Northern States Power Company

Prairie Island Nuclear Generating Plant

1717 Wakonade Dr. East
Welch, Minnesota 55089

January 31, 1995 Generic Letter 92-08

US Nuclear Regulatory Commis ion
Attn: Document Control Desk
Washington, DC 20555

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
Docket Nos. 50-282 License Nos. DPR-42
50-306 DPR-60

Response to the November 17, 1994 Request for Additional Information Regarding Thermo-Lag Related Ampacity Derating Issues (TAC Nos. M85592 and M85593)

In a letter dated November 17, 1994, the Nuclear Regulatory Commission (NRC) has transmitted a Request for Additional Information (RAI) Regarding Thermo-Lag Related Ampacity Derating Issues for Prairie Island Nuclear Generating Plant.

This letter provides NSP's response (see Attachment 1) to the first 12 concerns expressed in the RAI. As discussed in our letter to the NRC of December 21, 1994, we will respond to the remaining concerns by the end of June 1995.

We are planning to replace all Thermo-Lag material at Prairie Island with a qualified alternate material. The derating factors will be based on that new material. We intend to confirm these plans within 2 months. Because of the likelihood of replacement and subsequent recalculation of ampacity deratings, you may choose not to review the response which we are providing with this letter. We will keep you informed of our plans.

In this letter we have made no new NRC commitments.

Ltr Encl

A001 Add: NRR/DE/EELB 1 1
NRR/DRPW/PDB-1 1 1

Please contact Jack Leveille (612-388-1121, Ext. 4662) if you require further information.

Michael D Wadley

Michael D Wadley
Plant Manager
Prairie Island Nuclear Generating Plant

cc: Regional Administrator - Region III, NRC
NRR Project Manager, NRC
Senior Resident Inspector, NRC
Kris Sanda, State of Minnesota

Attachments: (1) Response to Ampacity Derating Issues (Concerns 1 - 12)
(2) Affidavit

Response to Ampacity Derating Issues (Concerns 1 - 12)

General Calculation Approach and Methodology

The calculation approach used simplified heat transfer methodology to calculate the ability of fire wrap to transfer and reject heat to the ambient. Analysis of each individual cable loading was used to estimate the heat being generated inside the wrapped section. The rate of heat transfer across the fire wrap and the heat rejection from the wrapped tray to the ambient environment are then used to predict the temperature rise across the wrap and the resulting steady state temperature within the wrapped section of tray. The estimated steady state temperature inside the fire wrap is then used to derate the enclosed cables per industry standards to the new calculated steady state temperature.

The assumptions and calculations are then validated by correlation with field test results.

ASHRAE methodology was selected since the problem and characteristics of the type of material used to wrap the tray is similar to that encountered and are well documented by this organization.

The calculations supporting the report are based on the simplifying assumption that the entire envelope within the wrapped tray will reach a uniform steady state temperature with a minimal temperature gradient across the enclosed tray section. (Reference paragraph 4, on page 3-2 of the study.) The heat transfer mechanism out of the enclosed envelope considered in the supporting calculations is assumed to be via conduction through the fire wrap, and via convection and radiation at the surface boundaries of the fire wrap. This assumption is justified for several reasons:

a. The thermal resistance of the fire wrap is large (8 $Hr(Ft^2)(°F)/BTU$) with respect to other thermal resistances in the system such as the wrap to air boundary resistances (0.765 $Hr(Ft^2)(°F)/BTU$), metallic tray, and metallic cable armor. This large thermal resistance effectively isolates the inner envelope from the outer environment. This thermal isolation allows consideration of the inner envelope as a uniform isolated system.

b. High thermal conductivity of metallic cable tray and the metallic cable armor contributes to minimizing temperature gradients within the wrapped section. Partial direct contact between the armored cables and the Kaowool will also contribute to a relatively uniform ambient temperature at equilibrium inside the wrapped tray.

c. The tests used to validate the calculations monitored the ambient temperature outside the tray and the surface temperature on the jacket of the cable in the tray with the dominant heat release. This testing validated that the calculation techniques were within reasonable accuracy, and demonstrated that more rigorous calculations accounting for heat transfer mechanisms within the enclosed section were not necessary.

Responses to Concerns

The following section responds to each area of concern identified by the NRC. The response numbering corresponds to the numbering in the NRC letter. Each concern contained in the RAI has been briefly restated with our response following.

1. Applicability of ICEA P-46-426 Ampacity Tables

Comment The ICEA P-46-426 ampacity tables "apply specifically to cables where significant air gaps are maintained between the cables such that even in a "still" ambient environment significant convective buoyancy driven air flow currents will develop in the vicinity of the cables and cable tray."

Response As discussed in the General Calculation Approach and Methodology section, the calculation methodology is based on the assumption that the entire envelope within the wrapped tray from the cable jacket to the fire wrap will reach a uniform steady state temperature.

This method is more conservative than the ICEA standard. As noted in the staff comments, the ICEA standard relies on convective cooling of the cables. This type of a cooling process requires that the jacket temperature of the cables be higher than the ambient temperature. Thus the ampacity values determined from ICEA result in a jacket steady state operating temperature higher than the ambient temperature around the cable. The model used in the report assumes that once the system is in equilibrium, the temperature of the cable jacket will be the same as the ambient. The cables are then derated accordingly. Therefore, analytical consideration of the convective driven air currents is not deemed necessary.

Note that consistent with this approach, the validating testing monitored the ambient temperature outside the tray and the surface temperature on the jacket of the cable.

2. Maintained Spacing Correction Factors

Comment Cable ampacity ratings from ICEA P-46-426 are based on 1/4 to 1 diameter maintained cable spacing. This spacing is not consistent with typical cable installation practices in tray.

Response The use of the correction factors associated with "maintained" spacing is appropriate. PINGP installation standards require maintained spacing and a single layer of cables in all power cable trays. USAR Section 8.7.1 states "the cables are clamped in the ladder to ensure a specified spacing exists...". The Fluor Power Services Field Standards Nos. 13 and 14 used during construction of the plant delineate the spacing required. The current PINGP Field Standards for electrical installation (STD 1.21.WI Rev.Orig.Note 4) also requires similar spacing distance between cables. The spacing required by these installation standards meets the 1/4 to 1 cable diameter spacing required by the ICEA Standard to use the "maintained spacing" derating factors.

3. Four Sides in Heat Transfer Analysis

Comment The Stone & Webster analysis assumes that heat transfer is equally effective from all four sides of the barrier.

Response Based on the calculation assumptions, effective heat transfer will exist at all four sides of the barrier, and the calculation is conservative. Consideration of heat transfer through the sides of the fire wrap is consistent with the assumption that components inside the wrapped section of the tray will reach a uniform equilibrium temperature as discussed in the General Calculation Approach and Methodology section. Under steady state conditions, heat transfer will occur through all boundaries of the tray section. The supporting calculations used the same heat transfer factor through all faces of the tray. This factor was the average for horizontal up and horizontal down surfaces. Use of this factor is analytically accurate for the top and bottom surfaces of the section, and conservative for the side sections. The ability of vertical surfaces to remove heat is greater than the average of horizontal up and horizontal down surfaces.

Comment An isolating air gap between the cable tray side rails and the fire barrier will impede heat flow.

Response For the reasons discussed in the General Calculation Approach and Methodology section, the uniform steady state conditions assumed in the model preclude the need to account for detailed internal heat transfer mechanisms. Test results validate this approach.

4. ASHRAE Correlations

Comment: The "efficiency of the convective heat transfer in a confined space is significantly lower than that which takes place in an open environment. The ASHRAE correlations do not account for this behavior."

Response: The study did not assume or specifically take credit for any convective heat transfer within the wrapped envelope. For the reasons discussed in the General Calculation Approach and Methodology section, the uniform steady state conditions assumed in the model preclude the need to account for detailed internal heat transfer mechanisms. Test results validate this approach.

Comment: The Stone & Webster calculation methodology assumes that radiative heat transfer within the protected envelope takes place from the cables to the air and then from the air to the fire barrier. In reality, the primary mechanism for radiative exchange is direct transfer from the cable to the barrier."

Response: The study did not assume or specifically take credit for "radiative heat transfer place from the cables to the air and then from the air to the fire barrier. For the reasons discussed in the General Calculation Approach and Methodology section, the uniform steady state conditions assumed in the model preclude the need to account for detailed internal heat transfer mechanisms. Test results validate this approach.

5. Marinite Board

Comment: The effects of the Marinite board are neglected in the Stone & Webster study.

Response: The configuration using Marinite board was considered as a possibility in preliminary phases of the study. However, NSP decided not to use this configuration, thus detailed derate analysis did not need to account for it.

6. Zetex or Foil Coverings

Comment: The effects of "special coverings such as foil or Zetex are neglected" in the Stone & Webster study.

Response: The configuration using special coverings such as foil or Zetex was considered as a possibility in preliminary phases of the study. However, NSP decided not to use this configuration, thus det[illegible]led derate analysis did not need to account for it.

7. Calculation Errors

Comment: The column headings for [illegible] 1-hour and 3-hour barrier systems are reversed.

Response: The column headings for the M20R 1-hour and 3-hour barriers are not reversed. The column heading for the 1-hour 3M barrier is correct. The data for the 3-hour barrier is in error. This error was discovered in September 1983 and the supporting calculation was corrected. The error results in a one to three °C error. This represents less than a 5% error in the tray derating values. Since NSP did not use the 3M product, the error had no impact.

Comment: Using the values in the report, the calculated value of the "U" factor for Kaowool differs significantly from the value used by Stone & Webster in the study.

Response: The table on page 3-3 of the report has two errors. Both errors are typographical in nature, resulting from the conversion of information from the supporting calculations to the report. In both bases the correct numbers were used in the supporting calculations, and therefore these errors do not affect the results or conclusions presented in the report.

First, the table on page 3-3 correctly identifies a 1-hour Kaowool barrier as two inches in thickness (2 one-inch wraps); however, the corresponding thermal resistivity listed is for a single wrap (1 one-inch wrap) of Kaowool. The correct thermal resistivity value for two wraps is 8 Hr(Ft^2)(°F)/BTU. Using the correct thermal resistivity, the correct "U" factor of 0.05535 W/ft^2/°C can be calculated. The correct "U" factor of 0.05535 W/ft^2/°C was used in all applicable calculations.

Secondly, the U value listed in Table 2 of the study is 0.05532 W/ft^2/°C. The correct value and the value used in the supporting calculations was 0.05535 W/ft^2/°C.

8. Zero Ampere Values

Comment: Provide further clarification of conductor currents listed in Tables 4 and 5 with zero ampere values.

Response The loads listed in the tables as having zero amps are cables servicing equipment, such as motor operated valves. Motor operated valves can be identified in Tables 4 and 5 by the equipment number prefix MV included in the service column. This assumption is valid since motor operated valves in power plants have infrequent limited duty cycles. These cables will only be energized during opening or closing operations. Cycle time of motor operated valves ranges from several seconds to several minutes. These intermittent and infrequent loads have negligible impact on the ultimate steady state temperature of a wrapped tray system.

9. Control Cable Ampacity

Comment The analysis cites an average conductor current of .79 amperes and a total heat gain of 0.57 watts per foot. The subject analysis does not reflect an estimate of load diversity of the cables in the subject tray. Estimates of heat release based on a single (average) are likely to underestimate the heat generation. An alternate method is to calculate a representative current based on the square root of the sum of the squares.

Response Consideration of each control cable in the subject tray was performed as part of the supporting calculation. The 0.79 ampere value is not an arithmetic average, but rather the square root of the sum of the squares of the estimated current in each conductor of each cable in the tray. This methodology resulted in the .57 watts/ft. average reported in the study. The resulting heat gain calculation is conservative in that each cable was evaluated to determine the service, an estimate of current was developed for each type service, and the estimated current was assumed to be continuous in every conductor in every cable. The estimated currents for each type of service are documented in the report on page 3-5. In addition to the conservatism resulting from neglecting conductor duty cycle, each cable typically has one or more spare conductors which will have zero current. Also, many control cables typically contain conductors for red and green indicating lights and only one or the other will be illuminated at any one time. Conductors serving motor operated valve open and close coils also have a very limited duty cycle as described in the response to comment 8. The heat load for each cable was calculated by summing the I^2xR for each cable. The average current corresponding to this heat release is 0.79 amperes per conductor. This number is provided for information only and was not used as an input or value in any calculations.

The detailed tray analysis and analysis are documented in Stone & Webster Calculation 12911.23-E-4.

10. Charging Pump Feeder Test Results

Comment Page 4-3 of the report notes that in order to compare measured temperatures to the predicted temperatures, the predicted temperatures must be adjusted to the conditions existing at the time of the survey. Since the predicted values are based on full load operation of all equipment served by the tray, only the equipment in service at the time of the test should be considered in the comparison calculations. The report also states that all other feeders in the trays are assumed to be out of service since they serve safeguards equipment (i.e. RHR pumps, SI pumps, MOVs, and containment spray pumps). In the report, only the analysis for tray 1AG-LA30 assumed all other loads were out of service during the test. For the other trays, the other loads must be set to zero in order to properly compare the predicted current values with the measured current values.

Response All testing was done during full power operation. The assumption on page 4-3 of the report that the RHR pumps, SI pumps, MOVs, and containment spray pumps are out of service is valid during full power operation. The statement that "...all other feeders in the trays being studied are assumed to be out of service" is not accurate. This statement should address only the equipment identified above (RHR pumps, SI pumps, MOVs, and containment spray pumps). The assumption that all other cables were out of service, as stated in the report, is only applicable to only tray 1AG-LA30. Each of the other two trays, 2AG-LB5 and 2AG-LB8, were modified to include cables serving a component cooling water pump and two cooling fans. These loads operate continuously during power operation and should be considered in making a comparison of the field results to the calculated values of temperature rise. The revised comparison of the measured and predicted values is as follows:

Tray ID	Measured Temperature Rise	Revised Calculated Temp Rise	Original Calculated Temp Rise
1AG-LA30	35 °F	39 °F	39 °F
2AG-LB5	26 °F	28 °F	38 °F
2AG-LB8	23 °F	33 °F	26 °F

Based on this adjustment, and the clarification of the U value per comment 7, the predicted temperature and the measured temperature rises still correlate to the measured temperatures. In all cases, the measured versus the predicted temperature differences are conservative. (Comparison spreadsheets are attached to this response calculating these values.)

11. Diesel Generator Feeder Tray Test Results

Comment — Main diesel generator power feed cable testing was not completed. After fifteen hours, temperatures inside were still rising. The testing concluded that the cable was undersized for this application.

Response — Section 4.3 of the study presents the results of the Diesel Generator Feeder Tray Test. The results do not claim to validate the thermal model since the test was terminated prior to achieving a steady state temperature.

The report documents the observed rate of temperature rise for this tray and compares it to that predicted by the model. This predicted and observed temperature rise correlation is presented in the report for information but does not influence or change the results or conclusions. This information, together with the model's steady state temperature prediction, was used to verify that the generator cable as installed did not have adequate margin to operate in the elevated ambient temperature inside a 1-hour Kaowool fire wrap. Informal calculations prior to the test indicated that the maximum allowable ambient temperature for this cable to operate at full power was 61 °C. This translates to a maximum allowable temperature rise of 21 °C (38 °F) for this cable. The test was terminated when it became clear that this temperature would be exceeded in both trays. Kaowool was subsequently replaced with a Thermo-Lag configuration.

12. Control Tray Test Results

Comment — It is not clear to what extent the concerns of comment 7 affect the test results.

Response — Comment 7 concerns have been addressed and resolved in the response to comment 7 and do not affect the test results presented for the control trays.

Comment — Apparently a different U value was used in the calculations.

Response — The control tray used in the test 1AM-TA9 is a 30" tray. The per square foot "U" value used for this tray is the same as was used for all of the other trays. The associated area results in dissipation value of 0.30448 Watts/°C per linear foot of 30 inch tray.

Comment — Detailed calculations are not tabulated for the control power trays in the same manner as cited for the power cable applications. Additional detailed information should be provided on actual loads present in the tray at the time of the test.

Response — As identified in response 7, a detailed tabulation and heat release calculation is provided in the supporting calculation for this tray.

Actual loads in control trays (444 individual conductors) are extremely difficult to measure or predict. For control trays, the calculation methodology is intended to develop a bounding case limit, and the test is intended to demonstrate that actual conditions are well below the bounding conditions.

From Study, Table 5, Page 1 of 29

TRAY	1AG-LA30
TRAY LOSS FACTOR	0.13840

Cable		FLA	Cable Ohms/Ft	Watts/Ft
1K1-3	MV	0.00	2.60E-03	0.00000
1K1-4	MV	0.00	3.90E-03	0.00000
1K1-11	MV	0.00	3.90E-03	0.00000
1K1-14	MV	0.00	3.90E-03	0.00000
1K1-21	CHARGING PUMP	134.00	3.90E-04	7.00643
1K1-26	MV	0.00	3.90E-03	0.00000
1K1-33	MV	0.00	3.90E-03	0.00000

HEAT GENERATED	7.00643	Watts/Ft
DELTA TEMP	50.62450	C
DELTA TEMP	91.12411	F

Adjusted to test conditions

TRAY	2AG-LB5
TRAY LOSS FACTOR	0.13840

Cable		FLA	Cable Ohms/Ft	Watts/Ft
1K1-3	MV	0.00	2.60E-03	0.00000
1K1-4	MV	0.00	3.90E-03	0.00000
1K1-11	MV	0.00	3.90E-03	0.00000
1K1-14	MV	0.00	3.90E-03	0.00000
1K1-21	CHARGING PUMP	88.00	3.90E-04	3.02171
1K1-26	MV	0.00	3.90E-03	0.00000
1K1-33	MV	0.00	3.90E-03	0.00000

HEAT GENERATED	3.02171	Watts/Ft
DELTA TEMP	21.83316	C
DELTA TEMP	39.29968	F

From Study, Table 5, Page 17 of 29

TRAY	2AG-LB5
TRAY LOSS FACTOR	0.30448

Cable		FLA	Cable Ohms/Ft	Watts/Ft
2DCB-34	2-SOVS	4.00	2.60E-03	0.04160
2HVB-18	COOLING FANS	3.00	3.90E-03	0.03510
2HVB-33	COOLING FANS	2.50	3.90E-03	0.02438
2KA2-3	MV	0.00	3.90E-03	0.00000
2K2-1	MV	0.00	3.90E-03	0.00000
2K2-2	MV	0.00	3.90E-03	0.00000
2K2-4	CHARGING PUMP	152.00	3.90E-04	9.01518
2K2-6	MV	0.00	3.90E-03	0.00000
2K2-7	MV	0.00	3.90E-03	0.00000
25403-1	COMPONENT COOLING PUMP	32.20	1.54E-03	1.59414
25404-1	RHR PUMP	25.00	1.54E-03	0.96094
25405-1	SI PUMP	100.00	6.14E-04	6.13600
25409-1	CS PUMP	32.80	1.54E-03	1.65410

HEAT GENERATED	19.46144	Watts/Ft
DELTA TEMP	63.91697	C
DELTA TEMP	115.05054	F

Adjusted to test conditions

TRAY	2AG-LB5
TRAY LOSS FACTOR	0.30448

Cable		FLA	Cable Ohms/Ft	Watts/Ft
2DCB-34	2-SOVS	4.00	2.60E-03	0.04160
2HVB-18	COOLING FANS	3.00	3.90E-03	0.03510
2HVB-33	COOLING FANS	2.50	3.90E-03	0.02438
2KA2-3	MV	0.00	3.90E-03	0.00000
2K2-1	MV	0.00	3.90E-03	0.00000
2K2-2	MV	0.00	3.90E-03	0.00000
2K2-4	CHARGING PUMP	88.00	3.90E-04	3.02171
2K2-6	MV	0.00	3.90E-03	0.00000
2K2-7	MV	0.00	3.90E-03	0.00000
25403-1	COMPONENT COOLING PUMP	32.20	1.54E-03	1.59414
25404-1	RHR PUMP	0.00	1.54E-03	0.00000
25405-1	SI PUMP	0.00	6.14E-04	0.00000
25409-1	CS PUMP	0.00	1.54E-03	0.00000

HEAT GENERATED	4.71693	Watts/Ft
DELTA TEMP	15.49174	C
DELTA TEMP	27.88513	F

From Study, Table 5, Page 19 of 29

	TRAY	2AG-LB8		
	TRAY LOSS FACTOR	0.24912		
Cable		FLA	Cable Ohms/Ft	Watts/Ft
2DCB-34	2-SOVS	4.00	2.60E-03	0.04160
2HVB-18	COOLING FANS	3.00	3.90E-03	0.03510
2HVB-33	COOLING FANS	2.50	3.90E-03	0.02438
2KA2-3	MV	0.00	3.90E-03	0.00000
2K2-2	MV	0.00	3.90E-03	0.00000
2K2-4	CHARGING PUMP	152.00	3.90E-04	9.01518
2K2-7	MV	0.00	3.90E-03	0.00000
25403-1	COMPONENT COOLING PUMP	32.20	1.54E-03	1.59414

HEAT GENERATED	10.71040	Watts/Ft
DELTA TEMP	42.99292	C
DELTA TEMP	77.38726	F

Adjusted to test conditions

	TRAY	2AG-LB6		
	TRAY LOSS FACTOR	0.24912		
2DCB-34	2-SOVS	4.00	2.60E-03	0.04160
2HVB-18	COOLING FANS	3.00	3.90E-03	0.03510
2HVB-33	COOLING FANS	2.50	3.90E-03	0.02438
2KA2-3	MV	0.00	3.90E-03	0.00000
2K2-2	MV	0.00	3.90E-03	0.00000
2K2-4	CHARGING PUMP	88.00	3.90E-04	3.02171
2K2-7	MV	0.00	3.90E-03	0.00000
25403-1	COMPONENT COOLING PUMP	32.20	1.54E-03	1.59414
25405-1	SI PUMP	0.00	6.14E-04	0.00000
25409-1	CS PUMP	0.00	1.54E-03	0.00000

HEAT GENERATED	4.61565	Watts/Ft
DELTA TEMP	18.52862	C
DELTA TEMP	33.35152	F

AFFIDAVIT

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

PRAIRIE ISLAND NUCLEAR GENERATING PLANT DOCKET NO. 50-282
50-306

THERMO-LAG 330-1 FIRE BARRIERS

Northern States Power Company, a Minnesota corporation, with this letter is submitting information requested by Generic Letter 92-08, Thermo-Lag 330-1 Fire Barriers, pursuant to 10 CFR 50.54(f).

This letter contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By Michael D Wadley
Michael D Wadley
Plant Manager
Prairie Island Nuclear Generating Plant

On this 31st day of January 1995 before me a notary public in and for said County, personally appeared Michael D Wadley, Plant Manager of Prairie Island Nuclear Generating Plant and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof, and that to the best of his knowledge, information, and belief the statements made in it are true and that it is not interposed for delay.

Marcia K. LaCore

MARCIA K. LaCORE
NOTARY PUBLIC-MINNESOTA
HENNEPIN COUNTY
My Commission Expires Jan. 31, 2000

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