documents which included TU Electric engineering evaluations, proposed fire test design details and fabrication drawings, and an OPL proposal to conduct the overall fire test program. Additional reports, procedures and work packages reviewed us while at OPL's facility are listed in Attachment 2. A list of personnel that we interfaced with at the OPL facility is in Attachment 3.

Mr. Calvin Banning, TU Electric Project Manager, and Mr. Deggary Priest, President of OPL, were given a copy of the final report, "Special Review Team For The Review of Thermo-Lag Fire Barrier Performance", dated April 1992, during the laboratory visit on May 6, 1992. Mr. Banning and Mr Priest were informed that the report identified technical concerns with a number of previously performed fire endurance tests. As indicated in the final report, NRC staff regarded some of the previous tests indeterminate. It appeared that TU Electric's fire test program may include some of the concerns previously identified by the special review team.

Observations and Identified Concerns

TU Electric is constructing the fire test assemblies in various configurations to try to reflect a spectrum of plant installations. Five test assemblies are being constructed at the OPL facility. A 30 inch wide U-shaped cable tray with a "tee" section, a 36 inch wide U-shaped cable tray with a "tee" section, a 36 inch wide straight vertical-run cable tray with a Thermo-Lag built-up fire stop, a 12 inch wide U-shaped cable tray and a multi-conduit and junction box assembly, as well as, several back up test specimens. During the site visit to OPL, we questioned a few of the design details in the fire test specimens. On May 8, 1992, Mr. Banning indicated that one of the back up fire test specimens would be altered from a 36 inch wide cable tray to a 30 inch wide cable tray. TU Electric intends to test the 36 inch wide tray first to try to qualify all the cable tray configurations at CPSES, but in the event the 36 inch wide cable tray specimen fails, the 30 inch wide tray would be tested. According to Mr. Banning, TU Electric has installed 30 and 36 inch wide cable trays in Unit 1, but nothing wider than 30 inch cable trays in Unit 2; therefore, conducting a test on the second test specimen would be applicable to the typical configurations installed in Unit 2 and most cable tray installations in Unit 1.

One of the items that TU Electric is trying to accomplish by conducting the fire tests is the validity of the 9-inch rule for penetrations in Thermo-Lag fire barrier systems. Most utilities use 18 inches as the minimum penetration length to be protected in a fire barrier system. For CPSES the 9-inch rule establishes a minimum length that needs to be protected to prevent heat transfer into the fire barrier that could result in damage to protected components within the barrier. CPSES's installation procedure specifies that all penetrations in a fire barrier system be protected to the same level of fire resistance on the raceway for a distance of 9 inches, minimum, as measured from the outer surface of the fire barrier, covering all continuous paths. In testing of the 9-inch rule TU Electric is installing a unistrut stub on the 36 inch wide cable tray and two 3 inch by 3 inch tube steel stubs on the multi-conduit assembly. The tube steel stubs on the conduit assembly are 12 inches long. When the Thermo-Lag is installed on the stubs to verify the 9-inch rule only 3 inches will be exposed to the test fire. Mr. Banning was informed that the special review team concluded that a similar fire test

(ITL Report 84-12-181) was not suitable for determining the protection required for a penetrating member. This finding is documented in the review team's final report.

Another concern we identified was in regards to the installation of double layers of Thermo-Lag on the structural steel supports on the test specimens. TU Electric intended to install the double layers on the steel to prevent the supports from contributing to failure of the specimens during the fire tests. However, installation of double layers of Thermo-Lag on the structural supports does not reflect actual plant conditions at CPSES. Mr. Banning was informed that the use of fire tests of specimens that were atypical of installed configurations to justify the installation of the barriers was identified as a concern in the special review team's final report.

During the trip we expressed a concerned that the placement some of the thermocouples on the fire test assemblies are not in accordance with NRC guidance provided in Generic Letter 86-10. Mr. Banning was informed that thermocouple placement was identified as a concern in the special review team's final report.

We observed that there were several clients constructing test specimens in the OPL laboratory facility and that there did not appear to be any measures in place to prevent commingling of the various projects. We considered that good laboratory practice is to segregate similar projects to ensure the integrity of the test programs. Mr. Banning and Mr. Priest informed us that reasonable efforts would be taken to segregate the projects. For example, Mr. Priest informed us that either the OPL Shop Foreman or Assistant Shop Foreman, who were familiar with and involved with all ongoing projects, would be in the shop whenever a client was present in the shop. In addition, Mr. Priest allotted a designated area to each client.

Attachment 1

Documents Reviewed Prior To Arrival At Omega Point Laboratories

1. TU Electric Design Engineering Organization Scope B Engineering Report, "Evaluation of Thermo-Lag Fire Barrier Systems," ER-ME-067, Revision 0, Preliminary, March 30, 1992. Marked "For Information Only."

2. Proposal No. P920423-01, "One Hour Fire Endurance Tests Of Articles Protected With The Thermo-Lag 330 Fire Barrier System," April 23, 1992, Omega Point Laboratories. Marked "For Information Only" and "Comment Copy". Marked up with TU Electric's comments (pen and ink).

3. "Comanche Peak Steam Electric Station Unit 2 - Scope B Thermo-Lag Confirmatory Testing," schedule, April 18, 1992.

4. Interoffice Memorandum, From: MKQuick, TU, To: WMcPhail, TU, "Thermo-Lag Fire Test Details," April 13, 1992.

5. "Comanche Peak Steam Electric Station Construction/Quality Procedure," CQP-CV-107, "Application Of Fire Barrier and Fireproofing Materials," December 19, 1991.

6. Texas Utilities Electric Comanche Peak Steam Electric Station Unit 2 Specification, "Procurement and Installation of Fire Barrier and Fireproofing Materials," CPES-M-2032, Revision 0, February 28, 1991.

Documents Reviewed At Omega Point Laboratories

1. Comanche Peak Steam Electric Station Construction/Quality Procedure Unit 2, CQP-EL-222, "Installation and Fabrication of Conduit Raceway Systems," December 6, 1990.

2. Comanche Peak Steam Electric Station Construction/Quality Procedure Unit 2, CQP-EL-225, "Cable Tray and Supports," Effective Date: August 13, 1991.

3. Texas Utilities Electric Comanche Peak Steam Electric Station Unit 2 Specification, "Electrical Installations," Stone and Webster Engineering Corporation, CPES-E-2004, Revision 1, July 1, 1990.

4. Draft Test Procedure, "One Hour Fire Endurance Tests Of Articles Protected With The Thermo-Lag 330 Fire Barrier System," Proposal No. P920423-01, Revision 1, May 2, 1992, Omega Point Laboratories.

5. Comanche Peak Steam Electric Station Construction/Quality Procedure Unit 2, CQP-CV-107, "Application of Fire Barrier and Fireproofing Material," April 9, 1992.

6. Comanche Peak Steam Electric Station Construction/Quality Procedure Unit 2, CQP-MS-125, "Penetration Seals and Maintenance of Separation Gaps," December 12, 1991.

7. Texas Utilities Electric Comanche Peak Steam Electric Station Unit 2 Specification, "Procurement and Installation of Fire Barrier and Fireproofing Materials," CPES-M-1061, Revision 0.

8. Work packages reviewed:
   - Raceway Installation Card
   - Tray Installation Checklist
   - Sketches of Test Assembly

Contacts:

Deggary Priest, President, Omega Point Laboratories (OPL)
Constance Humphry, Quality Assurance Manager and Vice President, OPL
Kerry Hitchkock, Shop Foreman, OPL
Cal Banning, TU Electric Project Manager, ABB Impell
Melvin Quick, TU Test Assembly Mechanical Coordinator, Stone & Webster
Chester Pruett, Quality Assurance Manager, TU Electric
Michael Jordan, Quality Control (QC) Inspector, Peak Seals
Ralph Bridwell, QC Inspector, Peak Seals
Leo Werner, General Foreman, Peak Seals
Les Black, Project Manager, Peak Seals
Ben Evans, Quality Control Manager, Thermal Science, Inc.

9 AUXILIARY SYSTEMS

9.1 Fuel Storage and Handling System

9.1.1 New Fuel Storage

In SSER 22, the staff described administrative controls to which the applicant committed in order to control the spacing between new fuel assemblies in the spent fuel storage racks. On the basis of the "expanded checkerboard" array committed to by the applicant, the effective multiplication factor (K_{eff}) of an array of assemblies in the spent fuel pool is less than that in the new fuel storage racks under all credible accident conditions.

In a letter of October 23, 1989 (TU Electric letter TXX-89760 to NRC), the applicant agreed to impose administrative controls to ensure that within the fuel handling building, no more than two fuel assemblies shall be outside of an approved shipping container, fuel inspection station, storage rack, or the fuel transfer tube at any one time and a minimum 12-inch edge-to-edge distance shall be maintained between such assemblies. In a letter of January 3, 1990 (TU Electric letter TXX-89867 to NRC), the applicant stated that it would revise the FSAR in a future amendment to document its commitment. This was done in FSAR Amendment 78.

In a letter of December 18, 1992 (TU Electric letter TXX-92618 to NRC), the applicant requested an exemption from the monitoring requirements of Title 10 of the Code of Federal Regulations (CFR) Section 70.24 as provided for in 10 CFR 70.24(d). [This exemption request is identical to a Unit 1 request (letter of June 30, 1989, TXX-89438), which was addressed in SSER 22.] The basis for the exemption request is that storage facilities and procedures offer assurance that criticality cannot occur during receipt, inspection, or storage of new fuel. The reasons for the exemption are valid, and good cause exists for the exemption. The shipping containers and storage racks provide physical protection to ensure subcriticality. The procedural controls provide reasonable assurance that nuclear criticality will not occur during fuel handling, and monitoring is not needed. Even if the procedural controls were violated, optimum conditions of neutron moderation, physical spacing, and neutron reflection would be required for assemblies to be in a critical situation. The procedural controls, considering the limited activities and material handling methods, are deemed adequate to grant the exemption. This exemption is authorized by law, will not endanger life, property, or the common defense and security, and is otherwise in the public interest. The Commission has determined that the granting of this exemption will not significantly alter the environment. The environmental assessment and finding of no significant impact was published in the Federal Register on January 19, 1993 (58 FR 5035).

9.2 Water Systems

9.2.5 Ultimate Heat Sink

In the SER, the staff discussed the findings of the applicant's safe shutdown impoundment (SSI) thermal analysis presented in the FSAR. In this analysis, the applicant used onsite data selected from 30 years of airport meteorological data to determine maximum temperature and evaporation loss from the SSI under accident conditions. The original analysis included the use of 39 years of data from the Dallas-Fort Worth Airport and the selection of separate periods for maximum temperature and maximum evaporation. These reanalyses are discussed in more detail in Section 2.4.5 of this SSER.

The NRC staff still concludes that the SSI meets the guidelines of RG 1.27 and the requirements of GDC 44.

9.5 Other Auxiliary Systems

9.5.1 Fire Protection

Supplement 21 to the SER (SSER 21) which was issued in April of 1989 contained a review of the Comanche Peak fire protection program as documented in the FSAR through Amendment 71 and as described in Revision 1 to the Fire Protection Report.

This supplement documents a review of fire protection related changes and modifications made to the FSAR through Amendment 87 and through Revision 6 to the Fire Protection Report. Changes in these documents are primarily related to the inclusion of issues related to Unit 2. Although Units 1 and 2 are similar in design, the previously reviewed documents generally addressed only Unit 1. The purpose of this review is to ensure that the fire protection program for Unit 2 is in accordance with the guidance provided in Appendix A to Branch Technical Position (BTP) APCSB 9.5-1 as well as with Sections G, J, and O of Appendix R to 10 CFR 50. This review included a site visit on September 16-17, 1992.

9.5.1.1.b Fire Hazards Analysis

Revision 6 to the Fire Protection Report contained a number of additions to address Unit 2 fire areas. Revision 6 also identified a number of new deviations from the guidelines of Appendix A to BTP APCSB 9.5-1 and Appendix R to 10 CFR 50. The new deviations are as follows:

1b (2)	Unit 2 Chiller Units and Pumps
3a (2)	Room x-195/x-207, Removable Concrete Block
3a-1 (2)	Room 2-077A/2-088, Removable Concrete Block
3b (2)	Unit 2 Containment Penetration Seals
3d (2)	Unit 2 Water Tight Doors
3e (2)	Unit 2 Containment Air-Locks
3g (2)	Unit 2 Containment Mechanical Penetration Seals

3ha (2) Unit 2 Cable Spreading Room BR-PR Door (Door F-24)
3hb (2) Unit 2 Cable Spreading Room BR-PR (Door E23)
4a (2) Unit 2 Pressurizer Relief Valves
4a-1 (2) Unit 2 Containment Building RHR Valves
8c (2) Unit 2 Main Steam Isolation Valves

All of these deviations, with the exception of 1b (2), Unit 2 Chiller Units and Pumps, are equivalent to deviations previously reviewed and approved for Unit 1. These deviations were reviewed to ensure that the plant configuration and associated fire protection features were indeed equivalent to Unit 1. Based on this review, the above deviations were found to be acceptable and are therefore approved.

Deviation 1b (2), Unit 2 Essential Chiller Units is a deviation from Section III.g.2.b of 10 CFR 50 Appendix R for lack of separation between redundant components. Although, the physical configuration for the safety chiller room is the same for Units 1 and 2, the applicant is installing water curtains over each of the two partial walls. The applicant has protected the vital cables in Unit 2 as in Unit 1, however, the intervening cable trays containing non-vital cable are not enclosed in a 1-hour fire barrier material in Unit 2 as they are in Unit 1. The Unit 2 essential safety chiller room was walked down during the site visit. During this walkdown the partial height 1-hour fire barrier walls separating the Unit 2 essential chillers and pumps were verified to extend above and along the entire length of the chiller units and pumps. The applicant as part of their fire protection enhancements has also installed curbs from where the chiller pump partial wall terminates to the wall of the room. These curbs are installed to preclude a combustible liquid spill fire from impacting both chiller pumps. In addition, additional smoke detectors have been installed in this area to enhance their ability to rapidly detect a fire condition. In the overhead of this room, cable trays transverse the area. These trays are considered to be an intervening combustible hazard to redundant chillers and their associated pumps. In order to preclude fire propagation along these trays, caused by an electrically originated fire, the applicant has installed fire stops in the trays at the vertical extension plane of the partial height fire barrier walls which separate the chillers and the pumps. These fire stops will preclude fire extension along the tray so that a tray fire presents an exposure to only one chiller or pump. The chiller and pump area is protected by area wide sprinklers installed at the ceiling level. The applicant has installed a water curtain at the vertical extension plane of the partial height fire barrier walls. These water curtains consist of closely spaced fast response sprinklers designed to apply a discharge rate of 3 GPM/linear foot of curtain length.

The ceiling of the chiller room has deep beams running across the width of the room along the C-A and D-A column lines. These beams have created a beam pocket over the chiller pumps and two beam pockets over the chiller units. The significance of these beam pockets is that they will aid in the collection of heat at the ceiling area directly over the fire and will improve the response of the ceiling level area sprinklers and the water curtain fast response sprinklers.

For example, if a fire were to involve a chiller pump, a fire plume would develop and heat would spread across the ceiling and be collected within the beam pocket directly over the pumps. The fire barrier wall between the pumps would preclude direct fire exposure and propagation to the redundant chiller pump until the water curtain fast response and ceiling level area sprinklers could react to the fire condition. Based on the fast response sprinklers used for the water curtain, it is anticipated that they will respond to the fire condition prior to the actuation of the ceiling level sprinklers. The partial height fire barrier walls which separate the essential chillers and the chiller pumps in combination with the water curtain and the ceiling level sprinklers provide reasonable assurance that a fire, if one were to occur, would be mitigated and fire damage would be limited to one train of essential chillers. Based on the information provided in Revision 6 of the Fire Protection Report and the physical review of the Unit 2 essential chiller room, the staff determined that the lack of full height fire barriers to separate the Unit 2 essential chillers and pumps will not adversely affect the plant's ability to achieve post-fire safe shutdown and therefore, the applicant's deviation request can be granted. Based on information provided in Revision 6 of the Fire Protection Report and a physical review of the room in question, it is determined that the lack of complete separation of the safety chillers in Unit 2 does not adversely affect plant safety and a deviation can be granted.

Deviation 1a which deals with separation of redundant safety water pumps and associated components in the intake structure, was modified in Revision 6 to account for Unit 2 components. During the plant visit, the intake structure was walked down to verify that configurations did not differ from Unit 1 and that adequate fire protection features were present. Based on the review of information provided in Deviation 1a which was provided in Revision 6 to the Fire Protection Report and on the walkdown of the Safety Water Intake Structure, this deviation is found to be acceptable.

9.5.1.2 Administrative Controls

System Operability and Surveillance Requirements

The proposed operability and surveillance requirements for Unit 2 Fire Protection Features are equivalent to those provided for Unit 1 and consistent to NRC guidance provided in Generic Letters 86-10 and 88-12 with the exception of operability requirements for water curtains in the Unit 2 essential chiller room. The operability and surveillance requirements for the water curtain were reviewed as part of the deviation evaluation, discussed in this SER and were found acceptable.

9.5.1.3 Fire Brigade

The Fire Brigade for Unit 2 will be composed of the same brigade members that currently respond for Unit 1. The fire brigade staffing and training program was previously reviewed and found acceptable. However, the applicant has made one change in the brigade make-up from that which was originally reviewed. Three members of the brigade will continue to be from plant operations, however,

the additional two members which were drawn from the plant security staff are now contract emergency response personnel. These personnel receive the same level of training as originally identified by the applicant and therefore the brigade make-up continues to be consistent with staff guidance.

9.5.1.5 General Plant Guidelines

Penetration Seals

The penetration seal program was reviewed during the site visit. The applicant has used the same contractor seal specification for Unit 2 as Unit 1, however, a different installation contractor was selected. The reviewer discussed with the applicant the impact that this would have on ensuring the penetration seal designs for Unit 2 were adequately qualified. During this discussion, the applicant presented the design detail drawings which cross referenced each of the details used in Unit 2 with vendor test reports. The applicant stated that each test report was assigned to a detail based on a review by the applicant. In addition, the applicant stated that any configurations within the plant which did not directly correspond to a design detail are reviewed by an engineer for disposition. The applicant stated that a report of any analyses of non-conformances, would be available for NRC review upon completion of the penetration seal installation program.

The applicant also included in Revision 6 to the Fire Protection Report, additional criteria for sealing inside of conduits. This criteria, which limits the sealing requirements for conduits based on size and percentage of fill, is based on criteria established in the "Conduit Fire Protection Research Program". This report, which documents the finding of fire tests on various conduit assemblies, was submitted to the NRC as a Topical Report by Wisconsin Electric Power Company. The report was reviewed by the staff and was subsequently accepted. Based on acceptance of this Topical Report, the use of the contained sealing criteria at Comanche Peak is considered acceptable.

Thermo-Lag

The applicant installed 1 hour fire rated Thermo-Lag barriers to separate one train of redundant safe shutdown components when both trains of a system required for hot standby are located in the same fire area and are not separated by more than 20 feet.

During a meeting with the Nuclear Management and Resources Council (NUMARC) on February 12, 1992, the Office of Nuclear Reactor Regulation (NRR) Special Review Team for the Review of Thermo-Lag Fire Barrier Performance expressed concerns regarding the Thermo-Lag 330-1 fire barrier system. In response to the concerns, the applicant conducted an assessment of test results and documentation, ampacity derating design basis, and installation and inspection specifications and procedures applicable to Thermo-Lag fire barrier configurations at CPSES. In letters of May 1, 1992 (TU Electric letter TXX-92219 to NRC), and May 6, 1992 (TU Electric letter TXX-92208 to NRC), the applicant informed the staff that it had initiated a comprehensive confirmatory

test program to envelope the full range of protected conduit and cable tray configurations used at CPSES.

The staff audited the construction of fire endurance test specimens at the applicant's contract testing laboratory May 6 through 8, 1992, May 12 through 14, 1992, and September 29 through October 2, 1992. The staff observed the installation of cables, test instrumentation, and penetration seals, and the construction of the test specimen fire barriers. The staff also observed the test laboratory's and the applicant's quality control (QC) and quality assurance (QA) activities.

The staff observed fire endurance tests June 17 through 25, 1992, August 19 through 22, 1992, November 3 through 6, November 12, 13, 16 and 18, 1992, and December 1, 1992. The staff observed the test setups, the fire exposure and hose stream tests, thermocouple data collection, and the cable insulation resistance testing. The staff also observed the fire barrier condition and the cable condition after the fire and hose stream tests.

The staff met with the applicant to discuss the test program and fire test results on July 13, 1992, September 10, 1992, September 15, 1992, October 27, 1992, December 17, 1992, and January 21, 1993.

Fire Endurance Test Acceptance Criteria

During the early laboratory site visits and meetings, the staff expressed concerns about certain aspects of the applicant's fire test methodology and acceptance criteria including test specimen sizes and configurations, test methodology, and acceptance criteria. In a letter of September 8, 1992 (TU Electric letter TXX-92429 to NRC), the applicant provided an interim report entitled "Evaluation of Thermo-Lag Fire Barrier Systems," Revision 1, to describe the qualification of the Thermo-Lag barriers used at CPSES. During a telephone conference of September 22, 1992 to discuss the interim report, the staff requested additional information and clarifications from the applicant. The applicant provided additional information in a letter of September 24, 1992 (TU Electric letter TXX-92466 to NRC), and met with the staff on October 27, 1992 to discuss the fire test methodology and acceptance criteria. During the meeting, the applicant committed to supplement its acceptance criteria. In a letter of October 29, 1992, the staff stated that the applicant's proposed acceptance criteria were acceptable as supplemented by the conditions discussed during the meeting. In summary, the approved fire test acceptance criteria were:

1. External conduit, cable tray rail, and cable jacket temperatures should not exceed 250°F (121°C) plus ambient temperature (using thermocouple averaging) and no single thermocouple reading should exceed 30 percent above the specified average temperature rise.

2. The fire barrier should not burn through or develop any openings through which either the test specimen raceway or cables were visible.

3. If the temperature rise criteria were not satisfied, the cables should be inspected for visible cable damage. The following attributes constitute cable damage: jacket swelling, splitting, discoloration, hardening, blistering, cracking, or melting; conductor insulation exposed, degraded, or discolored; shield exposed; or bare copper conductor exposed.

4. If the fire barrier burned through during the fire exposure, or if a visual cable inspection revealed any of the damage attributes listed above, then the barrier was considered to have deviated from the acceptance criteria. Use of the fire test results to qualify a deviating fire barrier would require that cable functionality be demonstrated. Cable functionality test methodology and criteria were specified in the staff's letter.

In its letter of October 29, 1992, the staff concluded that the applicant's acceptance criteria, as supplemented by the conditions stated in the October 29, 1992 letter, ensured that adequate cable and barrier tests would be performed and that satisfactory results from these tests would constitute an acceptable basis for qualifying the CPSES Unit 2 fire barriers. The staff stated that its review of the applicant's evaluations of any test deviations, should they occur, would be included in its safety evaluation of the applicant's fire barrier test program.

Fire Tests Used to Qualify the CPSES, Unit 2 Fire Barriers

In a letter of December 23, 1992 (TU Electric letter TXX-92626 to NRC), the applicant provided Revision 2 of its interim engineering report entitled "Evaluation of Thermo-Lag Fire Barrier Systems." The report, ER-ME-067, documented the applicant's bases for the acceptance and continued use of 1 hour rated Thermo-Lag fire barriers at CPSES. It summarized the qualification of the Thermo-Lag fire barrier configurations used by the applicant for the protection of safe shutdown related components at CPSES, including the fire endurance test methodology and acceptance criteria. In the report, the applicant stated that it used the acceptance criteria included in the staff's letter of October 29, 1992.

ER-ME-067, Revision 2, identified 17 schemes that were tested by the applicant. By a letter of January 19, 1993 (TU Electric letter TXX-93023 to NRC), the applicant docketed the test reports for ten of the 17 fire test schemes. These were: Scheme 1-2, Schemes 9-1 and 9-3, Schemes 10-1 and 10-2, Scheme 11-1, Schemes 12-1 and 12-2, Scheme 13-1, and Scheme 14-1. The letter of January 19, 1993, stated that these ten reports supported the Thermo-Lag installations for CPSES Unit 2. The staff audited the test reports for the fire endurance tests of the nine test schemes identified in Table 1. Except for Scheme 1-2, the applicant used the test acceptance criteria specified in the staff's letter of October 29, 1992.

The staff's preliminary review of the test report for Scheme 9-3 found that the test deviated from the acceptance criteria approved by the staff in its letter of October 29, 1992. Specifically, the conduit surface temperatures were not known, cable temperatures exceeded allowable limits, the barrier burned through,

and there was visible cable damage. On these bases, the staff concluded that the test specimen did not meet the acceptance criteria it had approved. The staff also found that the applicant did not provide evaluations of the test deviations. During a telephone conference of January 22, 1993, the staff informed the applicant that absent acceptable evaluations of the test deviations, Scheme 9-3 was not an acceptable basis for the installation of Thermo-Lag fire barriers in CPSES Unit 2. In a letter of January 28, 1993 (TU Electric letter TXX-93061 to NRC), the applicant informed the staff that it did not use Scheme 9-3 to qualify any of the Thermo-Lag fire barriers installed in Unit 2.

The staff was also concerned that the applicant issued ER-ME-067, Revision 2, before its test laboratory finalized the fire endurance test reports referenced throughout the report. In the letter of January 19, 1993, the applicant stated that it had reviewed the fire test reports and confirmed that they supported the conclusions provided in ER-ME-067, Revision 2. The applicant also stated that the report was no longer an interim report and that additional confirmation of the report was not required. This resolved the staff concern.

The staff reviewed and evaluated those portions of ER-ME-067, Revision 2, that applied to CPSES Unit 2. The staff also audited the nine fire test reports for the test schemes that the applicant used as the basis for qualifying the Thermo-Lag fire barriers installed in CPSES Unit 2. Table 1 identifies the nine test schemes and summarizes the test results and the staff's conclusions.

The staff noted errors and inconsistencies within the fire test reports and between the fire test reports and ER-ME-067, Revision 2. To the extent that the errors and inconsistencies did not affect the reports' conclusions or the staff's conclusions, the staff did not question the reports. The staff also observed that the applicant did not consistently address in the conclusions sections of the fire test reports how each test specimen satisfied the acceptance criteria approved in the staff's letter of October 29, 1992 or why deviations from the criteria were acceptable. In some cases, the staff reviewed the test reports to determine whether or not the criteria were satisfied. The staff also requested clarifications and additional information from the applicant during telephone conferences of January 22, 25, 26, and 27, 1993. The additional information was provided by letters dated January 25 (TU Electric letter TXX-93060 to NRC) and January 28, 1993. The following safety evaluation also documents independent evaluations performed by the staff where it disagreed with the applicant's conclusions.

Test Specimen Design, Configuration, and Construction

The applicant performed 1-hour fire endurance tests on test specimens of various sizes and configurations of cable trays and conduits, junction boxes, condulets, lateral bend boxes, and air drops. Each test specimen was constructed from raceway materials, cables, and fire barrier materials extracted from the applicant's CPSES stock material storage areas in accordance with the applicant's site procedures and were representative of materials installed at CPSES Unit 2.

The Thermo-Lag fire barriers were measured, cut, and installed to the test specimen raceways by the applicant's contract installers using applicant-approved CPSES drawings, procedures, and specifications. The installations were inspected by CPSES-certified quality control inspectors and the test laboratory's quality assurance manager.

The installers buttered each joint and seam with trowel-grade Thermo-Lag material before the individual panel sections and conduit preshapes were joined together. Except for straight runs of conduits larger than 2 inches in diameter, the fire barriers included applicant-designed upgrades. (The upgrades are not specified in the vendor's recommended installation procedures.) The upgrades, which were configuration dependent, were described in ER-ME-067, Revision 2, and the fire test reports. In summary, the upgrades consisted of overlays of additional Thermo-Lag material on small diameter conduits, reinforcement of certain seams and joints with stainless steel wire stitches, and reinforcement of certain seams and joints with stress skin and trowel-grade Thermo-Lag material.

In a letter of January 28, 1993, the applicant stated that the fire test specimens were conditioned in accordance with Section 11 of American Society for Testing and Materials (ASTM) Standard E 119-88, "Fire Tests of Building Construction and Materials."

The staff observed during its plant site visit of January 11 through 15, 1993, that the applicant's fire barrier installation specifications and procedures for CPSES Unit 2 included the tested fire barrier design upgrades.

<u>Bounding Configurations (Scheme 1-2)</u>

In its final report of April 21, 1992, the NRR Special Review Team for the Review of Thermo-Lag Fire Barriers indicated that fire tests of representative cable tray sizes and configurations should be conducted to determine the fire resistance ratings for the range of possible field configurations. The staff issued the report in NRC Information Notice 92-46, "Thermo-Lag Fire Barrier Material Special Review Team Findings, Current Fire Endurance Tests, and Ampacity Calculation Errors," June 23, 1992.

The staff was concerned that the fire endurance test used by the applicant as the basis for the widest cable tray fire barriers installed at CPSES Unit 2 (Scheme 1-2, 36-inch wide cable tray) was not performed in accordance with the test methodology and acceptance criteria approved by the staff in its letter of October 29, 1992 and, therefore, that the applicant had not adequately bounded the range of fire barrier configurations installed at CPSES Unit 2.

The staff discussed bounding configurations with the applicant on several occasions. During the meeting on September 15, 1992, the staff stated that the applicant's test configurations did not adequately address, or bound, previous test results or in-plant configurations. The staff informed the applicant during a followup telephone conference on September 22, 1992, that its concern would be resolved if TU Electric conducted a successful test of the widest cable

tray installed in CPSES Unit 2. On September 23, 1992, the applicant informed the staff that the widest cable tray installed at CPSES Unit 2 was 30 inches. It also committed to test a 30-inch wide cable tray. This was done as Scheme 12-1, which was a satisfactory test.

Subsequently, in its letter of January 19, 1993, the applicant informed the staff that a 36-inch wide cable tray was installed at CPSES, Unit 2 and that it used the results of test Scheme 1-2 (36 inch wide cable tray) and Scheme 12-1 (30 inch wide cable tray) as the bases for qualifying the 36-inch wide cable tray fire barriers installed in CPSES Unit 2. In letters of January 25, 1993 and January 28, 1993, the applicant provided additional information to justify the use of these two fire tests as the licensing basis for installing the 36-inch wide cable tray fire barrier configuration in CPSES Unit 2.

The staff evaluated the information provided by the applicant and reviewed the fire test reports for Schemes 1-2, 12-1, and 14-1. The staff's acceptance of the 36-inch wide in-plant cable tray is based on satisfactory tests of two 30-inch cable tray configurations (Schemes 12-1 and 14-1). The 36-inch in-plant cable trays were constructed with similar upgrades as those employed on the 30-inch test schemes. The staff concluded that it has reasonable assurance that the 36-inch wide cable tray Thermo-Lag fire barrier installed in the plant will protect one train of safe shutdown capability from fire damage. However, the staff further discussed with the applicant concerns about the Scheme 1-2 test (e.g., test acceptance criteria, specific configuration concerns, and the lack of a bounding test conducted in accordance with the acceptance criteria approved by the staff). In a letter of February 1, 1993, (TU Electric letter TXX-93076 to NRC), the applicant committed to either perform a confirmatory test of a 36-inch cable tray, participate in an industry testing program to resolve concerns over a 36-inch wide barrier, or provide additional information which adequately addresses the staff's concerns. The applicant committed to perform one of these actions by the completion of the first refueling outage for Unit 2. Based on the staff's review, and the applicant's commitment for confirmatory actions, the staff finds the 36-inch wide in-plant cable tray acceptable.

Fire Endurance Test Results

The test laboratory exposed each test specimen to the 1 hour external fire exposure (standard time-temperature curve) specified in ASTM E 119-88. The laboratory controlled the furnace temperature during each test such that the area under the measured time-temperature curve was within 10 percent of the corresponding area under the standard time-temperature curve for the 1 hour test period.

Following the fire exposure, each test specimen was subjected to a hose stream test for at least 5 minutes. Each stream was delivered through a 1½ inch (3.8 cm) fog nozzle with a spray angle of 30°, a nozzle pressure of 75 psi (517 kPa), and a minimum flow of 75 gpm (284 lpm). The fog nozzle was located about 5 feet (1.5 m) from the test specimen during the test.

The laboratory identified several technical issues in the fire test reports. The staff's evaluations of the indeterminate conduit surface temperatures (Schemes 9-1, 10-1, and 10-2), conduit temperatures and cable jacket damage (Scheme 11-1), erratic temperature readings (Scheme 12-1), hose stream damage (Scheme 12-2), maximum single point temperature exceeded (Scheme 14-1), and cable stiffening are documented below. The staff concluded that the test laboratory satisfactorily addressed and resolved the other issues and problems that it documented in its fire test reports and that, except for Scheme 1-2, the problems did not affect the successful results of the CPSES Unit 2 fire tests.

Based on its audit review of the test reports, its audits of the fire test specimen construction, and its fire test observations, the staff concluded that except for Scheme 1-2, the applicant and its contract test laboratory conducted the fire tests identified in Table 1 in accordance with the test methodology discussed with the staff during its visits to the test laboratory, the meeting of October 27, 1992, and the staff's letter of October 29, 1992. The staff also concluded that except for Scheme 1-2, the test specimens satisfied the acceptance criteria specified in the staff's letter of October 29, 1992, with the deviations approved below, and were, therefore, adequate to establish the 1 hour fire resistance ratings of the tested configurations.

Fire Barrier Thickness

Some of the applicant's Thermo-Lag fire barrier upgrades consisted of overlapping or wrapping seams and joints with stress skin embedded in and covered with trowel grade Thermo-Lag 330-1 material. During visits to the test laboratory, the staff observed that the licensee's installation procedures included a combination of qualitative and quantitative instructions for applying the Thermo-Lag 330-1 trowel grade material, but did not specify a maximum allowable thickness of trowel grade material. The staff was concerned that absent a maximum allowable fire barrier thickness specification, the thickness of the installed fire barrier would not be known and the ampacity derating of enclosed power cables may not be adequate.

The staff inspected the thickness of the trowel grade material at a number of points on a 12-inch wide cable tray test specimen (Scheme 13-1). The troweled layer ranged from less than 1/16 inch (0.2 cm) thick to about ¼ inch (0.6 cm) thick. The thickness of the trowel grade material at any particular point appeared to be a function of its location on the test specimen. For example, the hardware used to fasten the ends of the stainless steel bands were about ¼ inch (0.6 cm) thick and protruded above the surface of the barrier. These fasteners were difficult to trowel around. Therefore, the troweled layer around the band fasteners tended to be smoothed off about even with the top of the fasteners. This was most evident at the inside bend radii of the 12-inch wide cable tray where a series of closely-spaced bands (1 to 2 inches apart) were installed to hold the scored Thermo-Lag panels to the radii. The band fasteners were located along the centerline of the inside radii between the edges of two pieces of stress skin that overlapped the cable tray side rails. The fire barrier installers were trained to completely cover the stress skin and to blend or feather the trowel layer across the panel surface adjacent to the edge of the

stress skin. The edges of the stress skin in these areas were only 4 inches (10 cm) apart and had a series of protruding band fasteners between them. Feathering is difficult in these areas because of the protruding fasteners, the curve of the barrier, and the relatively small surface area available to feather into. Therefore, the inside bend radii were filled to the depth of the band fasteners with trowel-grade material. Conversely, the troweled layer on the outside of the radii, where there were no band fasteners, was only about 1/16 inch (0.2 cm) thick.

During the laboratory visit, the applicant informed the staff that the instructions and training provided to the applicant's contract fire barrier installers were consistent with the applicant's installation procedures and that the fire test specimens were constructed by the same installers used to construct the Thermo-Lag fire barriers at the CPSES Unit 2. Moreover, CPSES inspection procedures ensured that the barriers were inspected and that the installers followed the installation procedures. In the staff's judgement, nominal thickness variations are inherent in the Thermo-Lag fire barrier system, and the application of the trowel grade material with respect to thickness and quality of coverage could not be reasonably controlled better than that which was observed during the site visits. The applicant also informed the staff that the ampacity derating test specimens would be constructed using the same procedures and construction methods. Therefore, the ampacity derating factors derived from the tests will reflect typical barrier installations including the nominal thickness variations inherent in the system.

The staff concluded that the applicant's fire barrier installation and quality control procedures and specifications were adequate to ensure that the fire test specimens represented the materials, methods of assembly, dimensions, and configurations for which fire resistance ratings were desired.

Conduit Surface Temperatures (Schemes 9-1, 10-1, and 10-2)

The staff observed the fire endurance tests of Scheme 9-1 and Scheme 10-1 on November 3 and 5, 1992, respectively. During these tests the staff observed that temperatures reported by some of the thermocouples installed on the conduit surfaces between the conduit and the Thermo-Lag material rose faster and higher than expected. For example, after 31 minutes, a thermocouple on the 3-inch diameter conduit for Scheme 9-1 reported a temperature of 1480°F (804°C). The corresponding cable thermocouple temperatures were less than 200°F (93°C). By the end of the test, the temperature reported by this conduit surface thermocouple had dropped to 468°F (242°C). It was also noted that the thermocouple with the longest run of thermocouple wire had the highest temperature reading. During the post-fire inspection of the barrier, the staff observed that the fire barrier was intact and that virgin Thermo-Lag material remained between the char layer and the conduit surface thermocouples. When the laboratory disassembled the fire barrier, the staff observed that many of the thermocouple wires located between the outer conduit surface and the Thermo-Lag material were coated with a dark brown gummy substance and that the braided fiberglass thermocouple wire insulation was saturated with the substance in places. The foreign substance appeared to be a mixture of water and decomposed

Thermo-Lag material that had migrated into the enclosure under fire exposure and condensed on the cool conduit surfaces.

The morning after the fire test, the laboratory tested the operability of the Scheme 9-1 thermocouple that reported the highest temperature. It performed correctly. When the laboratory immersed a residue-saturated segment of the insulation in warm water, with the thermal junction exposed to ambient air, the thermocouple reported a temperature rise of about 10°F (12°C). The temperature reported by the thermocouple should not have changed. This demonstrated that the saturation of the thermocouple wire insulation affected the temperature reading.

The conduit surface temperatures for Schemes 10-1 and 10-2 were also irregular and inconsistent with visual observations. Following the tests of Schemes 9-1 and 10-1, the laboratory verbally informed the staff that it considered the conduit surface temperatures indeterminate. This declaration was not reflected in the fire test reports. However, the laboratory discussed the thermocouple readings as a problem in the fire test reports for Scheme 9-1, Schemes 10-1 and 10-2 and the applicant provided an evaluation of the thermocouple behavior in Revision 2 to ER-ME-067.

The test laboratory concluded that the high temperatures reported by the conduit surface thermocouples were caused by saturation of thermocouple wire insulation with a residue composed of water and Thermo-Lag off-gases which migrated through the Thermo-Lag material and condensed on the conduit surfaces. The saturation set up an ionic potential across the thermocouple wires which affected the thermocouple readings. The longer the thermocouple wire, the greater the potential, and the higher the temperature reported by the thermocouple. When the conduit surface reached 212°F (100°C), the water began to evaporate. This dried out the thermocouple wire insulation and reduced the potential, thereby lowering the thermocouple reading. The staff concurred with the laboratory's analysis and concluded that the conduit surface temperature measurements for Scheme 9-1, Schemes 10-1 and 10-2 were indeterminate. The staff also concluded, therefore, that these three test schemes deviated from the temperature acceptance criteria.

The fire test acceptance criteria specified that a fire test was successful if the barrier did not burn through and the cables did not have any visual fire damage even if the temperature criteria were exceeded. The staff concluded that the Scheme 9-1, and the Schemes 10-1 and 10-2 fire tests met the conditions of acceptance for post-fire barrier condition and post-fire cable condition; therefore the conduit surface temperatures were not needed to declare these three fire tests satisfactory. This was, therefore, an acceptable deviation from the temperature acceptance criteria.

Conduit Temperatures and Cable Jacket Damage (Scheme 11-1)

The staff noted several apparent inconsistencies and errors in the discussions and conclusions about conduit temperatures in the test report for Scheme 11-1. The report also indicated that the jackets of three cables in the 5-inch air

drop were blistered and cracked and the filler material within the cables was slightly melted. The staff was concerned that the test results may not have been an acceptable basis for qualifying the fire barrier configurations. The staff discussed these issues with the applicant during telephone conferences on January 22 and 27, 1993. The applicant provided additional information in letters of January 25 and 28, 1993. The applicant also provided a letter of January 28, 1993, from its test laboratory that clarified the test report.

The staff found that the test laboratory corrected the reporting inconsistencies and errors. The staff did not, however, concur with the laboratory's conclusion that conduit surface thermocouples affected by moisture saturation could be used to conclude that the conduit temperatures remained within allowable limits. The staff concluded, therefore, that the surface temperatures of the 1-inch, 2-inch, and 3-inch diameter conduits were indeterminate. The staff found, however, that the surface temperatures of the 5-inch diameter conduit were not affected by moisture saturation and were within acceptable average and maximum temperature limits.

The staff reviewed the fire test report against the criteria specified in its letter of October 29, 1992. The staff concluded that, except for the 1-inch, 2-inch, and 3-inch conduit surfaces, all raceway and cable temperatures were within the allowable average and maximum temperature limits, that the barrier remained intact and did not burn through during the fire and hose stream tests, and that the results of the cable insulation resistance tests were satisfactory.

The cables in the 1-inch, 2-inch, and 3-inch diameter conduits and air drops and in the cable tray were not damaged. The cable damage was limited to the outside of the cable jackets of three of the cables installed in the 5-inch air drop. The inside surfaces of the cable jackets and the insulation of the individual cable conductors did not have any visual fire damage. In its letters, the applicant postulated that three of the cables in the 5-inch air drop were damaged because the cable installation techniques required to assemble the test specimen allowed the cable jackets to contact the inside Thermo-Lag surfaces.

As stated above, the staff concluded that the surface temperatures of the 5-inch diameter conduit were within allowable limits and the surface temperatures of the 1-inch, 2-inch, and 3-inch diameter conduits were indeterminate. The staff determined that two explanations for damage to the cables in the 5-inch air drop were possible (temperature related or improper installation technique). Assuming the temperatures in the three smaller diameter conduits exceeded allowable limits, the staff concluded that it is not credible that high temperatures in these areas could have caused the cable damage observed in the 5-inch air drop. Therefore, the staff concurred with the applicant's basis for the cause of the cable damage. In its letter of January 28, 1993, the applicant stated that CPSES cable installation practices preclude CPSES cable installations from experiencing the installation problems encountered with the test specimens. The staff concluded that the CPSES cable installation practices provided reasonable assurance that the cable damage observed in the fire test specimen will not occur in the event of a fire in the plant.

The staff concluded that the Scheme 11-1 fire endurance test was an acceptable basis for qualifying the tested fire barrier configurations.

Erratic Temperature Readings (Scheme 12-1)

The staff observed the fire endurance test of Scheme 12-1 on November 16, 1992. The test specimen temperatures rose slowly and fairly uniformly during the first 14 minutes of the fire exposure. Then, the thermocouples began to exhibit erratic behavior. After about 20 minutes, the staff observed that most of the thermocouples reported obviously erratic temperatures. Many read 0°F while others indicated negative temperatures. At this point, the test laboratory began to troubleshoot its data acquisition and control system. The laboratory project manager removed the multiplex system circuit boards from the signal processor, cleaned their contacts, and reinserted them. This appeared to correct the data acquisition problem. About 46 minutes into the fire test, the laboratory restarted the data acquisition system and recorded the test specimen thermocouple temperatures. The system behaved normally during the remainder of the test. The furnace thermocouples were connected to a separate data acquisition system and were not affected.

Following the test, the staff observed that the test laboratory project manager verified that the thermocouple calibration was within specifications (±2°C). The project manager concluded that the data acquisition breakdown was a signal processing problem that was caused by a poor multiplex system board connection. This problem was documented in the fire test report.

The fire test acceptance criteria specified that a fire test was successful if the barrier is intact and the cables do not have any visual fire damage after the fire and hose stream tests, even if the temperature rise criteria are exceeded. Heat transfer through the Scheme 12-1 barrier (as measured during the beginning and end of the fire exposure) did not raise the average temperature of the cable tray rails or the cable surfaces above either the allowable average temperature (321°F, 161°C) or the allowable maximum single point temperature (396°F, 202°C). Moreover, the test specimen met the conditions of acceptance for post-fire barrier and cable condition. The staff concluded that the loss of the test specimen temperature data during the middle portion of the test was not a concern. The staff also concluded that Scheme 12-1 met the conditions of acceptance for post-fire barrier and cable condition and, therefore, that the fire test was successful.

Hose Stream Damage (Scheme 12-2)

In its letter of October 29, 1992, the staff approved the use of a fog hose stream test in accordance with NUREG-0800, "Standard Review Plan." According to Branch Technical Position (BTP) CMEB 9.5-1, Section C.5.a.(3)(c) of NUREG-0800 the hose stream test was successful if the barrier remained intact and did not allow projection of water beyond the unexposed surface.

The test report for Scheme 12-2 stated that an opening was present in the tee section of the cable tray system and that an opening was present along the lower

edge of the mouth of the cable tray tee section. The staff was concerned that the fire test report did not identify the cause of the opening and that the opening was an apparent test failure that was not evaluated by the applicant.

Revision 2 to ER-ME-067 indicated that the opening occurred during the hose stream test. However, because ER-ME-067 was based on the fire test report, which did not discuss the cause of the opening, and because ER-ME-067 was marked as an interim report, the staff also questioned the correctness of the information it contained on the fire barrier failure.

The applicant provided additional information in its letter of January 25, 1993. The applicant confirmed that the Thermo-Lag panel located below the fire stop in the tee section sagged leaving an opening between the panel and the fire stop during the hose stream test. The applicant attributed the failure to the absence of mechanical fasteners and failure of the trowel-grade Thermo-Lag to form an adequate mechanical bond at the joint between the penetration seal and the Thermo-Lag panel. The applicant also stated that it revised its fire barrier design to require mechanical attachment of bottom Thermo-Lag panels to fire stops. The applicant successfully tested the design change in Scheme 14-1, and implemented the design change into CPSES, Unit 2, through a design change authorization (which included upgrading previously installed configurations). The staff concluded that, based on the development and implementation of a corrective design change, failure of the hose stream test for Scheme 12-2 was an acceptable deviation from the fire test acceptance criteria specified in the staff's letter of October 29, 1992, and BTP CMEB 9.5-1, Section C.5.a.(3)(c).

Maximum Single Point Temperature Exceeded (Scheme 14-1)

The ambient temperature at the start of the test for Scheme 14-1 was 70 °F (21°C). Therefore, the maximum allowable individual temperature for Scheme 14-1 was 395°F (202°C). Thermocouple 91 (located on the horizontal centerline of the tray rail on the tee section, opposite the mouth of the tee) deviated from the maximum single point temperature limitation. It reached 395°F (202°C) at 59 minutes and 401°F (205°C) at 60 minutes. The Scheme 14-1 test report stated that the barrier did not burn through and there was no visible cable damage.

The fire test acceptance criteria specified that a fire test was successful if the barrier did not burn through and the cables did not have any visual fire damage even if the temperature criteria were exceeded. The staff concluded that Scheme 14-1 met the conditions of acceptance for post-fire barrier and cable condition and, therefore, that the fire test was successful.

Cable Stiffening

The laboratory removed the cables from each test specimen raceway and inspected them for visual damage after assessing the post-fire barrier condition. Except for Scheme 11-1, which was evaluated above, the applicant did not identify any of the cable damage attributes specified in the staff's letter of October 29, 1992.

The staff inspected the cables from Schemes 9-1 and 10-1 and concurred with the results of the visual cable inspections. However, the staff noted that when some of the cables that were exposed to the fire environment (heated cable) were flexed by hand, they felt stiffer than those that were not heated by the fire (unheated cable). Several cycles of flexing appeared to restore the flexibility of the cable segments that had been heated.

At the staff's request, the applicant dissected two sections of the instrumentation cable that was installed in a ¾-inch diameter conduit (Scheme 9-1). One section of the cable was located in a portion of the conduit that was heated during the fire exposure. The other section extended out of the conduit and, therefore, was not heated during the fire test. The staff's inspection of the heated cable section revealed that the cable jacket had not hardened, but the shielding material had constricted around the insulation of the individual conductors and the filler material located between the individual conductors had softened. These conditions caused the individual conductors to stick together and resulted in the heated cable being less flexible than the unheated cable. The cable jacket and the insulation of the individual conductors were free of visual fire damage. The shielding in the unheated section of the cable was not constricted and the filler material was not softened.

Cable stiffening was reported in each of the fire test reports audited by the staff. In ER-ME-067, Revision 2, the applicant stated that cable stiffening had no effect on cable performance. The individual test reports indicated that the post-fire cable insulation resistance test results were within acceptable specifications. Based on its observations of cable condition, including the condition of the cable jacket and the insulation of the individual conductors, and the satisfactory cable insulation resistance tests, the staff concluded that observed shrinkage of the shielding and softening of the cable filler material did not affect cable functionality.

<u>9-Inch Rule</u>

CPSES site specifications require that thermally conductive items that penetrate raceway fire barriers, including raceway supports, be covered with Thermo-Lag 330-1 material from the point of the penetration to a point 9 inches away from the point of the penetration. This is known as the 9-inch rule. With the exception of Scheme 1-2, the applicant applied the 9-inch rule to the raceway supports for the Unit 2 test specimens. The applicant's tests demonstrated that for the Unit 2 barrier configurations, covering heat conducting protruding items with Thermo-Lag for a distance of at least 9 inches from the barrier envelope is adequate to prevent excessive heat transfer into the barrier through the protruding item. The 9-inch rule is, therefore, acceptable for the Unit 2 Thermo-Lag fire barriers.

<u>Cable Types and Cable Fill</u>

During the meeting of October 27, 1992, the applicant informed the staff that CPSES procedures prohibited cabling from extending above the cable tray side rails, and that all CPSES Unit 2 power and instrument cable met IEEE Standard

383 and had thermosetting insulation. In its letter of October 29, 1992, the staff requested that the licensee confirm these facts in writing.
In ER-ME-067, Revision 2, the applicant stated that Thermo-Lag installation specifications, electrical installation specifications and quality control (QC) inspection procedures preclude the installation of Thermo-Lag panels if the cable fill results in cables extending above the tray side rails except where cables enter or exit the tray. Where a specific cable tray is found to be overfilled, the applicant stated that the height of the Thermo-Lag panel pieces installed along the cable tray side rails is increased. This increases the height of the Thermo-Lag fire barrier and prevents the cables from contacting the inside surface of the Thermo-Lag panel installed over the top of the tray. This resolved the staff's concern that cables in direct contact with Thermo-Lag panels could be damaged during a fire exposure.

In letters of January 19, 1993, and January 25, 1993, the licensee confirmed that all cables installed in raceways protected with Thermo-Lag fire barriers to satisfy fire safe shutdown requirements are IEEE-383 qualified and have thermosetting or mineral insulation. This satisfied the staff's request.

Thermo-Lag 350 Topcoat

In SSER 12, the staff concluded that the CPSES interior finishes were noncombustible or had a flame spread rating of 50 or less. The staff concluded that the interior finishes met the guidelines of BTP CMEB 9.5-1, Section C.5.a, and were, therefore, acceptable. Revision 2 to ER-ME-067 indicated that the applicant's Thermo-Lag fire barriers are finished with the vendor's top coating product (Thermo-Lag 350 Topcoat).

In ER-ME-067, Revision 2, the applicant stated that the flame spread rating for Thermo-Lag was 5. However, the report did not indicate whether or not this flame spread rating applied to Thermo-Lag 350 Topcoat. In a letter of January 19, 1993, the applicant informed the staff that Underwriters Laboratories, Incorporated (UL) determined that the flame spread rating for Thermo-Lag with topcoat was 5. During the meeting of January 21, 1993, the applicant confirmed that the UL test was performed in accordance with ASTM Standard E-84, "Standard Test Method for Surface Burning Characteristics of Building Materials." This flame spread rating meets the guidelines of BTP CMEB 9.5-1, Section C.5.a, and is, therefore, acceptable.

The staff was also concerned that the top coating product was never subjected to full-scale fire endurance testing. The 350 Topcoat was applied by the vendor as part of the manufacturing process to the Thermo-Lag 330-1 prefabricated panels and preshaped conduit sections used to construct the test specimens. Top coat was also applied to each of the applicant's test specimens after assembly in accordance with CPSES installation specifications and procedures. With the exception of Scheme 1-2, the Unit 2 test specimens with the topcoat met the test acceptance criteria approved by the staff in its October 29, 1992 letter. This resolves the staff's concern.

Combustibility of Thermo-Lag 330-1

To evaluate a staff concern that Thermo-Lag 330-1 material may be combustible, the staff's technical assistance contractor, the National Institute of Standards and Technology (NIST), subjected Thermo-Lag 330-1 material to the test methods specified in ASTM Standard E-136, "Standard Test Method for Behavior of Material in a Vertical Tube Furnace at 750°C," and ASTM Standard E-1354, "Standard Test Method for Heat and Visible Smoke Release Rates from Materials and Products Using an Oxygen Consumption Calorimeter." The staff evaluated the results of these tests and concluded that Thermo-Lag 330-1 material is combustible as defined in BTP CMEB 9.5-1. On December 15, 1992, the NRC issued Information Notice (IN) 92-82, "Results of Thermo-Lag 330-1 Combustibility Testing," to alert licensees and applicants of the results of the combustibility tests.

In letters of January 19, 1993, and January 25, 1993, the applicant described how it addressed the combustibility of Thermo-Lag 330-1 at CPSES, Unit 2. The applicant stated that there is no Thermo-Lag installed that could act as an intervening combustible between safe shutdown trains or as radiant energy shields inside containment structures. The applicant also stated that, based on its fire hazards analysis, it had provided adequate fire protection features, such as sprinkler systems, to address the combustible properties of Thermo-Lag. The applicant also stated that it is actively participating in the generic NUMARC effort to address Thermo-Lag combustibility. The staff did not agree with the applicant's assertion that ASTM E-136 is not an appropriate test to determine the combustibility of Thermo-Lag. The staff concluded, however, that the applicant's approach to addressing the combustibility issues identified in IN 92-82 was adequate pending completion of the NUMARC program.

Thermo-Lag Receipt Acceptance Criteria

In a telephone conversation of October 20, 1992, and a letter of November 7, 1992, the manufacturer of Thermo-Lag fire barrier materials (the vendor) informed the staff that some preshaped Thermo-Lag conduit sections received by the applicant showed signs of delamination and voids. The staff was concerned that the use of defective fire barrier materials could affect the applicant's fire test results and the fire performance of the Thermo-Lag fire barriers installed at CPSES Unit 2. The staff requested additional information from the applicant in a letter of November 25, 1992. The applicant responded in a letter of December 15, 1992.

In its letter, the applicant described the actions it had taken to ensure that the fire barrier materials used in its fire test program were representative of the materials installed in CPSES, described its quality controls and receipt inspection process, and described how it had addressed the delamination and void concerns. ER-ME-067, revision 2, also provided information on the applicant's receipt acceptance criteria for Thermo-Lag materials.

The staff evaluated the information provided by the applicant, observed the construction of several fire test specimens, and audited the applicant's fire barrier material procurement specifications, procedures, and documents during

the CPSES, Unit 2 site visit of January 11 through 15, 1993. The staff concluded that the applicant's source inspections, including verification of the vendor's thickness and weight measurements, coupled with the applicant's receipt inspections provided reasonable assurance that the prefabricated and preshaped Thermo-Lag fire barrier materials used at CPSES Unit 2 are acceptable. The staff also concluded that the Thermo-Lag materials used to construct the fire test specimens were representative of the materials installed at CPSES, Unit 2, that the fire test program demonstrated that the nominal thickness variations and voids inherent in the prefabricated Thermo-Lag 330-1 fire barrier materials do not cause premature failure of the tested fire barrier configurations, and that the applicant had adequately addressed the delamination and void concerns that the vendor identified to the staff.

Generic Letter 92-08

On December 17, 1992, the NRC issued Generic Letter 92-08, "Thermo-Lag 330-1 Fire Barriers," to obtain additional information needed to verify that the Thermo-Lag 330-1 fire barrier system complies with the NRC's requirements. The generic letter required all addressees to submit a written report that addressed the use of Thermo-Lag fire barriers, fire endurance and ampacity derating testing, and the application of test results.

The applicant submitted the written report required by Generic Letter 92-08 in a letter of January 19, 1993 (TU Electric letter TXX-93038). The staff found the applicant's response acceptable for CPSES Unit 2 based on the satisfactory completion of the plant specific fire endurance test program, the applicant's use of the test results to design and construct the CPSES Unit 2 fire barriers, and its commitment to perform plant specific ampacity derating tests by the completion of the first CPSES Unit 2 refueling outage.

Fire Barrier Deviations and Special Configurations

By a letter of January 19, 1992, the applicant submitted its engineering report ER-ME-082, "Evaluation of Unit 2 Thermo-Lag Configurations," to the staff for review. The purpose of the applicant's evaluation was to establish the design basis for the Thermo-Lag fire barriers installed at CPSES Unit 2 that deviated from the tested configurations and to provide reasonable assurance that these Thermo-Lag fire barrier configurations will provide sufficient fire resistance to assure that at least one train of safe shutdown systems will remain free from fire damage.

The applicant's fire testing program established the technical and installation attributes for most of the Thermo-Lag fire barrier configurations installed in CPSES, Unit 2. The applicant documented about 180 cases where the application of Thermo-Lag fire barrier materials used to protect electrical raceways and structural steel deviated from the tested configurations. The staff recognized that there are actual field conditions that cause the application of fire barrier assemblies to deviate from the tested configurations. These cases may require the creation of a unique fire barrier design to address structural steel, other raceway, or mechanical equipment interferences. The staff also

recognized that it was not feasible to qualify all aspects of the fire barrier deviations through configuration-specific fire endurance testing. In Generic Letter 86-10 the staff provided guidance for performing engineering evaluations of raceway fire barrier systems that deviated from the tested configurations. The applicant in its engineering evaluation used this guidance to establish its fire barrier evaluation criteria. The following summarizes the applicant's criteria: the continuity of the fire barrier material applied was consistent with the tested configuration; the effective thickness of the fire barrier material applied to the unique configuration was consistent with the thickness of the fire barrier material which was tested; the nature and effectiveness of the fire barrier support assembly was consistent with the tested configurations; and the application and end use of the fire barrier material was consistent with the tested configuration. The applicant included its evaluations of the following: unique fire barrier configurations; minor protected commodity deviations; protruding and interfering item coverage deviations; and structural steel deviations.

The staff, during its review of the applicant's engineering report, sampled those unique configurations where the fire barrier installations installed on safe shutdown raceways deviated from the conditions of its fire test program. The following is summary of the staff's review and evaluation of these unique configurations.

Auxiliary Building Elevation 810', Room X-207

Configuration 1 - Three cable tray vertical stack assembly. This fire barrier configuration enclosed two 24-inch and one 30-inch cable tray in a box assembly. The fire barrier box assembly enclosed these trays for a straight run of approximately 6 feet. The box assembly was approximately 5 feet in height. Cable trays T230ACA75 and T230ACG75 are protected by Thermo-Lag as they enter and exit the fire barrier box assembly. One side of the fire barrier box assembly was attached to the concrete wall with Hilti bolts. Penetrating the concrete wall inside the fire barrier box assembly were 40 conduit sleeves which exit the cable spreading room and air drop its cables into the cable trays which are enclosed by the box assembly. The fire barrier box was constructed of ½ inch prefabricated Thermo-Lag 330-1 panels supported by a Unistrut frame. The joints and seams were stitched and reinforced with stress skin. The top and bottom sections of the box that extend from the tray to the wall use the score and fold method and are shaped accordingly. The bottom panel was tie wired to every other rung of the bottom tray and the sides were banded through the side of Thermo-Lag side panels to the trays.

The applicant's evaluation claimed that due to the large air volume and the thermal mass of the raceway and structural steel enclosed within the fire barrier assembly the thermal protection afforded to the protected raceways inside the enclosure was adequate. This conclusion was based on the fact that one side of this enclosure was a concrete wall, the methods of attaching the Thermo-Lag fire barrier panels to the raceway used conservative mechanical attachment techniques (for example, tie wire attachment of panels to tray bottom

and to the Unistrut frame), and that the barrier joints were reinforced by stitching and stress skin.

The staff, from its review of this configuration, could not fully establish the applicant's basis for determining that this box configuration had similar construction attributes to fire tested box configurations, such as junction boxes (JBs). The staff noted that the mechanical methods of attaching the vertical Thermo-Lag panels with tie wire had not been qualified by fire testing. In addition, the applicant, in its qualification of JB barriers installed a second layer of Thermo-Lag fire barrier panel material.

The staff concluded that this and other box configurations using similar fire barrier construction techniques are not adequately justified by the applicant's engineering report and that these types of barrier systems may not provide the level of assurance required to assure that one train of safe shut down capability remain free from fire damage.

The staff discussed their findings with the applicant, stating that the applicant would be expected to implement compensatory measures in accordance with CPSES procedures until the barriers are qualified and operable. In a letter of January 28, 1993, the applicant committed to implement compensatory measures and to establish the qualification of the box enclosure barriers. The staff concluded that the applicant's commitments are acceptable and that the compensatory measures (discussed below) will provide an adequate level of fire protection until the barrier concerns are resolved.

Auxiliary Building Elevation 790, Room X-174

Configuration 2 - This fire barrier assembly enclosed two parallel cable trays (T220ABC08 and T230ACA24), one 18 inch and one 12 inch, running horizontally down a corridor. This fire barrier enclosure was approximately 60 feet long. The enclosure was constructed in such a manner that the trays had a Thermo-Lag partition (except at the tray splice plates) separating the trays within the enclosure. The common enclosure top and bottom was fabricated using Thermo-Lag 330-1 panels with the bottom panels being secured to the rungs of the trays with tie wires. This tie wire attachment was applied to every other rung with at least two ties per rung. The seams of this configuration were provided with stress skin overlays and the butt joints were stitched and overlaid with stress skin.

The applicant's evaluation, found that the effective width of this configuration was similar to the 30 inch and the 36 inch tested tray configurations and that the upgrade techniques were used to secure the bottom fire barrier panels to the bottom of the cable trays.

The staff found, from its review, that this configuration was properly supported and the fire barrier material and its application were consistent with the construction and upgrade attributes established by the applicant's fire testing program for the 30-inch cable tray. The staff found this unique fire barrier configuration acceptable subject to the confirmatory resolution of staff

concerns regarding the 36-inch wide cable tray fire barrier, discussed above - "Bounding Configurations (Scheme 1-2)".

Safeguards Building, Elevation 810', Room 2-083

Configuration 3 - This configuration consists of two vertical 24-inch wide cable trays which air drop its cables into conduit sleeves which penetrate the concrete wall interfacing with Room 2-082. The two cable trays are independently protected with Thermo-Lag to the point that they terminate and the cables air drop. At this point a Thermo-Lag box enclosure (5 feet x 7 feet x 10 inches) was constructed to enclose the air drop cables and the conduit sleeves. The box was secured to the wall with Hilti bolts and the joints and corners were upgraded with stress skin overlays.

The applicant's evaluation claimed that due to the large air volume and the thermal mass of the raceway and structural steel enclosed within the fire barrier assembly that the thermal protection afforded to the protected raceways inside the enclosure was adequate. This conclusion was based on the fact that one side of this enclosure was a concrete wall, the methods of attaching the Thermo-Lag fire barrier panels to the wall and raceway used conservative mechanical attachment techniques and that all joints were reinforced with stitching and stress skin.

The staff found this configuration to be similar to configuration 1, evaluated above. The staff's concerns with the configuration 1 barrier design also apply to this configuration. Accordingly, this is another example of a box enclosure barrier that the staff has determined necessitates compensatory measures until the barrier is qualified and operable. In a letter of January 28, 1993, the applicant committed to implement compensatory measures and to establish the qualification of the box enclosure barriers. The staff concluded that the applicant's commitments are acceptable and that the compensatory measures (discussed below) will provide an adequate level of fire protection until the barrier concerns are resolved.

Configuration 4 - This configuration consisted of two oversized JBs, installed against a concrete wall and boxed together. Between the JBs only a single layer of Thermo-Lag panel was installed. The remaining exposed sides of the JBs were protected with two layers of Thermo-Lag fire barrier panel material. The joints and seams were overlaid with stress skin and trowel grade material. The banding application could not be applied circumferentially around the JBs. Therefore, the applicant attached the bands to steel angles which were bolted to the wall above and below these JBs.

The applicant's evaluation of this configuration found it acceptable on the basis that one side of these JBs was attached to the wall which will act as a heat sink in the event of a fire in this area. The applicant's evaluation identified that the JBs in this configuration exceeded the sizes of the JBs tested as part of its testing program. The applicant found the fire barrier configuration acceptable due to the extra thermal mass created by the size of these JBs. In addition, the applicant found the alternative banding method to

be equivalent to the tested method for banding the outer Thermo-Lag panels to the JBs.

The staff found, from its review, that this configuration, with the modified banding configuration, would assure that the outer Thermo-Lag panels would remain in place if a postulated fire were to occur in the area of this assembly. In addition, the staff found that the fire barrier material was applied to these oversized JBs using the same construction and upgrade attributes established by the applicant's fire testing program. Therefore, the staff found this unique fire barrier configuration acceptable and concluded that it will provide reasonable assurance that the shutdown functions being protected will be maintained free from fire damage.

Safeguards Building, Elevation 810', Room 2-082

Configuration 5 - This configuration consists of cables air dropping out of several embedded wall conduit sleeves and entering three short run horizontal cable trays above the two service water lines running down the corridor. These cables exited these horizontal trays and air drop into a 30-inch tray which runs under the service water lines. The cables leaving the sleeves are protected with Flexiblanket 660 fire barrier material. When these cables enter the three horizontal trays installed above the service water piping they are protected in the trays by Thermo-Lag 330-1 fire prefabricated panel system. These trays were protected independently. As these cables exited the tray segments above the service water piping, they were protected by Flexiblanket 660 fire barrier material. The cables entered the 30-inch tray through the top of panel of the Thermo-Lag fire barrier system installed on this tray. To accommodate the air drop cables entering the 30-inch tray, a 12-inch wide by 43-inch long opening was cut into the top tray panel. A 6-inch high curb constructed out of Thermo-Lag 330-1 prefabricated panels was installed around the opening and this opening was filled with Thermo-Lag 660 trowel-grade material.

The applicant found this configuration an acceptable deviation on the basis that the air drop cable bundles that exceed the 6-inch diameter limit established in its testing program contain more thermal mass and therefore are less sensitive to thermal fire conditions. In addition, the air drop-cable tray fire barrier penetration configuration was upgraded with techniques confirmed by test.

The staff found this configuration acceptable on the basis that the continuity of the fire barrier was applied in a consistent manner to the protected raceway and was similar in configuration to various attributes which were qualified by the applicant's fire testing program.

Safeguards Building, Elevation 831', Room 2-088

Configuration 6 - This configuration consisted of enclosing two JBs installed on a common support in one fire barrier enclosure. Each JB was enclosed in the first layer of Thermo-Lag 330 panel material separately and the second layer was applied using the score and fold method to enclose both JBs. The joints and seams were either overlaid with stress skin or were stitched.

The applicant's evaluation of this configuration found it acceptable on the basis that the common JB enclosure will be a greater heat sink than the JB fire barrier configurations the applicant tested as part of its fire test program.

The staff found, from its review of this configuration, that the fire barrier material was applied to this common JB enclosure using the same construction and upgrade attributes established by the applicant's fire testing program. Therefore, the staff found this unique fire barrier configuration acceptable and concluded that it will provide reasonable assurance that the shutdown functions being protected will be maintained free from fire damage.

From the sample of the fire barrier deviation conditions reviewed, the staff found that the construction and upgrade attributes used on these configurations is consistent with the design and installation requirements established by the applicant's design and installation specification and the installation procedure. The staff also found the continuity of material application, the thickness of the material applied and the upgrade techniques, except for the multi-conduit sleeve/cable tray box configurations, to follow the same design logic as those attributes applied to the fire test specimens. The remaining Thermo-Lag fire barrier deviation conditions documented by the applicant's engineering report ER-ME-082 and its adequacy to provide a reasonable assurance that they can maintain the protected safe shutdown component or raceway free from fire damage are subject to future NRC audit.

The fire barrier configurations tested by the applicant were plant specific to CPSES Unit 2, and bounded the range of fire barrier sizes and configurations installed in CPSES Unit 2.

<u>Compensatory Measures</u>

In a letter to the staff of October 5, 1991, the vendor stated that Thermo-Lag trowel-grade material takes about 30 days to reach its optimum properties. In its letter of January 19, 1993, the applicant stated that it considered its Thermo-Lag fire barriers to be functional (capable of performing their design function) immediately after completion of the barrier installation and inspection. The applicant did not provide a technical basis for its assertion. In its letter of January 25, 1993, the applicant provided additional information and a letter from the vendor. In its letter, the vendor stated that it had revised its curing recommendation. The staff found that neither the applicant nor the vendor provided a technical basis for the revised recommendation.

The applicant cured its fire test specimens for at least 30 days prior to conducting the fire endurance tests. The staff was concerned that Thermo-Lag fire barriers are not functional until they are either cured for 30 days in accordance with the vendor's original recommendation or the installed barriers reflect the tested conditions. In the case of the applicant's tests for CPSES, Unit 2, this would also be 30 days. During a telephone conference of January 22, 1993, the staff requested that the applicant submit a technical basis that supported its position that Thermo-Lag fire barriers are functional

immediately after completion of the barrier installation and inspection notwithstanding the cure time.

In a letter of January 28, 1993, the applicant committed to provide fire watches as compensatory measures in accordance with the CPSES fire protection plan for the Thermo-Lag fire barriers installed in areas that contain fire-safe shutdown conduits or cable trays until the barriers have cured for 30 days, and where box enclosures are located until this issue is adequately resolved with the staff.

The use of fire watches is consistent with the compensatory measures implemented by the applicant for the CPSES Unit 1 Thermo-Lag fire barriers in response to NRC Bulletin 92-01, "Failure of Thermo-Lag 330 Fire Barrier System to Maintain Cabling in Wide Cable Trays and Small Conduits Free From Fire Damage," June 24, 1992. The staff concluded, therefore, that the applicant's commitment is acceptable and will ensure that an adequate level of fire protection will be provided at CPSES Unit 2 until the Thermo-Lag fire barriers are cured to reflect the condition of the fire test specimens and the box enclosure issue is resolved.

Conclusions

Based on its observations during test laboratory site visits, plant site audits and inspections, and safety evaluations, the staff concluded that except for Scheme 1-2, the applicant's fire endurance tests for CPSES Unit 2, were conducted in accordance with the methodology and acceptance criteria specified in the staff's letter of October 29, 1992. The staff also concluded that except for the deviating box configurations discussed above, the Thermo-Lag 330-1 fire barriers installed in CPSES Unit 2 were bounded by the plant specific fire test schemes as to materials, methods of assembly, dimensions, and configurations or provided an equivalent level of protection. Moreover, the staff concluded that except for the deviating box configurations discussed above, the CPSES Unit 2 Thermo-Lag fire barriers meet the guidelines of BTP CMEB 9.5-1, Section C.5 and are, therefore, acceptable. Additionally, the applicant committed to resolve the staff's concerns (as discussed above) regarding the 36-inch cable tray bounding issue.

The staff concluded that the applicant's Thermo-Lag fire barri   program for CPSES Unit 2, with approved deviations, compensatory measures, and confirmatory resolution of the 36-inch wide cable tray configuration, meets the staff fire protection guidelines of BTP CMEB 9.5-1 and is, therefore, acceptable.

Test Scheme Configuration Description	Average Raceway Temperature	Maximum Individual Raceway Temp.	Average Cable Temp.	Maximum Cable Temp.	Barrier Condition	Cable Condition	Staff conclusions
Scheme 1-2 36" wide cable tray w/Tee Upgraded barrier design	294 °F	377 °F	263 °F	314 °F	Damaged by hose stream.	Satisfactory	Test not conducted in accordance with staff letter of Oct. 29, 1992. Staff required confirmatory test of 36 inch wide cable tray fire barrier configuration.
Scheme 9-1 5", 3", & ¾" dia. conduits w/JB Upgraded barrier designs	Indeterminate	Indeterminate	156 °F 204 °F 244 °F	191 °F 309 °F 290 °F	Satisfactory	Satisfactory	Satisfactory test. Indeterminate temperature evaluation documented in SSER.
Scheme 10-1 Two 3" dia. conduits w/JBs Upgraded barrier design	Indeterminate	Indeterminate	166 °F 163 °F 172 °F 146 °F	233 °F 232 °F 186 °F 198 °F	Satisfactory	Satisfactory	Satisfactory test. Indeterminate temperature evaluation documented in SSER.
Scheme 10-2 Two 3" dia. conduits w/JBs Upgraded barrier design	Indeterminate	Indeterminate	186 °F 197 °F 280 °F 259 °F	324 °F 294 °F 366 °F 334 °F	Satisfactory	Satisfactory	Satisfactory test. Indeterminate temperature evaluation documented in SSER.
Scheme 11-1 24" wide cable tray w/air drops Upgraded barrier design	Conduits: Indeterminate. Tray rail: 242 °F	Conduits: Indeterminate. Tray rail: 301 °F	199 °F 195 °F 202 °F 201 °F	291 °F 291 °F 253 °F 240 °F	Satisfactory	Some jacket blistering and cracking	Satisfactory test. See evaluation of indeterminate conduit temperatures and cable functionality in SSER.
Scheme 12-1 30" wide cable tray w/o Tee Upgraded barrier design	272 °F	363 °F	255 °F	311 °F	Satisfactory	Satisfactory	Satisfactory test. No test deviations.
Scheme 12-2 24" wide cable tray w/Tee Upgraded barrier design	287 °F	353 °F	229 °F	280 °F	Minor hose stream damage	Satisfactory	Satisfactory test. See evaluation of hose stream test damage in SSER.
Scheme 13-1 12" wide cable tray w/o Tee Upgraded barrier design	285 °F	330 °F	270 °F	285 °F	Satisfactory	Satisfactory	Satisfactory test. No test deviations.
Scheme 14-1 30" wide cable tray w/Tee Upgraded barrier design	283 °F	401 °F	242 °F	336 °F	Satisfactory	Satisfactory	Satisfactory test. See evaluation of maximum individual raceway temperature in SSER.

Table 1. Fire Endurance Test Schemes Applied To CPSES, Unit 2

Ampacity

The applicant completed performance of the fire endurance testing in December 1992 and provided an interim Engineering Report ER-ME-067, "Evaluation of Thermo-Lag Fire Barrier Systems", Revision 2 for staff review. The applicant has committed to complete the required ampacity derating tests by the completion of the first refueling outage for CPSES Unit 2. The following evaluation reviews the technical basis of the ampacity derating factors assumed for CPSES Units 1 and 2 over the interim period until the applicant can complete the ampacity derating tests and associated analysis.

NRC Requirements and Guidance for Ampacity Derating

GDC 17 requires that onsite electric power systems be provided to permit the functioning of structures, systems, and components important to safety. The onsite electrical power system is required to have sufficient capacity and capability to ensure that vital functions are maintained. The Institute of Electrical and Electronics Engineers (IEEE) Standard 279, "Criteria for Protection Systems for Nuclear Power Generating Stations," and IEEE Standard 603, "Criteria for Safety Systems for Nuclear Power Generating Stations," include guidance on acceptable methods of satisfying GDC 17 and the single failure criterion. These IEEE standards state that the quality of protection system components and onsite power system shall be achieved by specifying requirements known to promote high quality, such as the requirements for the derating of components, and that the quality shall be consistent with minimum maintenance requirements and low failure rates. Furthermore, IEEE-279 and -603 state that type test data or reasonable engineering extrapolation based on test data shall be made available to verify that protection system equipment continually meets the performance requirements determined to be necessary for achieving the system requirements.

In Regulatory Guide (RG) 1.75, "Physical Independence of Electric Systems," the NRC staff gave guidance for complying with IEEE Standard 279 and GDC 17 for the physical independence of the circuits and electric equipment comprising or associated with the Class 1E power system. The applicant uses Thermo-Lag 330-1 barriers to achieve physical independence of Class 1E electrical systems in accordance with RG 1.75. The staff's concerns about ampacity derating apply to Thermo-Lag 330-1 barriers installed to achieve physical independence of electric systems and to those installed to protect safe shutdown capability from fire.

Ampacity Derating Tests and the Application of Ampacity Derating Test Results

Cables enclosed in electrical raceways protected with fire barrier materials are derated because of the insulating effect of the fire barrier material. Other factors that affect ampacity derating include cable fill, cable loading, cable type, raceway construction, and ambient temperature. The National Electrical Code, Insulated Cable Engineers Association (ICEA) publications, and other industry standards provide general ampacity derating factors for open air installations, but do not include derating factors for fire barrier systems. Although a national standard ampacity derating test method has not been established, ampacity derating factors for raceways enclosed with fire

barrier material have been determined for specific installation configurations by testing.

The Thermo-Lag vendor has documented a wide range of ampacity derating factors that were determined by testing. For example, between 1981 and 1985, the vendor provided test reports to licensees that document ampacity derating factors for cable trays that range from 5.3 to 12.48 percent for 1-hour barriers and from 16.15 to 20.55 percent for 3-hour barriers. However, on October 2, 1986, the vendor informed the NRC and its customers by Mailgram that, while conducting a special services investigation in September 1986 at the Underwriters Laboratories, Incorporated (UL), it found that the ampacity derating factors for Thermo-Lag 330-1 barriers were greater than previous tests results (28.04 percent for 1-hour barriers and 31.15 percent for 3-hour barriers). However, the cable fill and tray configuration for each test differed from those tested previously. The NRC learned that UL performed duplicate cable tray baseline tests using a longer stabilization period (4 hours instead of 15 minutes) after the final current adjustment and obtained a higher baseline current, which yielded higher derating factors (36.1 percent for 1-hour barriers and 38.9 percent for 3-hour barriers). UL gave these test results to the vendor, but they were not submitted to the NRC or to licensees. While reviewing tests which had been conducted at Southwest Research Institute (SwRI) in 1986, the staff learned that the ampacity derating factor for another tested configuration was 37.4 percent for a 1-hour Thermo-Lag 330-1 barrier. The test procedures and test configurations tested at SwRI differed for each of the aforementioned tests. Therefore, the results from these different ampacity tests may not be directly comparable to each other.

The staff is concerned that the ampacity derating factors derived from the UL tests for similar Thermo-Lag 330-1 barrier designs are inconsistent with one another because of differing stabilization times, which calls into question the validity of the ampacity derating tests. While reviewing Industrial Testing Laboratories (ITL) test reports, the NRC staff noticed that ambient temperature and maximum cable temperature were allowed to vary widely for some tests (48°C instead of 40°C for ambient temperature and 94.4°C instead of 90°C for maximum cable temperature). ITL then used an ICEA procedure to calculate the ampacity derating factors by adjusting the tested current to 40°C ambient and 90°C cable temperature. Those tests may not be valid because the ambient and maximum cable temperatures were not maintained within specified limits in some tests. In IN 92-46, the NRC informed utilities that a licensee also discovered a mathematical error in the calculation of the ampacity derating factor as published in an ITL test report. A preliminary assessment of the use of lower-than-actual ampacity derating factors indicates that Thermo-Lag 330-1 barrier installations may allow cables to reach temperatures that exceed their ratings, which could accelerate cable aging.

The staff is also concerned that some licensees have not adequately reviewed the results of ampacity derating tests to determine if the tests are valid and if the test results apply to their plant designs. The staff ampacity derating concerns apply to the use of Thermo-Lag 330-1 on electrical raceways both as fire barriers to protect the safe shutdown capability and as barriers to create physical independence between electrical systems.

CPSES Fire Endurance Testing Results

As a result of the fire endurance testing conducted to date, the applicant has made the following conclusions:

1. Thermo-Lag material performs its design function if properly configured;

2. Thermo-Lag installations for conduit 2 inches diameter and smaller performs its design function when upgraded by addition of 1/4-inch thick overlay;

3. Thermo-Lag installations for cable trays perform their design function when unsupported bottom butt joints and vertical joints are reinforced with stitching and/or additional stress skin;

4. Thermo-Lag Box configuration for LBD boxes, JB boxes, etc. perform their design function when reinforced with additional stress skin;

5. Thermo-Lag 330-660 "flexi-blanket" installations on air drops perform their design function when properly configured.

A review of Engineering Report ER-ME-067 indicates that no deviations requiring cable functionality verification were identified by the applicant.

Interim Ampacity Derating Factors

The applicant selected the following cable ampacity derating factors for Thermo-Lag electrical raceways for CPSES Units 1 and 2:

1. 31 percent derating factor for single trays enclosed with Thermo-Lag material applied against ICEA P-534-440, "Cables in Random Filled Trays".

   Rationale:

   1 hour fire barrier derating factor taken based on 3 hour fire barrier test (1.0 inch thick Thermo-Lag product) as cited in the UL Report Project 86NK23826, File R6802. This determination is considered more conservative than the derating factor provided for the 1 hour fire barrier test (i.e., 28 percent).

2. 20 percent derating factor for single conduits enclosed with box design Thermo-Lag, applied against ICEA P-46-426, "Power Cable Ampacities ".

   Rationale:

   Derating factor has been determined by CPSES Calculation 16345/6-EE(B)-004.

3. 7.5 percent derating factor for single conduit enclosed with shell design Thermo-Lag, applied against ICEA P-46-426, "Power Cable Ampacities".

   Rationale:

   Derating factor was chosen based on the similarity of subject design to the TSI Report 111781 result for 1 inch conduit.

4. Other specific cable ampacity derating factors for free air wrapped cables.

Rationale:

Derating factors has been determined based on CPSES Calculation 16345-EE(B)-140.

Although the NRC Special Review Team recognized that in some extreme cases, nonconservative ampacity derating factors could induce premature cable jacket insulation failures over a period of time, the ampacity derating factor due to Thermo-Lag insulating properties represents but one variable to be used in determining the design ampacity for cable systems. For actual installations, the derating factors are typically applied to the ampacity values published in the ICEA Tables for each cable size. It should be noted that due to the conservative factors used, the ICEA ampacity values are lower than the base line values which have been typically determined by the ampacity derating tests. Cables are sized based on full load current times a factor of 1.25 in order to account for voltage and service factor requirements of the load. Upgrading of the cable size is another variable which may be required due to voltage drop consideration for long circuit lengths. Since most safety-related loads are operated intermittently, typically once a month during surveillance testing, the likelihood that cable related failures could be induced due to incorrect ampacity derating factors over the interim period has been judged by the staff to be improbable. The staff believes that the ampacity derating concern is an aging issue to be resolved over the long term. Therefore, the staff concludes that the use of interim ampacity derating factors is acceptable.

Additional Ampacity Derating Issues

In addition to the completion of the ampacity derating testing program, the following items were discussed with the applicant:

> Appendix C of the subject report references as the derating factor method "40% by Calculation/Testing ITL report 82-335-F-1" for cable trays. Although this report was not the report with the mathematical error identified in IN 92-46, the staff requested the applicant to clarify this reference.

The applicant responded by letter of January 25, 1993, stating that a cable derating factor of 31 percent was utilized using UL Report R6802. However, the applicant, in response to concerns raised by the NRC's Inspector General Report, performed a calculation to evaluate the acceptability of a 40 percent cable derating factor. The "40% derating by calculation" in Appendix C refers to this calculation. The applicant committed to revise the engineering report to reference the correct test report (UL 6802). The staff finds this acceptable.

The following issues were also discussed with the applicant, and will be reviewed further in conjunction with the staff's review of the applicant's ampacity derating test program:

1. The applicant states that ampacity derating based on ambient test environment of 40°C versus the normal plant ambient environment of 50°C (See Report Section 6.3) provides a more conservative parameter. The applicant discussed this issue further in their letter of January 25, 1993. The staff will review the applicable analysis which supports this assertion as part of the test program review.

2. The applicant states in the subject report that variations in configuration in the field that differ from the approved guidelines (for cable ampacity derating) are documented in the design change documents. The staff will review, in conjunction with the test program review, the engineering methodology used to determine that the ampacity derating was not impacted by the configuration variation.

3. Appendix C of the engineering report cites "various justification in DCA Engineering Basis" as the derating factor methodology for pull/junction boxes, electrical boxes in common enclosure, two conduits in common enclosure and two trays in common enclosure. The staff will review the technical basis for the acceptability of the derating factors assumed by TU Electric in conjunction with the test program review.

Conclusion

The applicant has committed in the engineering report (ER-ME-067, "Evaluation of Thermo-Lag Fire Barrier Systems"), to complete the required ampacity derating testing, and to identify corrective action, as required, by the completion of the first refueling outage for CPSES Unit 2. The staff will review the applicant's ampacity derating test program, which should be documented following the reporting requirements section of Generic Letter 92-08, "Thermo-Lag 330-1 Fire Barriers," specifically:

> State (1) whether or not the as-built Thermo-Lag 330-1 barrier configurations are consistent with the barrier configurations used during the ampacity derating tests relied upon by the licensee for the ampacity derating factors used for all raceways protected by Thermo-Lag 330-1 (for fire protection of safe shutdown capability or to achieve physical independence of electrical systems); (2) whether or not the ampacity derating test results relied upon by the licensee are correct and applicable to the plant design.

From the above, the staff concludes that there are no significant safety hazards due to ampacity derating concerns associated with the use of interim derating factors for cables enclosed by Thermo-Lag material for CPSES.

Seismic

As a result of the applicant's fire testing of the representative configurations of cable-trays conduits, junction boxes and their supports with representative Thermo-Lag material, the applicant decided to upgrade certain configurations to ensure their satisfactory performance in the plant. The upgrade consisted of (1) adding ¼ in. Thermo-Lag overlays on the existing Thermo-Lag for conduits 2 in. diameter and smaller, (2) stitching and/or installing stress skin layers to the unsupported bottom butt joints and

vertical joints, and (3) reinforcing the junction boxes, and box-out configurations of LBD boxes. This addition required the validation of the affected raceways and their supports. Also, the staff verified that the correct weights of the Thermo-Lag material were considered in the design of the electrical raceways and their supports.

This evaluation addresses the adequacy of the applicant's consideration of appropriate Thermo-Lag weights and seismic adequacy of the conduits, cable-trays and their supports. This evaluation also addresses seismic II over I considerations for Thermo-Lag material installed in the plant.

1. Weight Consideration:

   TU Electric letter of December 15, 1992 (TU Electric letter TXX-92589 to NRC), indicates that the applicant's quality assurance (QA) program for Thermo-Lag material required the verification of the weights of the prefabricated panels and conduit sections prior to shipment of the material (from the vendor) and at receipt inspection of the material at site. For example; the weight of a ½ in. (nominal) thick prefabricated panel was verified to be between 3.0 lbs/sq. ft. and 5.25 lbs/sq. ft., and that of a 3 ft. long half round section for 1 in. conduit to be between 2.6 lbs. and 4.5 lbs. The NRC staff verified the implementation of the QA requirement. Also, in TU Electric letter of December 23, 1992 (TU Electric letter TXX-92626 to NRC), Section 4.5.3, the applicant emphasized that the upper bound weights identified during the receipt inspection have been used in the seismic adequacy calculations. A review of TU Electric calculation No. 0218-CO-0429 confirmed the applicant's statement. A question, however, remained as to how the applicant assessed the weight of the trowelled Thermo-Lag material. For trowelled material, the applicant has used the material density of 84 lbs./cu. ft. However, depending on the density of the material, it could weigh up to a 120 lbs./cu. ft. In response to this concern, the applicant stated that the contribution of the trowelled material to the total Thermo-Lag weight was no more than 7%. Some difference from the assumed density would not affect the seismic analysis. The staff agrees with the applicant's assessment. Overall, the staff finds the applicant's consideration of Thermo-Lag weights in the seismic adequacy calculations reasonable and acceptable.

2. Seismic Adequacy of Electrical Raceways and their Supports:

   In Section 3.10B.3 of the FSAR, the applicant indicates that the full weights of the cable-trays and conduits (including the weight of the cables) have been used in the seismic analyses of the raceways and their supports. The FSAR does not explicitly indicate that the weights of the Thermo-Lag materials attached to the raceways have been considered in the analysis. However, Section 4.5.3 of TXX-92589 confirms that all Unit 2 electrical raceways and their supports have been qualified using the appropriate Thermo-Lag weights in accordance with the licensing basis documents. A review of sample calculations in TU Electric Calculation No. 0218-CO-0271 verifies the applicant's statement.

   One of the changes made in Section 3.10B.3 of Amendment 87 of the FSAR is related to the use of higher damping values (compared to the original FSAR

commitment) when the Thermo-Lag upgrades are considered for the safety related conduit systems. The use of the proposed higher damping values requires case by case studies. However, the applicant informed the staff that for qualification of the Unit-2 safety related conduit systems, lower damping values (i.e., 2% for OBE, 3% for SSE) had been used even in the upgrade validation program. The applicant stated this by letter dated January 19, 1993 (TU Electric letter TXX-93088 to NRC).

Based on the review of the typical calculations provided in calculation 0271, and the seismic design criteria in the FSAR, the staff concludes that the Unit 2 safety related electrical raceways and their supports have been seismically qualified in accordance with the staff guidance in the Standard Review Plan (NUREG-0800) and are acceptable. However, as a result of the applicant's validation program, a number of corrective actions (additions and modifications of raceway supports) are identified. These corrective actions were completed, as documented in TU Electric letter of January 28, 1993.

3. Seismic II over I Consideration for Thermo-Lag

The applicant classifies all fire-protection materials (including Thermo-Lag) as non-seismic. However, by provision C.2 of Regulatory Guide 1.29, "Seismic Design Classification", the failure of such material should not reduce the functioning of any Seismic Category I plant features. In Section 4.5.2 of TXX-92626, the applicant takes a position that the Thermo-Lag panels and sections are secured in place with extensive use of mechanical fasteners, staples, wire ties, additional stress skin, and steel bands, and would not fail in a gross manner (i.e., detachment of panels or sections from the raceways) to damage other Seismic Category I plant features. Based on the seismic analysis of the most commonly used panels and sections performed by the material supplier, and the tested material properties, the staff agrees with the applicant's assessment that in a maximum postulated seismic event at the plant, the Thermo-Lag material as attached to the raceways would not jeopardize the functioning of the essential plant features.

Conclusion

Based on the review of the applicant's submittals related to (1) Thermo-Lag weight consideration, (2) seismic adequacy of the safety related electrical raceways and their supports, and (3) II over I consideration for Thermo-Lag material; and audits of the implementation of the applicant's quality control procedure by the staff, the staff concludes:

1. The Thermo-Lag weights have been properly considered by the applicant in the seismic validation program.

2. The safety related cable-trays, conduits and their supports at CPSES Unit 2 affected by the additional weight of the Thermo-Lag material are able to withstand the postulated seismic loadings without exceeding the acceptance criteria commitments in the FSAR, and are acceptable. This conclusion is based on: (a) the higher damping values as proposed in Amendment 87 of the FSAR were not used for analyzing the Unit 2 conduit systems (as stated in

TU letter of January 19, 1993, and (b) the corrective actions as indicated by the validation program were implemented (as stated in TU letter of January 28, 1993).

3. The staff agrees with the applicant's assessment that the Thermo-Lag material as installed in the plant will not have damaging effects on other Seismic Category I features under the maximum postulated seismic event (i.e., SSE).

9.5.1.5.c Alternative or Dedicated Shutdown Capability

NRC Inspection Report 446/92-49 documents an onsite review of the applicant's safe shutdown capability. The inspection concentrated on specific circuits of concern, including those which have a physical separation that is less than that specified in Section III.G and have a connection to equipment whose spurious operation or maloperation could adversely affect the plant's safe shutdown capability. This concern is principally comprised of two items:

The maloperation of required equipment due to fire induced damage to associated cabling. Examples include false motor starts and stops, control signals, and instrument readings which may be initiated as a result of fire induced grounds, shorts, or open circuits.

The spurious operation of safety-related or nonsafety-related components that could prevent the accomplishment of a safe shutdown function.

The applicant has developed various methods to prevent and isolate spurious equipment operations that may occur as a result of fire. Specific examples noted include:

- administrative controls
- isolation/transfer switches which incorporate redundant fusing schemes
- fire wrap
- manual operator actions governed by written procedures

The applicant's post-fire safe shutdown analysis, for components having the potential to spuriously operate due to fire within a given fire area, such as flow path isolation or diversion valves, typically credits the use of manual operator actions. For interactions where reliance on manual operator actions is not feasible, other alternatives, such as fire wrapping of potentially affected cables have been implemented.

During a review (NRC Inspection Report 446/92-49) of plant schematic drawings and control circuit wiring diagrams, the staff noted that a postulated fire in the control room or cable spreading room could create a single hot short in the control circuitry of various motor operated valves (MOV), resulting in their spurious operation. The postulated fault could cause the position limit and torque switches to be bypassed. As a consequence, mechanical damage of the valve due to overtorque may occur. This condition could render the affected MOV inoperable (manually or automatically). This concern was previously described in detail by the NRC in Information Notice (IN) 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," dated February 28, 1992.

The applicant's assessment of this condition indicated the following:

CPSES MOV protection design is similar to the Washington Public Power Supply System Plant (WNP-2), i.e., all Class 1E thermal overload protection devices are bypassed for trip under all plant conditions

The concerns expressed in NRC IN 92-18, i.e., potential mechanical and/or electrical damage to MOVs sufficient to prevent operators from manually operating the valve, are valid for CPSES.

Approximately 55 MOVs are affected.

The control circuitry for the MOVs should be rewired internal to the motor control center (MCC) compartments so that the torque and limit switches in the valve operators are electrically connected downstream of the contacts located in the MCC.

The applicant's assessment of the Unit 2 modifications needed to correct the spurious operation condition indicated for those 55 MOV circuits which are vulnerable to failure that 41 MOV circuits potentially need to be modified and 14 require no modification.

In response to the NRC's concerns, the applicant committed in docketed correspondence dated December 23, 1992 (TU Electric letter TXX-92640 to NRC) to implement design changes in the control circuits of the affected MOVs, as required to assure that the torque and limit switches in the valve operators are electrically connected downstream of the contacts located in the MCC. The applicant committed to perform these alternative shutdown system design enhancements prior to startup from the first refueling outage for Unit 2 and prior to startup from the third refueling outage for Unit 1. These design enhancements will provide additional assurance, that a fire in either the control or cable spreading rooms, will not cause a spurious operation which will have an impact on alternative shutdown capability. The control and cable spreading rooms are equipped with fire detection and the cable spreading room contains automatic suppression. The control room is continually manned, and operators have been trained in manual fire fighting. The fire protection program in these areas meets Branch Technical Position 9.5.1, Appendix A. The staff finds the applicant's actions to address the concerns associated with IN 92-18 to be satisfactory and the planned corrective actions in conformance with their fire protection plan and therefore, acceptable.

9.5.1.5.e General Plant Guidelines

Electrical Cable Construction, Cable Trays, and Cable Penetrations

In SSER 12, the staff noted that there were small amounts of low-power service cable not qualified according to IEEE 383-1974 associated with radiation monitors and security systems located throughout the plant, and that they were all located in conduit, except for short connectors at the detectors. Further, the staff concluded that this was an acceptable deviation from Branch Technical Position (BTP) CMEB 9.5-1, Section C.5.e. In FSAR Amendment 87, the applicant noted that the same situation existed for the low-power service cabling for the Unit 2 secondary sampling system oxygen analyzer. The staff

concludes that this additional small amount of cable not qualified to IEEE 383-1974, does not change the staff's evaluation and conclusions given in SSER 12, and is, therefore, also acceptable.

Fire Resistant Cables

By letters dated July 29, 1991 (TU Electric letter TXX-91248 to NRC), and April 1, 1992 (TU Electric letter TXX-92163 to NRC), the applicant proposed to use Rockbestos Fire Zone "R" cable in various safety-related safe shutdown systems as one-hour fire barriers.

Specifically, in the July 29, 1991, submittal, the applicant submitted information regarding the use of Rockbestos Fire Zone "R" cables in Class 1E and non-1E power and control fire safe shutdown circuits. The proposed cable is constructed of a continuously welded, corrugated, 12-mil-thick, stainless steel sheath with high-temperature, nickel-clad, copper conductors; glass braid cable jacket; and silicone rubber insulation. This cable is used in power and control circuits for the equipment required for fire safe shutdown systems outside the containment. During a site audit, the applicant identified that this cable is used specifically in the following applications: a circuit breaker for the train "B" diesel generator, turbine-driven auxiliary feedwater pump turbine trip and throttle valve, train "B" RHR pump room fan, train "B" RHR pump recirculation valve, a breaker in the 480-V ac switchgear train "B," and train "A" centrifugal charging pump room fan and recirculation valve.

In areas where one-hour fire-rated cables are used outside the containment, both detection and automatic suppression are provided, with the exception of three areas: in the laundry holdup area at auxiliary building elevation 790 ft., in valve room 66 at safeguards building elevation 790 ft., and the safeguards building stairwell areas. These areas were identified by the applicant by letter dated May, 13, 1992 (TU Electric letter TXX-92232 to NRC). Each of these areas was evaluated in the fire hazard analysis, which established administrative controls on the maximum permissible fire loadings. The proposed cable size is limited to No. 8 AWG. The voltage levels of the proposed cables will be between 125 V dc/120-V ac and 480-V ac.

The applicant also submitted for staff review Underwriters Laboratories, Inc., Report File R10925-1, "Report on Fire Resistant Cables," dated April 10, 1984. This describes the detailed description of the tests conducted on cables sizes ranging from No. 14 AWG to No. 6 AWG. The staff reviewed the Underwriters Laboratories, Inc. test data report, which was performed in accordance with ASTM E-119, and found that the test configuration was representative of the proposed cable configuration to be installed at CPSES Unit 2. In a letter of May 13, 1992 (TU Electric letter TXX-92232 to NRC), the applicant provided an analysis regarding the adequacy of the raceway supports for the fire zone "R" cable supports. The analysis identified that the raceway supports are able to retain their structural integrity in case of fire.

The test data and the analysis also indicated that the Rockbestos cable retained its ability to function when exposed to water suppression in postfire conditions in that these conditions did not create shorts or postfire

mechanical forces that could affect the operability of the safe shutdown equipment.

On the basis of these reviews, the staff concluded that the proposed use of this cable in safe shutdown systems would not impair the ability of the plant to achieve and maintain safe shutdown in the event of a fire. Therefore, the use of Rockbestos Fire Zone "R" cables in the proposed applications is acceptable.

9.5.1.6 Fire Detection and Suppression

Fire Detection

The presence of fire detection systems was evaluated through review of the Fire Protection Report and by plant walkdown. Many of the partial installation issues which existed in Unit 1 and which required evaluations based on guidance in Generic Letter 86-10, do not exist for Unit 2 because full area detection was installed. Based on this review, which also included a comparison of the existing coverage for Unit 1, the detection for Unit 2 as described in Revision 6 to the Fire Protection Report is found to be acceptable.

Water Fire Suppression

The status of sprinkler system installation was reviewed during this evaluation. Although the number and type of systems are essentially the same for Unit 2 as exist in Unit 1, Unit 2 does not have the extent of partial coverage systems. In particular, the switchgear rooms in Unit 2 have been provided with complete coverage thereby eliminating the need for formal review of partial coverage configurations. At Comanche Peak Unit 2 automatic fixed water fire suppression systems are installed in safety related areas of the plant where a high fire hazard exists; where redundant safe shutdown equipment or cabling outside the containment building is located in the same fire area and is not separated by a three hour fire barrier; and where there is a congestion of cabling (e.g., tray stacks of four trays or more).

Several systems were walked down during the site visit including those in the switchgear rooms. The sprinkler installations and the selection of the thermal actuation setpoints of the ceiling level sprinklers follow the guidance of NFPA 13, "Standard for the Design of Automatic Sprinkler Systems." In addition to the ceiling level sprinklers, automatic fixed cable tray suppression systems in areas where cable congestion is present are installed. The cable tray suppression coverage is an extension of the sprinklers provided for area coverage. The current layout of these systems, for horizontal tray stacks, has the nozzles arranged in a "vertical stand-off" fashion, spaced 6-12 inches away from the tray side rails. The nozzles are on only one side of the tray stack and are offset 6-12 inches above the horizontal plane of the trays. In addition, the top of the tray is protected by nozzles positioned over the mid-line of the top tray. The individual cable tray water spray nozzles are provided with baffles. These baffles have a dual function, they

prevent "cold solder" effects[1] and act as a heat collector to improve the nozzle actuation time. The applicant's design basis for these systems is to confine a fire to the congested tray array. The applicant has applied certain aspects of NFPA 15, "Water Spray Fixed Systems For Fire Protection," to the design of the cable tray suppression systems. These systems are designed to apply a water spray application density of 0.15 gpm per ft^2 of cable tray. The cable water spray nozzles have an actuation setpoint of 175°F. It is anticipated that these cable tray water spray systems would react to a flaming cable tray fire condition in the following manner: as the fire transitions from a smoldering to a flaming phase the heat generated by the fire plume would be collected by the water spray nozzle baffle; this baffle, acting as a heat collector, will collect the heat generated by the fire plume and direct the heat towards the water spray nozzle fusible actuation element; and, based on the design and layout of these cable tray water spray system, the upper level nozzles would be the first to react to the fire condition and would control and confine the fire to the affected cable tray array. The design concepts used by the applicant and the philosophy associated with the installation and the application of the Unit 2 automatic water fire suppression were found to be consistent with Unit 1 and the guidance of Branch Technical Position 9.5-1, Appendix A and therefore, are acceptable.

Halon Testing

The status of testing the Halon systems was discussed with the applicant. Unlike Unit 1, the applicant does not intend to perform Halon discharge tests as part of the system acceptance testing. Rather, the applicant intends to perform a system design review coupled with a room integrity test using the "door fan" technique. This practice is consistent with current guidance provided in NFPA 12A, "Standard on Halon 1301 Fire Extinguisher Systems" which has been changed to address the environmental concerns associated with Halon discharge to the atmosphere; therefore, the staff finds this acceptable.

9.5.1.7.b Fire Protection of Specific Plant Areas

Control Room

In Section 9.5.1.6 of SSER 12, the staff stated that the applicant would install carpeting that has ASTM E-84 ratings of 30 for flame spread, 30 for fuel contribution, and 100 for smoke development in the control room. The staff concluded this was an acceptable deviation from Section C.7.b of Branch Technical Position (BTP) CMEB 9.5-1.

In Amendment 83 to the FSAR, the applicant indicated that in lieu of ASTM E-84, the control room carpet was purchased to comply with Class II, or higher, interior floor finish requirements of National Fire Protection

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[1] Cold Solder effects occur when an adjacent operating sprinkler sprays water directly onto the fusible operating element of an adjacent sprinkler. Without the use of a baffle to shield those sprinklers which are located within the zone influenced by the operating sprinkler, the water spray will create a significant delay on the operation of subsequent sprinklers in the area of the fire.

Association (NFPA) Code 101, 1991 Edition. However, the staff requires that Class I (not Class II) interior floor finish testing requirements be met. A minimum critical radiant heat flux of 0.45 watts per square centimeter, tested in accordance with NFPA-253, is the criterion for a Class I interior floor. The minimum critical heat flux for a Class II floor is 0.22 watts per square centimeter, which is less conservative. The staff has previously approved Class I floor finishes at other plants where the carpeting was purchased to NFPA 101 requirements in lieu of ASTM E-84.

The staff had previously determined (NRC Inspection Report 50-445/91-42; 50-446/91-42) that the installed carpet is equivalent to requirements previously approved by the NRC and is, therefore, acceptable. However, SSER 25 contained a confirmatory item to track the applicant's revision of the FSAR to conform with the approved installation. The applicant submitted an advance FSAR change by letter of December 22, 1992 (TU Electric letter TXX-92637 to NRC) which committed to incorporate in FSAR Amendment 88 a statement that the carpet installed in the control room envelope complies with Class I interior floor finish requirements of NFPA 101, 1991 Edition. This commitment and the proposed FSAR revision is acceptable.

Conclusion

Based on the review of the FSAR through Amendment 87 and the Fire Protection Report through Revision 6, the fire protection program for Comanche Peak Steam Electric Station Unit 2 is found to be acceptable. The requirements of 10 CFR 50.48 are met.

9.5.9 Emergency Diesel Generator Reliability

In August 1983, a crankshaft failed in an emergency diesel generator (EDG) at the Shoreham plant. The EDG was manufactured by Transamerica DeLaval, Inc. (TDI)[2]. As a consequence of this failure the nuclear facilities that owned TDI EDGs formed a TDI Owners Group which, in conjunction with the staff, initiated an extensive review of the acceptability of the TDI diesel generators for use as emergency power sources at nuclear power plants. This review was conducted in two phases, and consisted of a review of the design and an inspection of a large number of engine components. Phase I involved a design review of 16 major engine components and an inspection of the installed components to validate the quality of their manufacture. Phase I concentrated on engine components with known problems. Phase II was identical to Phase I, but was performed at a different time and concentrated on other important engine components. The activities associated with Phase I and Phase II reviews and inspections are known as the Design Review/Quality Revalidation (DR/QR) program.

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[2]On November 18, 1988, the Cooper Industries purchased the Enterprise Engine Division from IMO-DeLaval, Inc. (previously owned by Transamerica DeLaval, Inc.) and renamed the company Enterprise Engine Services, a division of Energy Service Group of Cooper Industries. In the interest of continuity, however, the staff will continue to use the abbreviation TDI throughout this evaluation.

The TDI Owners Group DR/QR program was evaluated for the staff by Pacific Northwest Laboratory, Inc. (PNL). The findings of the PNL evaluation relative to DR/QR actions for Phase I components are documented in PNL-5600, "Review of Resolution of Known Problems in Engine Components for Transamerica Delaval Inc., Emergency Diesel Generators," dated December 1985. The staff endorsed PNL-5600, with minor exceptions, in NUREG-1216, "Safety Evaluation Report Related to the Operability and Reliability of Emergency Diesel Generators Manufactured by Transamerica Delaval, Inc.," dated August 1986. The results of the PNL evaluation relative to DR/QR actions for Phase II components are documented in PNL-5444, "Review of Design Review and Quality Revalidation Report for the Transamerica Delaval Inc., Diesel Generators at Comanche Peak Steam Electric Station Unit 1," dated October 1985. PNL concluded that the studies conducted on the individual Phase II engine components were generally adequate and sufficiently detailed to establish that the components in service will perform their intended function. The PNL conclusion is also endorsed in NUREG-1216.

The staff has reviewed the QR action associated with Phase I engine components for Comanche Peak Units 1 and 2. The findings of these reviews were documented in SSER 22 and SSER 25 for Units 1 and 2, respectively. On the basis of its review in SSER 25, the staff concluded that with the exception of the open issues pertaining to the engine block metallurgical examination and procedural upgrades/commitments, the applicant had satisfactorily demonstrated compliance with the recommendations and requirements of PNL-5600 and NUREG-1216 regarding the Unit 2 TDI diesel generator Phase I components. This supplement addresses the findings of the staff review of the actions associated with Units 1 and 2, Phase II engine components required to implement the quality revalidation (QR) recommendations of the DR/QR program. The staff findings are addressed below.

<u>Phase II Engine Components QR Review</u>

Phase II QR activities covered 155 individual components on each of four engines. For the majority of components, two or more separate actions were necessary to comply with the QR requirements. Consequently, there were approximately 450 independent QR actions per engine for the staff to audit, or a total of approximately 1800 QR actions for both Units 1 and 2.

Of these above 1800 QR actions, some 132 are associated with the seismic qualification of engine-mounted, small-bore piping and piping supports. The applicant's program for determining the seismic adequacy of these components was evaluated independently from the staff audit by Brookhaven National Laboratories (BNL). The findings of the BNL evaluation are documented in BNL Report L-1161, dated September 1989. BNL concluded that the seismic qualification of on-engine small-bore piping and supports is acceptable. The staff concurs with the BNL findings. These 132 components were, therefore, excluded from part of the staff review of Phase II components. For the remaining Phase II engine components, the staff reviewed various documents relative to the completion of the associated QR actions. These applicant documents included work orders, maintenance action requests, technical evaluation reports, design change requests, station operation plans, data recording sheets, and inspection procedures. The staff review covered all of the individual Phase II QR actions for the EDGs in both Units 1 and 2. In

light of the number of QR actions and documents reviewed, however, this supplement will not include a written evaluation of each QR action. Rather, a generic conclusion is presented for each major area of review discussed below. In summary, the staff review revealed that more than 98 percent of the individual QR actions have been acceptably completed. In the few instances in which adequate documentation was not available at the time of the staff review, the applicant has implemented actions to complete them in a reasonable time. In a letter of December 18, 1992, the applicant committed to complete all open items for the Phase II DR/QR activities before the end of the first refueling outage of CPSES Unit 2. Therefore, on the basis of its review, the staff concludes that, with regard to Phase II components, the EDGs at Comanche Peak Units 1 and 2 are acceptable for nuclear service.

Confirmatory Issues from SSER 25

In SSER 25, the staff concluded that the applicant's actions relative to the Phase I components for the Unit 2 EDGs were acceptable with the exception of two confirmatory issues. The resolution of these issues, 5 and 6, is discussed below.

PNL-5600 contains a recommendation that the engine blocks be metallurgically examined to ensure that the microstructure is characteristic of typical gray cast iron of the grade specified for the block. The examination had not been conducted at the time of the staff Phase I review, and the staff concluded that the engine blocks would be acceptable on confirmation that the examinations had been successfully completed. The metallurgical examinations have now been completed and the results were documented in Failure Analysis Associated (FaAA) letters of October 26, 1992 (for Train A EDG), and August 18, 1992 (for Train B EDG). FaAA has concluded that the engine blocks can be classified as typical of ASTM A48 CL-40 gray cast iron that does not contain any evidence of Widmanstätten graphite. This conforms to the recommendation of PNL-5600, and the staff concludes that the engine blocks are acceptable. This resolves SSER 25 Confirmatory Issue 5.

PNL-5600 also contains a recommendation that crankshaft oil holes and fillets be non-destructively inspected at 5-year intervals. This recommendation is endorsed in NUREG-1216, but includes a 10-year interval corresponding to the major engine overhaul. The requirement to inspect crankshaft oil holes and fillets is included in the applicant inspection document REI-503, but there was confusion regarding the frequency of inspection. The staff concluded that the applicant's inspection program would be acceptable on confirmation that REI-503 was revised to accurately specify the proper inspection interval. On October 5, 1992, the applicant implemented the necessary changes in REI-503. The requirements now state that the first inspection would be conducted at the end of 5 years of operation and the subsequent inspections would be at 10-year intervals. The staff finds this consistent with the intent of NUREG 1216, and therefore, acceptable. This resolves SSER 25 Confirmatory Issue 6.

Outstanding Issues

Outstanding Issue 31 (from SSER 25) has two parts. The first part deals with revising the appropriate procedures at Comanche Peak to include actions to be taken in the event cracks occur in an EDG block. Specifically, in SSER 25,

the staff stated that the applicant should revise plant procedures to include the requirement to declare an EDG inoperable in the event cracks appear in the block top or cylinder liner landing area. In addition, the procedure should include the requirement for the EDG to remain inoperable until the proposed disposition or corrective actions or both have been approved by the staff. The applicant has submitted copies of revised procedures STA-501 and MSM-PO-374, both of which include appropriate language to implement the above requirement. The staff finds this acceptable and concludes that the first part of Outstanding Issue 31 is resolved.

The second part of Outstanding Issue 31 involves the requirements to air roll the EDGs before starting. The purpose of the air roll is to detect water in the cylinders which could cause severe engine damage on starting. Performing the air roll, however, requires the EDG to be rendered inoperable for a period of time. If the plant was in an Action Statement of Technical Specification (TS) 3/4.8.1 which requires that the engine be able to start, performing the air roll would cause the affected EDG to be inoperable along with the other ac source(s) that is/are inoperable. The staff, therefore, concluded that the applicant should revise plant procedures to ensure the air roll is not conducted when starting an EDG in accordance with an Action Statement of TS 3/4.8.1. The applicant has submitted a copy of revised procedure SOP-609B which includes a caution not to perform the air roll when in an Action Statement, if doing so involves a potential loss of function, or when the turbine-driven auxiliary feedwater pump is inoperable. This caution is consistent with the plant TS, and fully addresses the staff's concern. This procedure revision adequately resolves the remaining part of Outstanding Issue 31.

Maintenance and Surveillance Program

The staff evaluations and conclusions detailed above and in SSER 22 and SSER 25 pertain to actions associated with Phase I and Phase II engine components.

These actions were necessary to establish the initial acceptability of TDI EDGs for nuclear service. In addition to Phase I and Phase II, however, NUREG-1216 includes a discussion of an acceptable maintenance and surveillance (M/S) program which contributes to satisfactory engine performance and facilitates the timely identification of potential problems. The staff has concluded that an acceptable M/S program should include the manufacturer recommendations, additional items required by the staff as indicated in Section 2.1.3 of NUREG-1216, and the recommendations found in Revision 2 of Appendix II of the Comanche Peak DR/QR Report. The applicant has committed to implement an M/S program at Comanche Peak which incorporates the above elements. The applicant commitments are stated in Enclosure 4 to TXX-6236, dated February 13, 1987, and in Enclosure 4 to TXX-91336, dated December 19, 1991. In NUREG-1216, the staff also concluded that any changes to the M/S program should be subject to a review in accordance with the provisions of 10 CFR 50.59. In Enclosure 4 to TXX-6236 and Enclosure 1 to TXX-91336, the applicant has made such a commitment. The staff finds these commitments acceptable.

The elements of the M/S program described above have been integrated into a single applicant document entitled, "Results Engineering Inspection Manual-503

(REI-503)." The staff reviewed this document as part of its Phase I and Phase II reviews. On the basis of its review, the staff concludes that REI-503 adequately reflects the requirements/recommendations of NUREG-1216, the TDI maintenance and instruction manual, and Revision 2 of the DR/QR Appendix II. The staff also concludes that REI-503 adequately implements the applicant's commitments regarding an M/S program described above.

REI-503 is the applicant's principal document for the Comanche Peak M/S program. To implement this program, the applicant has entered the data from REI-503 into the Managed Maintenance Computer Program (MMCP). The MMCP is designed to automatically generate maintenance-related work requirements at the appropriate time. The staff reviewed the MMCP against REI-503 and found that REI-503 maintenance and surveillance requirements are fully reflected in the MMCP data base. The staff, therefore, concludes that the M/S program for Comanche Peak is fully implemented.

Conclusion

On the basis of its review of Phase II engine components and the M/S program described above, the staff concludes that all actions required to show that TDI EDGs at Comanche Peak Units 1 and 2 are acceptable for nuclear service have been completed. This concludes the staff's activities relative to the Comanche Peak DR/QR program.