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U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Gentlemen:

Subject: Three Mile Island Nuclear Station, Unit I (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Response to the Request for Additional Information Related to Thermo-Lag Associated Ampacity Derating Issues

The purpose of this letter is to provide a response to the NRC request for additional information dated July 5, 1996 regarding Thermo-Lag associated ampacity derating issues. Included with the response to the fifteen questions is a package comprised of a calculation and supporting documentation. The calculation utilized an increased electrical raceway fire barrier system ampacity derating factor of 32% and comparison of the revised ampacity values against the expected load currents. The documentation supports the assessment of the ampacity of power cables in trays protected with Thermal-Lag fire barriers.

We will be available to provide any clarification or additional information which may be necessary by your continuing review of the ampacity derating issue.

Sincerely,

J. Knubel
J. Knubel
Vice President and Director, TMI

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WGH
Attachments
cc: Administrator, Region I
TMI Senior Resident Inspector
Sr. Project Manager NRC, TMI

Response to the Request for Additional Information Related to Thermo-Lag Associated Derating Issues

Item 1

The TMI documentation regarding the Thermo-Lag fire barrier issue is not well organized. It consists of attachments that do not seem to support one another and contains incomplete references which makes the logic of the study difficult to follow. The licensee should resubmit a more coherent package of information that documents all aspects of the analysis, identifies how the various documents are used to support the overall assessment, and includes the cited references required to support its analysis.

Response to Item 1

The references in the following paragraphs are identified in the attached calculation, C-1101-770-E420-018.

At TMI-1, derating of control , control power and instrumentation cables is not considered because neither type of cable carries any significant load near its ampacity rating. These words are adopted from the FSAR (Ref. 3.11) section 8.2.2.11.b. in the fifth sentence. However, in cases where power cables are routed with control power cables, then the control power cables are considered because they can effect each others' ampacity.

At TMI-1 there are 480 VAC or 4160 VAC power circuits that are protected by three-hour rated barriers as per the FHAR (Ref. 3.1). For 4160 VAC power circuits, the one-hour barriers are installed over cable trays or over cables that are in cable trays. For 480 VAC power circuits, fire barriers are installed over cable trays or over conduit. Testing performed for Texas Utilities (TU) showed one-hour fire barrier derating factors of 31.6% for cable trays and 10.7 % maximum for conduit (Ref. 3.8). The one-hour fire barrier configuration at TU plants bounds the one-hour fire barrier configuration at TMI-1 (Ref 3.13). Conduit is not included in this calculation because cable tray derating associated with the addition of Thermo-Lag is considered the bounding case. Table 2 shows the comparison between the cable trays and conduit.

Table 2: Comparison of Tray and Conduit Ampacities with One-hour Thermo-Lag Derating

AWG	Tray Ampacity w/o Thermo-Lag (A)	Tray Ampacity w/ Thermo-Lag (A)	Conduit Ampacity w/o Thermo-Lag (A)	Conduit Ampacity w/ Thermo-Lag (A)
#8	41	28	36	32
350 MCM	285	194	253	225

Values in columns two and four of Table 2 are taken from Ref. 3.14 which is based on Ref. 3.6 for a 90°C conductor rating operating in a 40°C ambient when installed with a total of 7 to 24 current carrying conductors inclusive. Columns three and five are calculated by multiplying the respective values in columns two and four by 0.680 and

0.890 representing derating factors of 32% and 11% respectively. When comparing columns three and five, it can be seen that the ampacity for cables routed in tray protected by a one-hour fire barrier is significantly less than that for cables in conduit. Thus, the analysis of ampacity of cables installed in trays protected by one-hour fire barriers is bounding when compared to that for cables in conduit.

Calculation # C-1101-770-E420-018, attached, provides a more coherent package of information regarding the Thermo-lag fire barrier ampacity derating issues. The calculation identifies all documents used, all assumptions made, and references required to support the analysis.

Item 2

The licensee's package included a "TSI Derating Study Test Plan." It is not clear that the tests described have been or will be performed. Regarding the tests plan, provide answers to the following questions:

Have the tests called for in the plan been performed?

If not, will they be performed in the future, and if so, when will the test results be made available for review?

If the tests have been performed, provide documentation of the results and describe how the test results have been factored into the TMI ampacity assessment.

Response to Item 2

The tests called for in the "TSI Derating Study Plan" were not performed. We do not plan to do any testing because our analysis, calculation # C-1101-770-E420-018, uses test results from TU/TVA configurations which bound our configuration.

Item 3

The Cycle 6 cable sizing criterion does not indicate the basis of ampacity values included in each table. It appears that the licensee did not use the ICEA P-46-426 tables for ampacity values. The licensee should document the source of its base ampacity values including any corrections to the base ampacities due to temperature, cable diameter variation, and number of conductors, etc.

Response to Item 3

The Cycle 6 cable sizing criteria (Rev. 1) page 2 paragraph 6 does give the basis for the base ampacity values by stating that "Specific cable manufacturer's free-air ampacity shall be used in lieu of IPCEA P-46-426 table ampacities...". The Cycle 6 cable sizing criteria

has ampacity tables for Kerite and also for Rockbestos manufactured cables. Calculation C-1101-770-E420-018 documents the source of the base ampacity values including any corrections to the base ampacities due to temperature, number of conductors in the tray, and the effect of Thermo-Lag fire barrier material.

Item 4

The base cable ampacities used by the licensee are not consistent with either NEC or ICEA P-46-426 ampacity tables. The ampacity-values should be reconciled or discrepancies between the licensee-cited values and those values documented in nationally recognized standards should be explained.

Response to Item 4

The base cable ampacities used are not those given in the NEC or IPCEA P-46-426 because base ampacities from the manufacturer (Kerite) are used for original cables supplied in the late 1960's. Kerite has given free-air ampacity values for 90 °C conductor temperature operating in a 40 °C ambient. Since ampacity values given by the manufacturer are taken to be the most accurate values available, reconciliation with NEC or IPCEA P-46-426 is not required.

Item 5

It appears that the licensee used ICEA P-54-440 to determine cable tray ampacity. These calculations lack the documentation of ICEA tables from which the values are derived, method for calculating cable depth or fill, and corrections due to temperature, depth of fill and cable diameter, etc., to the base values.

Response to Item 5

ICEA P-54-440 was applied in some of the cases as an alternate verification of the ampacity values calculated by IPCEA P-46-426 methodology. Where ICEA P-54-440 was used, in some cases more margin was indicated and in other cases less margin was indicated. Our Updated FSAR is based on using the Cycle 6 cable sizing criteria (section 8.2.2.11 and ref. 8.6.2 of FSAR) which is based on IPCEA P-46-426. Thus we used IPCEA P-46-426 methodology for the attached calculation # C-1101-770-E420-018. Calculation # C-1101-770-E420-018 uses the following: for ambient temperature, maximum HVAC design ambient temperature is used vice using 40°C across the board, for number of conductors, number of conductors is used vice number of cables, and for Thermo-lag a derating factor of 32% is used vice 28.04%. In general, the resulting ampacity values are lower and more conservative ampacity values than those calculated in the previously submitted analysis. For three cables (CG83, LP2 and LP6) the maximum expected load current exceeds the revised ampacity when using the IPCEA P-46-426 methodology. For a closer evaluation, the 1996 National Electric Code (NEC) Article

318-11 methodology is applied to tray 590 which contains the three cables. The resulting revised ampacity for the three cables is greater than the maximum expected load current.

Item 6

The licensee needs to provide sufficient information regarding the physical and electrical characteristics including manufacturer, number of conductors, cable configuration (e.g., single conductor, three conductor, triplexed, shielded, insulated and jacketed cable, etc.), cable outside diameter, voltage rating, conductor size, etc., of the Thermo-Lag protected cables used at TMI.

Response to Item 6

The requested information is provided in the attached calculation # C-1101-770-E420-018 Table 3.

Item 7

The documentation of the cable tray 590 temperature measurement experiment is considered inadequate. Test documentation should include the description of the test procedure, documentation of experimental methods and instrumentation, and at least a minimal demonstration of quality control over the experiments. This information should be provided if this, or other in-plant experiments, are to be credited.

Response to Item 7

We agree on further review that Attachment 2 of GPU Nuclear letter to NRC dated March 29, 1995 page 9 and 10 does not represent adequate documentation for a credible test. The material submitted is no longer applicable since our current analysis, calculation # C-1101-770-E420-018, is based on testing results from TU/TVA configurations which bound the TMI configuration and eliminate the need for further testing.

Item 8

The licensee has assumed an ampacity derating factor of 28.04 percent for a 1-hour Thermo-Lag cable tray fire barrier. This value does not reconcile with other Thermo-Lag ampacity derating test results using IEEE Standard Procedure P848, "Procedure for the Determination of the Ampacity Derating of Fire Protected Cables." The licensee should reconsider its analysis using more reasonable estimates of the ampacity derating impact of a Thermo-Lag fire barrier system or explain the basis for variation in parameters. (For example, Texas Utilities found a value of 32 percent for a nominal 1-hour Thermo-Lag 330-1 cable tray barrier system.)

Response to Item 8

We have reconsidered our position on TSI derating in light of the latest information available and because the TU configuration bounds our configuration we are using the latest TU number; 32%.

Item 9

The licensee did not describe the fire barrier system for trays 551/553. A description of the fire barrier system for these trays should be provided.

Response to Item 9

The fire barrier for trays 551 and 553 is a 1-hour TSI wrapped fire barrier similar to all other trays wrapped with a 1-hour fire barrier.

Item 10

The licensee's analysis appears to incorrectly interpret the cable tray multiple conductor derating correction to refer to a count of cables rather than conductors in the case of multi-conductor cables (see note 3 of TMI Cycle 6 Tables X and XI). This appears in direct conflict with the guidance of the NEC Handbook which quite clearly indicates that the count should be based on the actual number of power cable conductors. The licensee should reconsider its analyses using the actual count of power cable conductors as the basis for multiple conductor derating.

Response to Item 10

We have reconsidered our position and calculation #C-1101-770-E420-018 determines ampacity values for cables in tray using the number of conductors vice using the number of cables resulting in lower, more conservative ampacity values.

Item 11

The licensee needs to provide a definitive technical basis to support the assessment of cable ampacity for those cables which are overloaded over the equipment life cycle. The licensee should indicate what measures will be taken to monitor for signs of accelerated age-related degradation.

Response to Item 11

Based on the attached calculation no cables are overloaded over the equipment life cycle. Consequently, measures for monitoring for signs of accelerated age-related degradation will not be required.

Item 12

The constant KVA loads will draw 11 percent more current at 90 percent of rated voltage available at its terminals. Additionally, some loads may operate at overload or at a service factor of 15 percent. Accordingly, the full load current (FLA) could be as high as 125 percent of FLA at nominal voltage. The licensee needs to address this aspect of system operation in its analysis.

<u>Response to Item 12</u>

Full Load Current (FLA) for constant KVA loads are based on measured or calculated load values. For the circuits listed below, 125% of the FLA is greater then the derated ampacity of the cable. The affect of reduced voltage was evaluated by either determining the FLA for the motor at the minimum expected grid voltage during normal operation, or determining the FLA at 90% of the motor nominal voltage. For other Thermo-Lag protected constant KVA load cables, 125% of full load current is well within the derated cable ampacity. Since measured or calculated FLA were used operate at the limit of the motor service factor was not considered.

Circuit Number	Component	Nameplate FLA	De-rated Ampacity	Load Current @ Nominal Voltage	Load Current @ Degraded Voltage
LS6	NS-P-1B	140 amps	147 amps	144 amps(1 & 2)	146 amps(3)
LP6	NS-P-1A	140 amps	161 amps	141 amps(1)	143 amps(3)
LS5	NS-P-1C	140 amps	147 amps	144 amps(1)	146 amps(3)
CG83	IC-P-1A	87 amps	105 amps	82.7 amps(4)	91.9 amps(4)
CH61	IC-P-1B	87 amps	107 amps	82.7 amps	91.9 amps(4)
LP2	DC-P-1A	120 amps	133 amps	103.2 amps(5)	106 amps(7)
CL43	AH-E-7A	105 amps	89 amps	66 amps(6)	75 amps(6)
CM43	AH-E-7B	105 amps	89 amps	63.5 amps(6)	72 amps(6)

Note (1) Load Currents from TDR 995 (Ref. 3.9.2), Table 1A-A and Table 1A-B

Note (2) NS-P-1B is modeled as not running in TDR 995 (Ref. 3.9.2), normal operation 2 of 3 pumps are running, used load current value for NS-P-1C.

Note (3) Load current values from Lotus Notes from Tom Akos to Dick Bensel dated 9/9/96 (Ref. 3.9.5). Currents are based on a grid voltage of 232 KV.

Note (4) Load current from TDR 836, Rev. 6 (Ref. 3.9.1), Table 1A, Operating Load at 100% Power at Nominal Voltage and 100% Power at Degraded Bus Voltage. Degraded Bus Voltage values are calculated by applying a multiplier of 0.9 to the equipment rated voltage (460 VAC).

Note (5) Shutdown during normal operation, ES load operates only for testing, load current at nominal voltage from TDR 836, Rev. 6 (Ref. 3.9.1), Table 1P, Operating Load LOCA at Nominal Bus Voltage. Load current at degraded voltage from TDR 995, Rev. 3 (Ref. 3.9.2), Table 4A, LOCA loads grid at 225.6 KV.

Note (6) Reactor Building Purge Exhaust Fans, FLA values from Memo # MSS-86-079 (Ref. 3.9.4). One fan in operation during refueling outages or Reactor Building entries. Purge is operated less than 500 hours per year. Degraded Bus values based on FLA corrected to 90% of motor nominal voltage.

Note (7) Load current values from Lotus Note from Tom Akos to Dick Bensel dated 9/11/96(Ref. 3.9.5). Currents are based on a grid voltage of 232 KV.

Item 13

The maximum load current of transformer (1000/1333 KVA) is based on breaker setting of 185 amperes. Breaker setting has a tolerance of +/- 10 percent. As a result the maximum current seen by the cable shall be 203.5 amps (185 + 10 percent). Provide justification why 185 amperes shall be selected instead of 203.5 amperes.

Response to Item 13

Using the breaker setting of 185 amps instead of the 203.5 amps is conservative, since the normal loading on the transformers is significantly less than the breaker setting. The normal loading for the affected cables is as follows:

Circuit No.	Transformer	Measured Load(1)	Calc. Load
MB11	1H Bus Transformer	< 70 amps	176 amps(2)
MB13	1U Bus Transformer	< 10 amps	56 amps(3)
MC12	1M Bus Transformer	< 50 amps	178 amps(2)
ME11	1T Bus Transformer	50 amps	70 amps(4)
MD11	1R Bus Transformer	80 amps	69.4 amps(4)

Note (1) Based on 4 KV feeder breaker ammeter reading obtained on 9/03/96 with the plant at 100% power. The 1H Bus and 1G Bus are supplied through a shared breaker therefore the measured load is the total load for both buses. The 1M and 1L Buses are supplied through a shared breaker therefore the measured load is the total load for both buses.

Note (2) The 1H Bus load of 176 amps is a calculated value based on cold weather space heating load (see Calculation No. C-1101-770-E420-018, Appendix 1). The 1M Bus load of 178 amps is a calculated value based on cold weather space heating load (see Calculation No. C-1101-770-E420-018, Appendix 1).

Note (3) The 1U Bus load of 56 amps is based on Post Cooling Tower operation and operation of other connected loads (see Calc. No. C-1101-770-E420-018, Appendix 1).

Note (4) Load values from TDR 836, Rev. 6 (Ref. 3.9.1),Operating Load at 100% Power.

Item 14

The licensee should consider either the load amperes flowing through cables based on breaker setting with a positive 10 percent tolerance (i.e., 110 percent of breaker setting) or the actual amperage of the load in its analysis.

Response to Item 14

The attached calculation considers the actual amperage of the connected load which is either based on field measurements or calculation. The calculation includes references for the source of the load current values. The loading for affected transformers under all anticipated operating conditions is less than the nominal trip setting for the breaker. The calculation therefore used the actual/anticipated load to evaluate the derated ampacity for these circuits.

Item 15

Circuits MA9 and MB9 for SR-P-3A and SR-P-3B are both on tray 756. If both A and B pumps are on the same tray, how has the separation criteria been met. Circuits MB13, ME11, and ME10 share both trays 751 and 756. The licensee should provide a discussion on how the analysis is consistent with the cable separation criteria as described in FSAR Section 8.2.2.12.

Response to Item 15

Circuits MA9 and MB9 for SR-P-3A and SR-P-3B are Balance of Plant (BOP) non-Engineered Safeguards circuits, therefore separation criteria for redundant circuits does not apply. Circuits MB11 and MB13 are feeder circuits to BOP 480 VAC Buses. Circuit ME10 for RR-P-1B is appropriately routed in Engineered Safeguards Channel "B" trays. Plant circuit routing criteria allowed BOP circuits to be routed in Engineered Safeguard trays for one channel providing it never entered a tray associated with a redundant channel.