TUELECTRIC

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U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES) - UNIT 1
DOCKET NO. 50-445
RESPONSE TO SAFETY EVALUATION OPEN ITEMS ON CPSES
UNIT 1 REGARDING THERMO-LAG CABLE FUNCTIONALITY ISSUES
(TAC NO. M85536)

REF:
1) NRC letter dated May 22, 1996, from Mr. Timothy J. Polich to Mr. C. Lance Terry

2) TU Electric letter logged, TXX-94157, from Mr. William J. Cahill, Jr., to NRC dated June 16, 1994

3) TU Electric letter logged, TXX-94267, from Mr. C. Lance Terry, to NRC dated November 9, 1994

This is in response to the open items identified via reference 1. The NRC staff's open items (as we understand them), and TU Electric's response to each open item are presented below:

**Open Item 1:**

For raceways at CPSES Unit 1, where the total enclosed thermal mass is less than the total enclosed thermal mass of the tested configurations, the test results do not provide an adequate basis for evaluating fire barrier performance. The rating of these barriers (if any) is therefore indeterminate, and these configurations may deviate from the licensee's commitment, in section 9.5.1 of the CPSES Final Safety Analysis Report (FSAR), to provide barriers having a fire resistance rating of 1 hour at CPSES Unit 1. This item remains open.

**Response:**

TU Electric selected conduit percentage fills which were representative of installed configurations. This allowed us to bound conflicting criteria



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associated with higher percentage fills such as:

1) Greater thermal mass
2) Increased metal-to-cable contact.

The higher the percentage fill of the conduit the greater the thermal mass, and the cables will tend to help cool the conduit (page 4 of reference. 1). However, as the percentage fill of the conduit increases the cables will have greater surface contact with the conduit walls. It is the staff's position that the cables "would experience a higher temperature profile because of the greater metal-to-cable contact, even though the average cable temperature would be expected to be lower because of the larger mass" (page 19 of reference. 1).

On page 5 of reference 1, the NRC staff states the following with regard to conduits with percentage fills less than the tested configurations: "For raceways at CPSES Unit 1, where the total enclosed thermal mass is less than the total enclosed thermal mass of the tested assemblies, the test results do not provide an adequate basis for evaluating fire barrier performance. The rating of these barriers (if any) is therefore indeterminate, and these configurations may deviate from the licensee's commitment, in Section 9.5.1 of the CPSES Final Safety Analysis Report (FSAR), to provide barriers having a fire resistance rating of 1 hour at CPSES Unit 1". This position is inconsistent with the staff's position, as stated on page 19 of the same report, that the higher percentage fill conduits would provide the worst case temperature profiles.

TU Electric has implemented its testing program such that we have tested Thermo-Lag barrier performance on a full range of raceway commodity sizes installed at CPSES, with representative cable fills, consistent with the methodology promulgated by NRC letter dated October 29, 1992. The barrier systems, raceway commodities and associated cabling configurations tested were representative of those installed at CPSES. No commitment was made by TU Electric relative to "bounding specific cable fills or mass enclosed contents by test." Reference 1 (page 4) states that cable fill information was provided in Appendix C of Engineering Report (ER)-ME-067 revision 2 was used as part of the basis to accept Thermo-Lag fire barriers at CPSES Unit 2. However, cable fill information was inadvertently deleted from revision 3 of ER-ME-067. The cable fill values provided in revision 2 are also applicable to tests performed for Unit 1. TU Electric will revise the ER-ME-067 to incorporate cable fill values which were inadvertently omitted in revision 3.

It is TU Electric's position that our test program provided an adequate basis for evaluating fire barrier performance, because the testing bounded our installed conditions with respect to this issue and that we have fulfilled our licensing commitments.

**Open Item 2:**

Test Scheme 11-4 did not meet the acceptance criteria for a hose stream test

as specified in the NRC letter dated October 29, 1992. An engineering analysis has not been submitted by TU Electric for NRC staff review to address this unsatisfactory condition. As this configuration has been declared acceptable by the licensee without NRC review and concurrence, the licensee may have deviated from the commitment specified in its September 24, 1992, letter. This issue remains open.

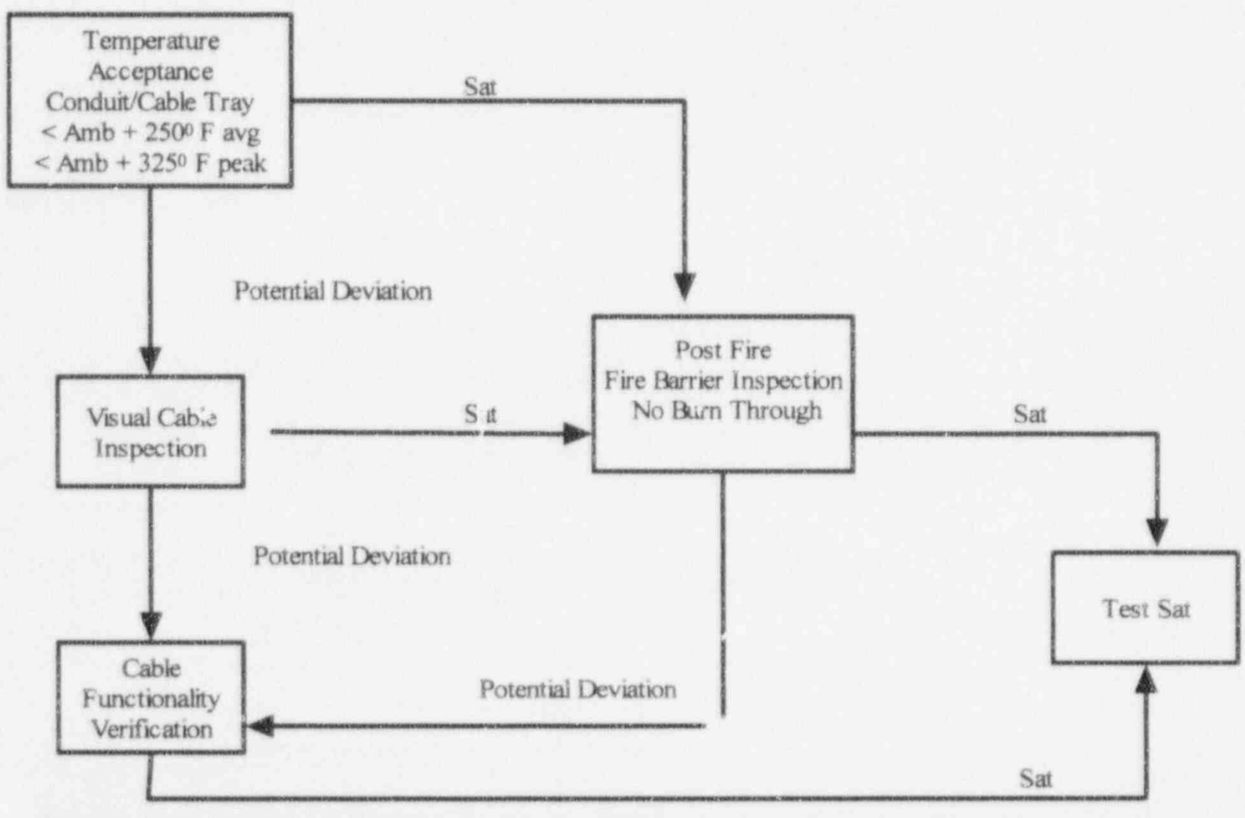
**Response**:

TU Electric asserts that the commitments specified in the September 24, 1992 and the October 29, 1992 correspondence have been met. Via reference 2 TU Electric has previously stated that, "[T]he recognized basis for the hose stream test is to provide reasonable assurance that fire exposure, the barrier system is capable of mitigating significant damage to enclosed raceway elements and cabling where subjected to in-plant fire fighting activities or external objects which may fall during a fire." The test sequence as depicted in October 29, 1992 letter is as follows:

<u>Test Sequence (Figure 1)</u>

| Build Sample → | Fire Test → | Fog Nozzle Test |
|---|---|---|
| Megger | Measure | Hot Megger |
| | Continuity | Fire Barrier Inspection |
| | Temperature | Functionality Tests * |
| | | Visual Cable Inspection * |

* If Required



Fire endurance test utilizing Scheme 11-4 was conducted on August 16, 1993. The fire endurance test, hose stream test and cable functionality (Megger) tests were performed to the requirements (acceptance criteria) of the NRC letter dated October 29, 1992 and TU Electric letter dated September 24, 1992 (illustrated in figure 1 above and documented in Omega Point Laboratories Test Report No. 12340-95767).

Scheme 11-4, as tested, met the requirements contained in the NRC letter dated October 29, 1992 and TU Electric letter dated September 24, 1992 for the following parameters:

a) single point and average temperature increase parameters were not exceeded,

b) the barrier opened during the hose stream test, however, a visual cable inspection revealed no apparent thermal damage to the conductor insulation, and

c) the results of the Megger tests were well within the allowable limits

d) as an additional conservative measure to ensure adequate performance of the installed fire barriers, box-out enclosures of this magnitude in the plant received additional seam reinforcement (stitching, in addition to stress skin), beyond that which was tested.

Based on the above, an engineering analysis is not and was not required. Nonetheless, additional analyses were performed by TU Electric on all Unit 1 fire endurance tests and submitted to the NRC via reference 3. The subject test was found to be acceptable. This acceptance is documented in reference 1, enclosure 2 paragraph 6.2.5. Based on the acceptance of this test TU Electric does not believe that further analysis is required or warranted.

**Open Item 3:**

The licensee references Test Scheme 4 as the basis for qualifying Thermo-Lag cable tray fire stops at CPSES Unit 1, however this test report was not provided for NRC staff review. Summary data regarding Test Scheme 4, provided by the licensee in ER-ME-067, Revision 3, states that the maximum single point temperature recorded was 466°F with a maximum average temperature of 380°F. These temperatures exceed the maximum allowable temperatures specified in the NRC letter dated October 29, 1992 (maximum single point 325°F above ambient, maximum average 250°F above ambient). The staff concluded that raceway barriers that have Thermo-Lag 330-1 fire stops installed similar to that configuration tested in Scheme 4 may not meet the acceptance criteria for a rating of 1 hour. Therefore, these configurations may deviate from the licensee's commitment in Section 9.5.1 of the CPSES FSAR, to provide barriers having a fire resistance rating of 1 hour at CPSES Unit 1. This item remains open.

**Response:**

TU Electric did not use Scheme 4 to certify firestops. We used Scheme 14-1 and 11-2, which are acceptable tests as depicted in NUREG 0797 supplement 26 to certify Unit 1 firestops. The Scheme 4 discussion submitted via reference 2 was for reference purposes and not certification of fire stops. It should be noted that TU Electric did not certify firestops based entirely on silicone foam construction. The certification of fire test relied on 330-1 Thermo-lag board material (with silicone foam) which did not exceed the required acceptance temperature criteria of 325°F above ambient (refer to fire endurance test scheme 14-1 and 11-2). Furthermore, this configuration does not deviate from FSAR Section 9.5.1, i.e., to provide barriers at CPSES Unit 1 which have a fire resistance rating of 1 hour. The firestop qualification is based on acceptable test Scheme 11-2. Moreover, TU Electric specification MS-38H "Cable and Raceway Fire Barrier Materials and Structural Steel Fireproofing," §3.2.11.3.a requires that silicone elastomer material be installed for fire stops. This specification was used to construct Unit 1 fire stops, therefore adequate confidence exists that 'foam' was not used to construct fire stops at CPSES Unit 1.

**Open Item 4:**

With regard to the silicone foam fire stops installed at CPSES Unit 1, where the qualification is based on CPSES Unit 2 fire tests, that utilized silicone elastomer, the staff concludes that as the material properties of silicone foam and silicone elastomer are significantly different (i.e., the density of silicone elastomer is 3 to 4 times that of silicone foam), no correlation of fire performance can be assumed. Therefore, the fire rating of raceway fire barriers that have fire stops constructed of silicone foam is indeterminate. These configurations may deviate from the licensee's commitment, in Section 9.5.1 of the CPSES FSAR, to provide barriers having a fire resistance rating of 1 hour at CPSES Unit 1. This remains an open item.

**Response:**

TU Electric did not certify fire stops based exclusively on silicone foam construction, the certification of fire test relied on 330-1 Thermo-Lag board material (with silicone foam) which was a tested condition and during tests did not exceed the required acceptance temperature criteria of 325°F above ambient (refer to fire endurance test scheme 14-1 and 11-2).

**Open Item 5:**

Based on information submitted to the NRC staff, the staff found that (1) there is insufficient evidence to demonstrate that Test Scheme 9-3 (1 ½" and 2" conduit) would ensure that the subject cables would function during and after exposure and (2) several factors (i.e., calculated composite and hot-spot cable IR values and apparent burn through on the 2" conduit specimen) also indicate unacceptable performance.

**Response:**

TU Electric has revised its functionality evaluations for 1 1/2" and 2" conduits. The revised evaluation addresses NRC concerns and demonstrates that the cables ( power, control and instrument ) installed in these conduits will perform their intended functions in the event of a design basis fire.

The first change is in the temperature profile. The new profile is a composite of the highest measured temperatures at each thermocouple group, regardless of the cable type which it was connected to. The new profile is then utilized to evaluate representative cable types for power, control and instrument circuits. This methodology has been employed because TU Electric concurs with the staff and SNL that a "composite" value provides and estimate of the cable IR over the full exposure length of the test cable. It is this value which can be considered an accurate analytical estimate of the actual cable IR which might have been measured had such measurements been made at the peak of the fire exposure." This methodology was indorsed provided that there was no evidence that the cable had been subjected to a "Hot Spot", which might be evident by jacket char. While there was some jacket char associated with these configurations, the damage was consistently attributed to Thermo-Lag damage found at LBDs and Radial bends. These locations were subsequently upgraded on all 1 1/2" and 2" conduits in Unit 1, consistent with the techniques of Test Scheme 13-2.

Another area of conservatism associated with the new temperature profile is the fact that the cable jackets are excellent thermal insulators. While the cable jackets are not credited in the calculation of the cable IR, they will provide a thermal barrier which will ensure that the cable will not experience temperatures as high as those recorded on the cable jacket.

With regard to the spacing of thermocouples, the 6 inch spacing was believed to be optimum. If they had been placed any closer, the entire cable would have been covered with the glass tape used to secure the thermocouples in place. This thin radiation and thermal barrier would have been sufficient to protect the cable from physical damage (which aided in determining where to upgrade configurations).

The evaluation now provides data for the evaluation of power and control cables, as requested by the staff. A difference in the TU Electric evaluation and the one performed by SNL is the addition of 40° C to the "Hot Spot " temperature. This was done to allow margin for power cable self heating. Cables in 1 1/2" and 2" conduits at CPSES have a minimum ampacity margin of 100%. This cable margin will ensure that the cables will perform more like a control cable which will operate at approximately room temperature. Since cable self heating would be insignificant no additional conservatism has been added to our temperature profile.

The second noticeable difference between our revised analysis and the one performed by SNL is our reliance on an Insulation Resistance in Ω- 1000ft. An acceptance criteria based on a Ω -1000ft value is useful only as a method to compare specific test results. Individual circuit analysis is the best

way to ensure that a cable will perform its intended function during a design basis fire. This was the methodology employed by TU Electric. It is also our position that this is the methodology endorsed in the Oct. 29, 1992 letter. The letter states, in part, "in determining the insulation resistance levels required for nuclear instrumentation cables, an assessment of the minimum insulation resistance value (e.g., one meg-ohm) and its potential impact on the functionality of these cable should be evaluated." The one meg-ohm value provided here is arbitrary. The final assessment of the cable's functionality must be based on a case-by-case evaluation.

TU Electric further contends that a 1 meg-Ω 1000ft was not an acceptance criteria required by the NRC in the Oct. 29, 1992 letter. The memo did provide an acceptable IR value for Megger tests "pre-fire, during the fire [if performed], and immediately after the fire test":

IR (meg-ohms) = {[(1 meg-ohm per Kv)+1x1000ft}/Length(ft)

This criterion was utilized by TU Electric and is documented in our test reports.

The following table provides the results of the revised functionality analysis:

Table 1

| Conduit Size | Cable Type | Composite IR | "Hot Spot" IR Ω - 1000 ft |
|---|---|---|---|
| 1 1/2 " | Power | 1.9 Meg Ω | 1.13E3 Ω |
| 1 1/2 " | Control | 2 Meg Ω | 1.58E4 Ω |
| 1 1/2 " | Instrument | 2.8 Meg Ω | 1.06E5 Ω |
| 2 " | Power | 8.7 Meg Ω | 1.05E4 Ω |
| 2 " | Control | 9.1 Meg Ω | 2.10E5 Ω |
| 2 " | Instrument | 12.5 Meg Ω | 1.15E5 Ω |

The analysis demonstrates that all representative cable types and constructions exceed 1 Meg Ω. TU Electric also concurs with the staff and SNL that the " 'composite' analysis provides a best-estimate of the actual cable IR which would have been measured for each of the test cables had such measurements been made during the peak exposure period." Our "composite" analysis has been performed in accordance with guidelines provided by the staff and SNL.

It should also be noted that SNL provided a revised minimum acceptance criteria based on "Hot Spot" Insulation Resistance values, given in Ω-1000ft. Since self-heating of the power cables is not a factor for our configurations TU Electric also meets the minimum value of 1E3Ω-1000 ft.

provided in the analysis performed by SNL.

As a final note, the staff has stressed within reference 1 that, TU Electric did not perform Megger tests during the fire endurance testing. There were several factors that contributed to TU Electric's decision not to perform the Megger tests at that time. If Megger testing was to be performed concurrent with the fire endurance test it was only required to be performed once during the test (please refer to NRC letter dated October 29, 1992).

1) If cable testing began soon enough to allow all cables to be tested prior to the completion of the 1 hour test the majority of the cables would not be near their maximum exposure temperatures. The measured IR values would not be representative of actual values.

2) If Megger testing began during the last minute of the test, all cables could not be tested. Tests would only provide data for conductors which could be tested in the final minute.

3) The Megger testing could have begun during the final minute of the fire test and the assembly could have been left in place until the Megger testing was complete (as suggested on page 24 of reference 1 enclosure 2). However, this would have extended the fire test beyond the ASTM E119 requirements and it would not have been possible to adequately assess the performance of the fire barrier. Additionally, the cable surface temperatures would have continued to increase, thus preventing us from assessing the effects of a 1 hour fire.

4) The Megger testing could have begun during the final minute of the fire test, and the assembly could have been removed from the furnace and Megger testing could have been performed prior to the hose stream test. This would have allowed the cables inside the Thermo-Lag to "bake" with much of the same effects that would have occurred if the test assembly had remained in the furnace. This configuration would not have provided meaningful data with regard to the performance of the fire barrier or the contained cables.

In any of the configurations, the only way to reasonably determine cable IR was by calculations based on actual cable temperatures. As stated on page 12 of reference 1 enclosure 2, this methodology is "securely established" and provides an accurate assessment of cable performance. When the numerous technical problems associated with conducting the Megger testing during the fire exposure were combined with safety concerns raised by the test lab, it was deemed by TU Electric that the Megger test would not provide useful information and should not be performed.

**Open Item 6:**

Based on information submitted to the NRC staff, the staff found that (1) there is insufficient evidence demonstrating that Test Scheme 11-2 (2" air drop) would ensure the subject cables would function during and after a fire exposure and (2) several factors (e.g., calculated composite and hot-spot

cable IR values, charring) indicate also unacceptable barrier performance.

**Response**:

The same revised methodology described in our response to item 5 is applicable to item 6 as well. TU Electric has utilized a worst case temperature profile, based on the highest measured temperatures at each thermocouple location. The new profile is then utilized to evaluate representative cable types for power, control and instrument circuits.

As in the evaluation performed for scheme 9-3, this evaluation does not utilize the additional 40° C as was done in SNL's "Hot Spot" evaluation. Cables in 2" air drops at CPSES have a minimum ampacity margin of 100%. As stated in our response to item 5 this will ensure that the cables will perform more like control cables which will operate at approximately room temperature. Since cable self heating would be insignificant no additional conservatism needed to be applied to the temperature profile associated with Scheme 11-2.

The results of our revised functionality are provided below:

Table 2

| Air Drop Size | Cable Type | Composite IR | "Hot Spot" IR Ω - 1000 ft |
|---|---|---|---|
| 2 " | Power | 3E5 Meg Ω | 5.20E3 Ω |
| 2 " | Control | 3.2E5 Meg Ω | 1.42E7 Ω |
| 2 " | Instrument | 4.4E5 Meg Ω | 4.71E7 Ω |

The analysis demonstrates that all representative cable types and constructions exceed 1 Meg Ω, and will perform their intended function in the event of a Design Basis Fire. It should also be noted that our "composite" analysis has been performed in accordance with guidelines provided by the staff and SNL.

SNL also provided a revised minimum acceptance criteria based on "Hot Spot" Insulation Resistance values, given in Ω-1000ft. Since self-heating of the power cables is not a factor for 2" air drop configurations TU Electric also meets the minimum value of 1E3Ω-1000 ft. provided in the analysis performed by SNL.

**Conclusion for Response 5 and 6**

The overall acceptability of the 1 1/2" conduits, 2" conduits and 2" air drop should be based on their ability to perform their intended functions during a Design Basis Fire. At CPSES this is ensured by the conservatism of the fire tests and ampacity margins associated with the cables themselves.

This foundation ensures that the temperature profiles utilized in our functionality evaluations are conservative and that the calculated IR values are representative of expected cable performance.

The first area of conservatism is in the fire tests themselves. The areas associated with the referenced commodities are in areas of limited combustibles. The amount of fixed combustibles can on average sustain an E119 fire profile for 12 minutes. The maximum amount of combustible material can only sustain a fire for 21 minutes. Since the temperatures used within our evaluations are representative of temperatures experienced at 60 minutes during our E119 fire tests, they will more than bound actual field conditions.

The next area of conservatism is associated with the cable ampacity of the affected cables. All of the affected cables have an ampacity margin of greater than 100%. With these ampacity margins, the power cables will perform similar control cables. This ensures that cables will not operate at temperatures high enough to cause cable self heating to be a concern.

The temperature profile is also based on the maximum temperature at any one thermocouple location, regardless of the cable type attached to it. This further ensures that the temperature profile is worst case. Our functionality evaluation has demonstrated that the power, control and instrument cable will perform their intended functions during and after a design basis fire.

**Open Item 7:**

The use of Test Scheme 15-2 for cables smaller than 750 KcMil [MCM] is an open item.

**Response:**

TU Electric Test 15-2 was performed to bound a "unique" configuration. TU Electric does not use this test to certify configurations that are less than 750 MCM cable.

Should you have any questions or need additional information, please contact Obaid Bhatty at (817)897-5839.

Sincerely,

C. L. Terry

By [signature]
J. J. Kelley, Jr.
Vice President, Nuclear
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OB:ob

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