February 14, 1994

Docket No. 50-446

Mr. William J. Cahill, Jr.
Group Vice President, Nuclear
TU Electric Company
400 North Olive Street, L.B. 81
Dallas, Texas 75201

Dear Mr. Cahill:

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON COMANCHE PEAK STEAM ELECTRIC STATION UNIT 2 REGARDING THERMO-LAG RELATED AMPACITY DERATING ISSUES (TAC NO. M85999)

During the review of TU Electric's submittal dated May 26, 1993, concerning Thermo-Lag related ampacity derating issues at Comanche Peak Steam Electric Station Unit 2, the NRC staff has determined the need for additional information. Enclosed is a list of questions.

The reporting requirements contained in this letter affect fewer than ten respondents; therefore, OMB clearance is not required under Public Law 96-511.

We request that you incorporate your responses to these questions into an engineering report regarding Thermo-Lag that we understand you plan to submit to the NRC in February 1994.

Sincerely,

Original Signed By

Thomas A. Bergman, Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosure:
Request for Additional Information

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REQUEST FOR ADDITIONAL INFORMATION

COMANCHE PEAK STEAM ELECTRIC STATION (CPSES), UNIT 2

THERMO-LAG RELATED AMPACITY DERATING ISSUES

1. The subject test report does not describe how the acceptance criteria as detailed in the IEEE Standard Procedure P848, "Procedure for the Determination of the Ampacity Derating of Fire Protected Cables," Draft 11, dated April 6, 1992, are met or not met by the test data. In accordance with IEEE-P848, the following criteria must be met in order to utilize the current data in the determination of the ampacity derating factor:

   (1) In order to statistically assure thermal equilibrium, the conductor temperatures should be averaged at each sampling period and a linear regression analysis performed on the data obtained in units of °C/hour. As soon as the absolute value of the slope of these data becomes less than 0.55 (conduit) or 0.35 (tray), equilibrium has been reached.

   (2) The current in each test circuit shall be adjusted so as to give an equilibrium temperature of 90°C ± 1.1°C at the hottest point monitored within location #2 (those located at the center of the system).

   (3) The average temperature of thermocouple locations #1 and #3 shall be within ± 4°C of the average thermocouple location #2.

   Contrary to the above criteria the following items were noted:

   (1) There were several instances in which the temperature measured failed to stay within the equilibrium temperature range of 90°C ± 1.1°C based on the hottest point monitored within location #2. The test report did not explain these anomalies.

   (2) The test report did not provide sufficient data to establish that the average temperature of thermocouple locations #1 and #3 remained within ± 4°C of the average thermocouple location #2 during the equilibrium period.

   (3) The test report failed to provide a continuous three hour period of data where the absolute value of the slope of the conductor temperature was less than the required value (0.55 for conduit, 0.35 for tray) thereby establishing that the equilibrium temperature had been reached for all tests except the 3C/#6 in Air Drop (Baseline), 3C/#6 in 24" Cable Tray (Baseline and Clad), 3-1/C 750 kcmil in Air Drop (Clad) and 4-1/C 750 kcmil in 5" Conduit (Clad) tests.

The licensee should describe in the summary engineering report how all the data fit together to support the ampacity derating conclusions as well as addressing t st data anomalies.

2. The second photograph in Appendix F of the Omega Point Report indicates that a flexible blanket (Sil-Temp) was placed on top of the cables in the cable tray prior to installation of the fire barrier system. However, no further documentation of either this material or the installation procedure was provided in the body of any of the TU Electric documents. The licensee should document this aspect of the procedure. Further, the impact of this blanketing material on the ampacity derating results should be addressed by the licensee. The licensee should provide an analysis that justifies the use of these test results for CPSES tray configurations that do not contain the blanket.

3. The licensee should definitively state (1) that a plastic sheet covering the bottom of the tray during the baseline test and (2) the option to default to tabulated ampacity derating values instead of the experimental values in the base line test case, were not used in the ampacity derating test procedure. Although these changes were implied by the deletion of references present in previous versions of the test procedure, there should be a specific statement verifying these facts.

4. It was noted that the heat distribution of the cable tray had an average temperature for (Thermocouples 27-39) Location #3 higher than the center Location #2 (Thermocouples 14-26). Identify the points in time when the final amperage reading was taken to determine the ampacity derating factors shown in the test results section of the test report. Since IEEE-P848 assumes the center position on the test specimen to be the hottest point during the ampacity test, describe the impact of higher than allowed (> 4°C) temperatures at other thermocouple locations in the determination of the ampacity derating parameter. Should not the hottest temperature measurement be used irrespective of location in order to determine the ampacity derating factor?

5. The test report did not include the computer program for the data acquisition software used to average temperatures and determine temperature rate of change parameter (i.e., slope). Please provide a listing of the program line instructions and an explanation of any variables or nomenclature associated with the test measurements.

6. The licensee should perform a one-to-one comparison of any mathematical models to the available experimental results if used in any Comanche Peak Steam Electric Station Unit 2 configuration. If models were not used, please provide an explicit statement to that effect. In addition, the licensee should demonstrate that all tested or analyzed configurations are representative of the full range of applications actually present in CPSES Unit 2.

7. TU Electric identified in their engineering report multiple conduits/trays in a common enclosure. In addition, the licensee identified approximately 180 cases as noted in CPSES Supplementary Safety Evaluation Report 26 where the application of Thermo-Lag barrier materials used to protect electrical raceways and structural steel deviated from the tested configurations. The tests performed by the licensee do not apply to multiple trays or conduits in a single box. A large percentage of the heat is rejected off of the outer surface of both cables and the enclosure via thermal radiation. Multiple trays will inhibit radiative transfer since each tray would receive thermal radiation from a neighboring tray. In fact, the same concern would apply to trays which are individually protected, but contained within larger stacks of trays. Please provide analyses or tests to justify ampacity derating factors for these non-standard configurations.

8. The licensee stated that ampacity derating based on ambient test environment of 40°C versus the normal plant ambient environment of 50°C provides a more conservative parameter. The licensee provided the following explanation in their January 19, 1993 letter to the staff:

> "As the temperature of an insulating material increases the thermal conductivity increases. Therefore, since the resistivity is inversely proportional to the conductivity as the thermal conductivity of Thermo-Lag increases its thermal resistance will decrease. The thermal resistance of Thermo-Lag will be greater at 40°C than at CPSES's plant ambient of 50°C. With a higher thermal resistance, the cable derate factors will be higher. Therefore, the CPSES utilization of cable derate factors derived from tests conducted at 40°C ambient instead of 50°C is conservative."

The staff agrees that if properly applied, the ampacity correction factors (ACF) determined for Thermo-Lag at a 40°C ambient will be a conservative estimate of ACFs at a 50°C ambient because the thermal conductivity of Thermo-Lag will be somewhat higher at the higher ambient. The degree of conservatism introduced would, however, be small because conduction through the insulating barrier is not a dominant factor in the overall heat transfer process. The heat flux will obviously be higher between 90 and 40 degrees, for all reasonable resistivity variations.

The fact that the conductivity of one of the materials decreases with temperature will not counteract the increased driving potential. The licensee is requested to explain how the test results will be utilized with a 50°C ambient cable rating at CPSES Unit 2.

9. The licensee's analysis described in Attachment 3 of the letter from William J. Cahill to the U.S. NRC dated February 26, 1993, had several problems. For example:

The first equation in the subject attachment is a comparison of two ampacity correction factors (ACF) found numerically (number in parentheses refers to cable fill depth).

$$\frac{ACF(3) - ACF(1)}{ACF(3)} = \frac{78 - 75}{78} = 0.038 \qquad (1)$$

Attachment 3 states that the ACF for a 3-inch fill is 3.8 percent greater than that found for a 1-inch fill. However, the ampacities (actual current carrying capacity) for the various depths are significantly different.

Equation 1 can be rewritten where the ACF values are replaced by current ratios. Then it is seen that Equation 1 is the percent difference between ratios that do not have the same denominator:

$$\frac{\frac{I_{3,i}}{I_{3,b}} - \frac{I_{1,i}}{I_{1,b}}}{\frac{I_{3,i}}{I_{3,b}}} = 0.038$$

where $I_{x,y}$ is the current. The first subscript indicates the depth of cables, and the second subscript indicates if the cable tray is insulated or bare. It is difficult to see how the above result can be multiplicatively applied to anything with dimensions of amperes (as is done later in Attachment 3). The result should only be multiplicatively applied to an ACF.

The second equation in the subject Attachment is a standard correction to be applied to cables when the ones in use are of slightly different dimensions than the cables that are tabulated:

$$I_x = \frac{d_x}{d_o} I_o \qquad (2)$$

Equation 2 is a valid expression endorsed by the industry ampacity tables.

The third equation in the subject attachment applies the second equation to a specific example. It corrects a tabulated ampacity for a 0.72-inch cable packed to a one-inch depth to the 0.75-inch cable at a one-inch depth:

$$I_x = \frac{0.75}{0.72} 44A = 45.8A \quad (3)$$

The fourth equation in the subject attachment appears invalid since it seems inappropriate to apply the result from Equation 1 to the ampacity of a 0.75-inch diameter cable packed to a 1-inch depth. The units of the percentage change term do not equal amperes over amperes. Therefore, it is inappropriate to modify actual ampacity ratings in this manner.

$$45.8A \times 0.038 = 1.74A \quad (4)$$

Finally, the conclusion as stated in Attachment 3 does not appear to be logically derived from the analysis presented and is unclear. The 9.5 percent is the conservatism found built into a single case in the IPCA ampacity tables (which reports currents in amperes) and the 3.8 percent is the difference between two calculated ACFS. The licensee is requested to review, clarify and justify the analysis in Attachment 3.

10. The licensee's submittal failed to address the effects of inductive currents evident in the test on the 3/C 750 kcmil in 5" conduit specimen. The staff has noted that for similar tests performed by Tennessee Valley Authority using the IEEE-P848 procedure, those test specimens using 3 conductor configurations resulted in higher phase angles and voltages with lower current levels than the 4 conductor test configurations. The inductive currents result from unbalanced current flows associated with the odd number of conductors traveling through the conduits. The licensee should indicate how those conduit tests conducted using a three conductor configuration provide conservative results.