UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO GENERIC LETTER 92-08, "THERMO-LAG 330-1 FIRE BARRIERS"

COMMONWEALTH EDISON COMPANY

LASALLE COUNTY STATION, UNITS 1 AND 2

DOCKET NOS. 50-373 AND 50-374

1.0 BACKGROUND

Listed below is a brief outline of the history associated with the staff's review of LaSalle's fire barrier analyses:

5/18/94: The staff issued a Request for Additional Information (RAI) to obtain information on the licensee fire barrier test program (letter from A. Gody, Jr. to D. L. Farrar dated May 18, 1994).

6/2/94: Commonwealth Edison Company's response describes its ampacity derating methodology.

11/17/94: Second RAI issued by the staff requested information regarding licensee ampacity calculation.

6/2/95: Licensee response included Calculation No. 4266/19G52 dated March 4, 1994, for analysis of a combination Darmatt and Thermo-Lag fire barrier configurations (1 – 30 inch wide by 4 inch height cable tray and 1 – 30 inch wide by 6 inch height cable tray for each nuclear unit).

10/25/95: Third RAI issued by the staff requested information regarding Calculation No. 4266/19G52.

12/22/95 Commonwealth Edison Company submitted its response to the October 25, 1995, RAI regarding the ampacity derating analyses performed for the LaSalle County Station, Units 1 and 2, installations.

Although one staff question was addressed in the licensee submittal dated December 22, 1995, there remained a number of open issues and concerns regarding licensee Calculation G-63. The subject Calculation was also the subject of similar staff inquiries for the licensee's Braidwood and Byron Nuclear Stations. The staff's review of the LaSalle installations remained open pending completion of its review for Braidwood and Byron.

ENCLOSURE

2.0 EVALUATION

Listed below are the questions provided to the licensee in the staff's October 25, 1995, RAI and the licensee's responses as stated in their December 22, 1995, letter. Following that is the staff's analysis.

2.1 Question 1

The licensee's analysis, as documented in Attachment B of the June 2, 1995, submittal, Sargent & Lundy (S&L) Calculation 4266/19G52, Revision 0, "Ampacity Derating for Combination Thermo-Lag 330-1 Material and Darmatt Firewrap," begins with an assumption that the open top industry ampacity tables provide an accurate representation of the ampacity values, which will result in a 90 degree Celsius cable conductor hot spot temperature in an open top tray. It is generally recognized that for most, although not all cases, the subject tables provide a modest margin on operating ampacity.

Given this margin, the licensee methodology effectively assumes a lower bound value for the baseline heat load, and hence, would be expected to determine by calculation an upper bound value for the internal cable-to-cable tray thermal resistance factor. This result arises because the external resistance factors are fixed in accordance with the correlations used, and the driving temperature drop is fixed by the assumed values of cable and ambient temperature. Once the value of ampacity, i.e., heat load, is fixed then the internal resistance can be determined for the particular configuration. Hence, using a lower bound ampacity value with a downward bias would have a nonconservative effect because the higher internal resistance estimate would lower the baseline ampacity value thereby lowering the overall ampacity derating factor for the fire barrier system.

For the subject licensee analysis, the effect of this approach would be minimal given the nature of the tray type specified, i.e., the solid bottom cable tray. In fact, the industry ampacity tables provide an accurate estimate of the open top ampacities for a solid bottom tray due to the nature of Stolpe's original experiments.

The approach used to determine the internal resistance between the cables and the surface of a covered cable tray were based on the referenced 1982 ampacity experiments which used solid bottom cable trays. Therefore, the subject analysis is limited to the solid bottom cable tray application. In fact, the 1982 American Power Conference paper, "Tests at Braidwood Station on the Effects of Fire Stops on the Ampacity Rating of Power Cables," makes note of the fact that the industry ampacity tables were found to be nonconservative for some of the tested configurations.

Based on the above discussion, the licensee is requested to confirm that all of the cable trays under consideration for LaSalle County Station are solid bottom trays of the type used in the original tests performed for Braidwood Station as reported in the subject 1982 paper. If other types of cable trays are applicable for LaSalle County Station, then a specific and detailed justification for the applicability of the licensee methodology should be submitted by the licensee.

Licensee Response

All of the cable trays under consideration for LaSalle County Station are solid bottom trays of the type used in the original tests performed for Braidwood Station, and are governed by the methodology provided to the NRC staff in its submittal dated June 2, 1995.

Staff Analysis

The information provided by the licensee fully resolves the staff's concerns.

2.2 Question 2

The subject calculation (S&L Calculation 4266/19G52, Revision 0, "Ampacity Derating for Combination Thermo-Lag 330-1 Material and Darmatt Firewrap") is inconsistent with a similar calculation, ComEd Calculation G-63, Revision 2, "Darmatt Firewrap Material Cable Ampacity Derating Factor Calculation," dated January 23, 1995, and has the following discrepancies:

a. The subject Calculation does not include a thermal resistance factor associated with an assumed air gap between the firewrap and the cable tray. Calculation G-63 assumes a 1/16 inch air gap between the firewrap and the cable tray.

b. The input data parameter in the subject Calculation for the thermal conductivity of Thermo-Lag 330-1 material is 0.1 Btu/Hr-Ft-degree R (Rankine). Thermal Science Inc., Brochure 7.14, "Fire Resistive and Fire Retardant Subliming Coating System," specifies a thermal conductivity value of 0.1 Btu/Hr ft^2 °F/ft.

c. The input data parameter in the subject Calculation for the emissivity of the Darmatt surface is 0.6. Calculation G-63 specifies a emissivity value for the Darmatt surface of 0.7.

The licensee is requested to address the above apparent discrepancies and to revise its analysis accordingly.

Licensee Response

Calculation 4266/19G52, Revision 0, calculates the ampacity derating factor for a fire barrier installation that models a 1-hour fire barrier of Thermo-Lag 330-1 enveloped by an additional 1-hour fire barrier of Darmatt KM-1. This was done with the conservative assumption that no Thermo-Lag 330-1 would be removed with the installation of the Darmatt KM-1, when in actuality, essentially all Thermo-Lag has been removed except for some residual amount of the material remaining in Uni-Strut channels. This residual material is covered with the Darmatt material. The ampacity derating evaluation provides the basis to conclude that the affected power cables will perform their intended safety function with a modeled two-hour fire barrier. Accordingly, the calculation is considered to be conservative for the actual 1-hour fire barrier installation and is considered to acceptably represent this as-installed application.

a. Since the Thermo-Lag has been removed, the use of the Thermo-Lag thermal conductivity value for calculating the equivalent thickness of fire barrier material, results in essentially the same equivalent thickness for a 1-hour fire barrier, in comparison to the use of the thermal conductivity of air in Calculation G-63, Revision 2 (i.e., t = 1.531 inches vs. t = 1.508 inches, respectively). This is considered to be acceptable.

b. The thermal conductivity input value of 0.1 Btu/Hr-Ft °R was provided in a March 29, 1980, Thermal Science, Inc., letter to S&L, and was accordingly used as input to Calculation 4266/19G52, Revision 0. The units provided are consistent with the heat transfer equations used to determine the resistance of the fire wrap in °R-ft-hr/Btu in the calculation. These equations were taken from the calculation reference #4, "Heat Transfer Data Book," Schenectady, New York, General Electric Company, 1977, Kaminsky. D. A. (editor), for calculating the thermal resistance of the Thermo-Lag 330-1. Therefore, this input value is acceptable for Calculation 4266/19G52, Revision 0.

c. The emissivity value of 0.6 was based on early product data provided for the Darmatt KM-1 Fire Protection System, for the LaSalle County Station application, and it was the value specified at the time of Calculation 4266/19G52, Revision 0, preparation (March 1994). Subsequently, with the continued development of the Darmatt KM-1 Fire Protection System, the product data was revised in July 1994 to include an emissivity value of 0.7. This was used as input for Calculation G-63. The use of 0.6 is conservative in determining the radiation heat transfer from the surface of the wrapped tray for establishing the ampacity derating factor value.

It is recognized that incorporating the new data into the calculation would result in a calculation that may be more current with respect to input values. However, because of the conservatism in the calculation, this would not result in a significant change in the conclusion of the calculation nor a change in the ampacity derating factor determined for LaSalle County Station. Therefore, a revision to the calculation is not warranted at this time.

Staff Analysis

The information provided by the licensee for Calculation G-63 was considered to be incomplete given staff concerns associated with the ampacity derating reviews for Braidwood and Byron Stations that were outstanding at the time. Subsequent to the December 22, 1995, letter ComEd submitted additional information related to concerns associated with the reviews for Braidwood and Byron. The staff, in conjunction with its contractor, Sandia National Laboratories, has reviewed the additional information and concluded that it resolves the staff's concerns. The staff's review and the contractor's report are documented in a letter to ComEd dated November 2, 1999. This information resolved the open items as discussed below.

The licensee developed Calculation G-63 to determine the ampacity derating parameters for cable tray and conduit fire barrier configurations cladded with Thermo-Lag and Darmatt material in the standard design as described in IEEE Standard P848.

Calculation G-63 utilized with limited validation the following approach:

1. For conduits, first the baseline case of a conduit without any fire cladding was evaluated using heat transfer analysis to determine an ampacity value. This process was repeated using a similar thermal model which included the effects of the cladding material thereby representing the cladded case. The results of the two cases are then used to calculate an ampacity derating factor.

2. For cable trays, a similar analysis as outlined in (1) above is performed except that the baseline case uses a covered cable tray. The baseline case analysis also factors in the industry standard ampacity table values and earlier ampacity tests which were performed by the licensee to support the initial plant design and construction. This base case is then used to establish the net thermal resistance between the cables and the surface of the cable tray. In the cladded tray analysis, the added thermal insulation due to the cladding is incorporated into the external heat transfer behavior. The results of the two cases are then used to calculate an ampacity derating factor.

Overall, the staff found that the subject calculation possessed a net level of conservatism and was acceptable for ampacity derating determinations.

Disposition of Outstanding Concerns

Based on the additional information received and the review by Sandia National Laboratory which is documented in an enclosure to the November 2, 1999, letter to ComEd, the staff has made the following conclusions regarding the licensee's responses to Question 2, above:

a. The staff has concluded that the licensee adequately addressed the error in air gap treatment in a revision of Calculation G-63.

b. The licensee confirmed that the thermal conductivity input value was the correct value for Calculation No. 4266/19G52.

c. The information provided by the licensee fully resolves the staff's concerns.

Given that the licensee's methodology utilizes the appropriate industry test data and there are conservative features to ensure that the results are reasonable, the staff finds that the available information supports the conclusion that the fire barrier protected cables at LaSalle County Station, Units 1 and 2, are operating within acceptable ampacity limits for the applicable configurations.

3.0 CONCLUSIONS

From the above evaluation, the staff concludes that for LaSalle County Station, all of the ampacity related concerns have been resolved and the licensee has provided an adequate technical basis to ensure that all of the fire barrier enclosed cables are operating within acceptable ampacity limits. Therefore, the staff finds that there are no outstanding safety concerns with respect to GL 92-08 ampacity derating issues.

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Dated: