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June 25, 1998

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DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION REGARDING CONSUMERS ENERGY COMPANY'S CABLE AMPACITY ADJUSTMENT METHODOLOGY

This letter provides Consumers Energy Company's response to NRC's March 27, 1998, request for additional information (RAI) regarding the Palisades Plant cable ampacity adjustment methodology. It is expected that this information will serve to justify the methodology's characterization of cable tray thermal conditions, and the assumptions used in the application of the model at Palisades.

In response to a previous RAI dated May 27, 1997, Consumers Energy Company provided NRC with descriptions of our cable ampacity adjustment methodology, and of actions to reduce calculated cable tray overheating. This information was submitted on July 10, 1997, and December 18, 1997. These submittals provide background information to support NRC review and closure of this issue.

SUMMARY OF COMMITMENTS

This letter contains no new commitments and no revisions to existing commitments.

Gerry A. Torres
for
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Director, Licensing

CC Administrator, Region III, USNRC
Project Manager, NRR, USNRC
NRC Resident Inspector - Palisades

Attachment

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ATTACHMENT

CONSUMERS ENERGY COMPANY
PALISADES PLANT
DOCKET 50-255

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION REGARDING CABLE AMPACITY ADJUSTMENT METHODOLOGY

PALISADES PLANT

7 Pages

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NRC Questions 2.1 (a) and (b):

2.1 Potential Nonconservatisms Associated with Harshe-Black Model

(a) *If one is analyzing a relatively wide tray with a very small number of power cables, the localized heating effects of the power cables may be inappropriately "diluted." Consider, for example, a case involving a single powered cable in a larger mass of cables. Using the as-published Harshe-Black approach, the single cable would be modeled as a very thin layer stretching across the full width of the tray. This would be a very unrealistic model for this situation and overemphasizes the importance of tray width. In such a case those portions of the tray remote from the powered cable (more than a few cable diameters away) will have little real effect on the behavior of the cable of interest. The as-published Harshe-Black model would over-credit the heat dissipating effects of the surrounding cables and could very easily result in overly optimistic ampacity estimates.*

(b) *There is a potential that the Harshe-Black model might overestimate cable ampacity limits under certain conditions. In particular, if several powered cables happen to be clustered in close proximity to each other, then the localized heating effects may be more pronounced than will be estimated by Harshe-Black. We found the original arguments regarding this aspect of the model put forth by Harshe-Black to be unconvincing.*

The licensee is requested to reconsider its unqualified endorsement of the Harshe-Black ampacity methodology or alternately to provide additional technical justification in light of the specific findings and the thermal modeling concerns noted above.

Consumers Energy Response:

Consumers Energy recognizes that the Harshe-Black ampacity methodology contains limitations and as a result Consumers Energy does not provide unqualified endorsement. The analytical models used in the Palisades ampacity analysis borrow only the concept of 'layering' cables based on the cables' thermal loading from the Harshe-Black methodology. The parameters associated with these layers used in the Palisades analysis are different from those described in the Harshe-Black approach. In the Palisades approach, layer parameters and tray thermal models were developed based on conservative representation of the configuration of the cables in the cable mass.

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Specifically regarding the issues of thinning and clustering, the Palisades model reduces the width of the cable tray for those cases when there are a very small number of power cables in a cable tray. The width of the tray is adjusted to reflect the localized heating effects of power cables, and eliminate any "diluting" of heat sources. The tray is reduced to a width equal to the sum of the diameters of the hot cables + ½ the depth of fill. This is specifically described in the Palisades analysis methodology submitted July 10, 1997.

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NRC Questions 2.2 (a) and (b):

2.2 Modified Palisades Ampacity Methodology

We found that the Palisades modified Harshe-Black method does have a nominal ability to provide realistic and reasonable estimates of cable ampacity limits or cable operating temperatures under a range of diverse load conditions. However, validation studies performed by SNL also indentified certain conditions under which unreasonable results might be obtained through the subject method. These undesirable results relate to cases where there are a number of very large cables grouped together. Given these concerns, the staff finds that the application of the modified Palisades ampacity determination methodology should be subject to the following constraints:

(a) The Palisades modified diversity method should not be applied to any tray that includes two or more cables that (1) are powered to at least 80% of the nominal ICEA cable tray ampacity limit, and (2) whose diameter exceeds the tray fill depth when calculated using the ICEA definitions of depth of fill. For this case, as noted by Stolpe, a potential for a severe localized hot spot exists that would make it unwise to credit diversity in the ampacity assessment.

(b) A lower bound should be established on the thickness of the combined hot and warm zones in the diversity thermal model. This will (1) prevent excessive "thinning" of the more heavily loaded cables, (2) more accurately reflect the presence of larger diameter cables in the hot group, and (3) ensure a conservative treatment of potential clustering effects. The combined thickness of the hot and warm zones should equal or exceed 80% of the diameter of the largest cable in these two groups. If the condition is not met by the nominal model formulation, then the width of the analyzed section may be adjusted (reduced) so as to increase the hot/warm zone thickness until the restriction is met provided that the overall heat load for each cable group is maintained at its correct value.

The licensee is requested to consider these two restrictions for the Palisades modified Harshe-Black methodology in terms of their acceptability and to verify whether the existing analyses performed for the applicable raceways requiring adjustment according to Palisades FSAR Section 8.5.2 are bounded for the two application restrictions. Alternatively, the licensee is requested to provide comprehensive validation data sufficient to address the technical shortcomings of the modified Harshe-Black methodology as cited by the SNL findings.

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Consumers Energy Response:

(a) Consumers Energy agrees with the NRC concept that a potential exists for a localized hot spot if the two conditions identified above are present. Consumers Energy has performed a review of the analyzed Palisades cable trays for the simultaneous presence of the two conditions and has determined that there are no cases in which the conditions described in both of these criteria exist. In addition, Consumers Energy verified that 80% of the allowable ICEA open air ampacity is not exceeded.

(b) As described in Consumers response to NRC Question 2.1, the model used for the Palisades analysis adjusts the cable tray width when appropriate to address the thinning and clustering effects. However, Consumers Energy agrees with the NRC and is investigating the impact of a lower bound. To date, the review of the results of the Palisades ampacity analysis indicates that adequate margin exists in the maximum calculated cable trays' temperatures to account for any slight increases that may occur due to this lower bound and therefore we are in conformance with Palisades FSAR Section 8.5.2. Our plans are to continue our analysis for every cable tray with a combined thickness of the hot and warm zones less than 80% of the diameter of the largest cable in these two zones.

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NRC Questions 2.3 (a), (b) and (c):

2.3 Licensee Example Calculation

Although SNL observed that there are no specific errors in the implementation of the Palisades modified ampacity example calculation, the following points require additional clarification:

(a) *It is unclear what the basis is for the assessment of the assumed plant ampacity loads. Please explain the basis upon which the cable load ampacity values were obtained, and confirm that this practice has bounded the most conservative possible configuration for each tray analyzed, including consideration of all possible modes of plant operation.*

(b) *The example case provided by the licensee assumes an emissivity of the top surface of the cable mass of 0.95. This value is not consistent with either typical practice, nor the measured Palisades emissivity values cited in the Harshe-Black paper. The licensee is requested to explain the basis and justification for the assumed emissivity value.*

(c) *The licensee model cites the emissivity of the lower surface of the cable tray as 0.65. Regarding this assumption, please explain and justify the chosen value of 0.65 for the bottom surface of the cable mass. Are any of the cable trays under analysis solid-bottom type trays? If yes, (1) are the cables installed in direct and continuous contact with this bottom surface, or are they laid on internal rungs within the tray; and (2) is the bottom surface ventilated? If the cables are not in intimate contact with the bottom plate, and the bottom plate is not ventilated, then how has the model been adjusted to account for the additional air gap between the bottom of the cables and the tray bottom? Note that the Harshe-Black thermal model does not inherently allow for any such gap, but rather, inherently assumes either direct cable-to-bottom plate contact or installation in an open ladder-type tray.*

Consumers Energy Response:

(a) The basis for the Palisades ampacity analysis was to determine the maximum calculated expected cable tray temperature. To determine this maximum temperature, the cables which could contribute to the overall heat intensity in a given cable tray section were identified. These are the continuously energized power cables. A continuously energized cable is defined as a cable which is energized during any plant condition long enough to generate a significant amount of heat. Control cables and intermittent or infrequent loads such as motor operated valves, emergency equipment, test equipment, and cranes were not considered continuously energized.

The analysis conservatively assumes that continuous loads are energized at the same time. Additionally, the analysis did not take credit for diversity of safety-related loads (i.e. loads from redundant divisions are considered energized).

Palisades believes that these assumptions result in bounding of the most conservative possible configuration for each tray analyzed. The result is the maximum expected heat generated by the cables in each tray section analyzed.

(b) The emissivity value of the top surface of the cable mass and the bottom cable and tray surface used in the ampacity analysis was obtained from Appendix B of ICEA P-54-440 (Third Edition), WC-51, "Ampacities of Cable in Open Top Cable Trays." This standard identifies the effective thermal emissivity of the cable surface as 0.95 and the steel tray surface as 0.33. Based on this standard, the top cable surface was assigned the 0.95 value.

(c) The cable trays installed at Palisades are ladder type open-bottom trays. The bottom surface was assigned the arithmetic average of (0.95 + 0.33)/2 or 0.65 for emissivity. This conservatively assumes that there is an equal amount of cable surface and tray surface along the bottom of the tray. The spacing of the bottom rails for cable trays at Palisades provides for a larger amount of cable surface than tray surface, and therefore this emissivity value is conservative.

Additional justification for the emissivity values used for the Palisades analysis is provided in Omega Point Laboratories Report No. 14540-100770 "Ampacity Derating of Fire Protected Cables," dated December 5, 1996. Omega Point Laboratories conducted a test for Illinois Power Company (Clinton Station) to determine the ampacity derating of cables when an Electrical Raceway Fire Barrier System is installed on the cable system. The test was conducted on a 24" wide by 4" deep steel ladder back cable tray assembly, clad with 3M Interam fire protection materials. The test was performed in accordance with the IEEE P848, D16 "Standard Procedure for the Determination of the Ampacity Derating of Fire Protected Cables."

One of the measurements made during the test was the surface emissivity of the cable jacket and the cable tray (galvanized steel). All emissivity measurements were made with the test article at its equilibrium temperature. The surface emissivity of the test article was measured at nine points on each different surface type. The average emissivity of the nine locations is as follows:

Test Article	Surface Type	Measured Emissivity
24" Cable Tray	Galvanized Steel Cable Tray	0.38
24" Cable Tray	Cable Jacket Surface	0.99

The emissivity values used for the Palisades cable ampacity calculation (0.95 for the cable surface and 0.33 for the steel cable tray) are conservative since lower emissivity will result in lower cable temperature.