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 AMPACITY DERATING ISSUES

COMMONWEALTH EDISON COMPANY

BYRON STATION, UNITS 1 AND 2

BRAIDWOOD STATION, UNITS 1 AND 2

DOCKET NOS. STN 50-454, STN 50-455, STN 50-456 AND STN 50-457

1.0 BACKGROUND

On July 9, 1997, the NRC sent a Request for Additional Information (RAI) related to analytical calculations and ampacity methodology for a range of fire barrier installations for Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2, to Commonwealth Edison Company (ComEd, the licensee). The issue was a part of the staff's review of Thermo-Lag 330-1 Fire Barriers (Generic Letter 92-08). A telephone conference call was held between the staff and licensee representatives on February 2, 1998. By letter dated September 8, 1998, ComEd responded to the RAI.

The history of the review effort is summarized as follows:

2/15/95 The licensee submittal documented analyses of installed cable ampacity factors for two Appendix R cable tray and conduit fire barrier systems - Thermo-Lag and Darmatt. The calculations pertained to standard barrier configurations as described in the Institute of Electrical and Electronic Engineers (IEEE) Standard P848, "Procedure for the Determination of the Ampacity Derating of Fire Protected Cables."

11/2/95 Based upon several identified points of concern, the staff sent an RAI to the licensee for further clarification.

3/21/96 The licensee provided a limited response to the staff's RAI of November 2, 1995.

7/12/96 The licensee provided a second response to the staff's RAI of November 2, 1995, that included a new set of ampacity calculations for a range of "non-standard" fire barrier configurations involving multiple cable trays and/or conduits in a common barrier enclosure.

ENCLOSURE

7/9/97 Four points of concern which were identified related to the non-standard cable tray configurations were transmitted to the licensee in an RAI for further clarification. The previously identified concerns that were associated with the staff RAI dated November 2, 1995, were adequately resolved (see Attachment 4).

9/19/97 The licensee provided a response to the RAI dated July 9, 1997.

2/08/98 A telephone conference meeting was held with the staff, the contractor (Sandia National Laboratories (SNL)) and licensee representatives to discuss one unresolved issue related to the inconsistencies in the analysis of the baseline versus clad or barrier enclosed cases.

9/08/98 The licensee provided a response to the remaining point of concern.

The staff RAI dated July 9, 1997, had identified four remaining concerns requiring clarification by the licensee. The licensee's submittals dated September 19, 1997, and September 8, 1998, contained the response to staff questions regarding its ampacity derating methodology. The staff, with the assistance of SNL, has evaluated the licensee's submittals for Byron and Braidwood. SNL's evaluations are included in four Technical Letter Reports: "A Review of the September 1998 Braidwood RAI Supplemental Response on Cable Tray Ampacity Derating Calculation Method," dated February 22, 1999 (Attachment 1); "A Review of the Braidwood RAI Response Related to Calculation BYR96-082/BRW-96-194," dated November 20, 1997 (Attachment 2); "A Review of the Braidwood Station Calculation BYR96-082/BRW-96-19[4] on Fire Barrier Ampacity Derating Factors for Special Configurations," dated May 2, 1997 (Attachment 3); and "A Supplemental Review of the Braidwood Station Response to the USNRC RAI of 11/2/95 on Fire Barrier Ampacity Derating Factors," dated December 20, 1996 (Attachment 4). An Errata for Attachments 1-4 is included as Attachment 5.

The staff's evaluation of the ampacity derating methodology for Braidwood and Byron Stations follows.

2.0 EVALUATION

As a result of its review of the licensee's submittals and the SNL Technical Letter Reports (Attachments 1 through 4), the staff agrees with the SNL analyses and conclusions. The ampacity derating analysis questions, the licensee's responses, and the staff's evaluations of the responses follow.

2.1 Ampacity Derating Analysis Review

- Question 1

  SNL finds that the subject submittal is, in effect, comparing two different items. In particular, the licensee assessments of base line ampacity limits derive from a licensee table of allowable heat intensity limits while the clad case ampacities derive from the thermal model. This is considered by SNL to be extremely poor practice and, hence, is unacceptable. SNL recommends that estimates of fire barrier Ampacity Derating Factor (ADF) should be based on self-consistent treatment of the clad and base line cases. In

this case, it is considered critical to assess both the clad and base line ampacity limits using a self-consistent thermal model. If the thermal model is used to predict the clad ampacity limits, then a thermal model fully consistent with the clad case analyses should also be used to assess the base line ampacity limits as well. The licensee is requested to implement a thermal model for the analysis of the base line case ampacity that is fully consistent with its clad case analyses, and to then base its final ampacity derating assessments on a comparison of the clad and base line thermal analysis results.

Licensee Response

In its submittal dated September 8, 1998, the licensee presented a new set of calculation results modified to address the subject points of inconsistency.

Staff Response

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

- Question 2

The licensee has presented a table of heat intensity versus depth of fill values (Item 13 of page 13 of the subject submittal). This table is in apparent conflict with the heat intensity values cited by Stolpe and in the ICEA[1] Standard P-54-440. The cited values appear to modestly overstate allowable heat intensity limits and, hence, might lead to optimistic estimates of the cable ampacity limits. The licensee is requested to establish the basis for how this heat intensity table was developed and how it is applied in practice, and to reassess its ampacity limit calculations in light of this apparent discrepancy. The licensee is also requested to provide the supporting calculation cited in the study as the basis for this table (i.e., Calculation ESI150-1, Revision 0).

Licensee Response

In its submittal dated September 19, 1997, the licensee provided a copy of Calculation ESI150-1 and discussed in detail its approach in calculating the depth of fill values.

Staff Response

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

- Question 3

The licensee cites in item 2 on page 12 of the subject submittal that the base line ampacity for a 3/C, #6 AWG, 600 V cable with a 2.5" depth of fill is 27.5 A. The basis for this value is not clear in the subject analysis. SNL was unable to reproduce this limit using standard approaches to ampacity analysis given that the licensee thermal model has cited the ICEA definition as the basis for fill depth calculations. Two possible explanations were noted by SNL in this review, either of which would appear to be inconsistent with the

[1] ICEA: Insulated Cable Engineers Association

objectives of the analysis. The licensee is requested to describe in detail how this value was obtained, or alternately the subject calculation should delete references to and reliance upon this value as the "base line ampacity" for the cases examined.

Licensee Response

In its submittal dated September 19, 1997, the licensee provides the basis for the assumed 27.5 amperes baseline current. This value was used in the original plant design as an ampacity design limit for installed cables. Therefore, in licensee Calculation BYR96-082/BRW-96-194, this value was utilized as a screening assessment parameter to estimate for clad configurations, the depth of fill where the design maximum ampacity value would be potentially excessive as installed in the plant.

Staff Response

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

- Question 4

Several references are made in the subject calculations to a "SilTemp Sheet," but the fire barrier descriptions do not include a discussion of any such sheet used in the installation process. The licensee is requested to clarify if such a material is used in its fire barrier constructions.

Licensee Response

In its submittal dated September 19, 1997, the licensee clarified that SilTemp material was not used in the construction of fire barriers at Braidwood and Byron Stations.

Staff Response

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

2.2 Application of Ampacity Derating Methodology

The licensee initially 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. Later, the licensee developed Calculation BYR96-082/BRW-96-194 to determine ampacity derating parameters for non-standard fire barrier configurations.

2.2.1 Calculation G-63, Revision 4

The subject calculation 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.

All staff questions (except Item 9 of the RAI dated November 2, 1995, that requested examples) associated with the subject Calculation were adequately addressed by the licensee submittals dated March 21, 1996, and July 12, 1996 (See Attachment 4). As a result of the additional information provided in the licensee's submittals, the examples requested by RAI Item 9 are not essential to complete the staff's evaluation. 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 submitted information supports the conclusion that the Thermo-Lag protected cables at Braidwood and Byron Stations are operating within acceptable ampacity limits for the applicable configurations.

2.2.2 Calculation BYR96-082/BRW-96-194

The subject calculation documents the results of a set of case analyses performed to assess the derating impact for a number of special barrier and cable tray configurations. Specifically, the assessments pertain to a 3-hour fire barrier consisting of both single and double layers of material (Thermo-Lag and Darmatt materials), horizontal and vertical cable trays, and configurations with either a single trays or multiple trays in the same fire barrier enclosure.

The licensee's analysis proceeded in the following steps:

(1) Assume the nominal baseline ampacity limit of 27.5 amperes as an input to the thermal model and calculate a limiting depth of fill under clad conditions corresponding to its maximum ampacity limit (i.e., cable hot spot temperature of 90 degrees Celsius).

(2) The clad ampacity limit value is converted to an equivalent "Heat Intensity" factor for the clad case in a manner similar to the method used to develop the industry ampacity standard tables for an open top cable tray (ICEA P-54-440).

(3) The clad case heat intensity value is then compared to a baseline heat intensity value for the same depth of fill. The ampacity derating factor is calculated based upon a ratio of the two heat intensity values.

In general, the licensee thermal model is well documented and is based upon generally accepted thermal modeling techniques. Although aspects of the licensee's approach to modeling is unique, the overall approach has an acceptable premise. The subject calculation has received extensive review by the staff and SNL (Attachments 1 through 3). Although the licensee's thermal model contains non-conservative assumptions, it also contains offsetting

conservative assumptions. Since the identified concerns as stated above have been resolved (Questions 1-4), it is expected that the licensee's analyses will provide a conservative assessment of the ampacity impact for the applicable special configurations.

Given that the revisions to the subject calculation and the information provided by the licensee have addressed all of the identified concerns, the staff finds that the licensee has provided adequate information to resolve the ampacity-related points of concern raised in GL 92-08 for the applicable configurations.

3.0 CONCLUSIONS

Based on the above evaluation, the staff concludes that for Byron and Braidwood Stations, all of the ampacity related concerns have been resolved and the licensee has provided an adequate technical basis to ensure that all of the Thermo-Lag fire barrier enclosed cables are operating within acceptable ampacity limits. Therefore, the staff finds that there are no outstanding safety concerns with respect to Generic Letter 92-08 ampacity derating issues. Licensee documents and the staffs safety evaluation related to the ampacity derating issues should be retained by the licensee in the event of a future inspection or audit.

Attachments: As Stated

Principal Contributor: R. Jenkins

Dated: November 2, 1999