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Subject: Grand Gulf Nuclear Station
Docket No. 50-416
License No. NPF-29
Response to the Request for Additional Information Regarding Generic Letter 92-08 Item 2(c): Thermo-Lag Fire Barriers, dated February 26, 1997

GNRO-97/00022

Gentlemen:

Reporting Requirement Item 2(c) of Generic Letter (GL) 92-08 requests information concerning the evaluation and application of test results performed to determine the ampacity derating of cables enclosed in Thermo-Lag fire barriers. The most recent information that Grand Gulf Nuclear Station (GGNS) docketed in response to GL Item 2(c) was submitted by letter dated December 20, 1996 [Reference 1].

The December 20, 1996 submittal presented the GGNS response to questions raised from the Staff's preliminary review of GGNS Engineering Reports GGNS-96-0006, Revision 0 and GGNS-96-032, Revision 0 [References 2 and 3]. These reports were submitted to the Staff by letter dated June 28, 1996 [Reference 4] and provided the completed results of the GGNS Thermo-Lag evaluations for fire endurance and ampacity derating parameters.

Following review of the GGNS December 20, 1996 submittal, the Staff identified information presented in our submittal that requires clarification. The needed clarifications were discussed in a telephone conference call between Entergy and the NRC on February 20, 1997 and subsequently documented in the Staff's February 26, 1997 Request for Additional Information (RAI) [Reference 5].

The Staff's RAI is segregated into three distinct questions. A contextual synopsis of our response to each question follows below. Attachment 1 provides the detailed GGNS response to the Staff's February 26, 1997 RAI, including the supporting rationale for the conclusions drawn.

AO29/0

In Question 1, the Staff's RAI requests clarification of the grouping factors applied for multiple conduits in a common enclosure. Specifically, a breakout of the overall raceway derating that is attributable to the conduit grouping factors versus the contribution by the Thermo-Lag cladding is requested. In accordance with the Staff's request, GGNS has separately accounted for derating due to conduit grouping versus contributions from the Thermo-Lag overlay, as delineated in Attachment 1.

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Question 2 concerns ampacity derating considerations for continuously energized constant KVA loads which may draw more than their nameplate full load amperes (FLA) on a steady state basis. The concerns promulgated by this question envelopes eight circuits enclosed in two cable trays at GGNS. The GGNS response provided in the December 20, 1996 submittal was based on equipment nameplate ratings and/or design information available at the time. Subsequently, GGNS has collected data which is indicative of actual field conditions and based on review of that data, we concur with the Staff's characterization that cable ampacity margin determinations should be based on worst case continuous ampere loading rather than equipment nameplate data. We have revised our approach to apply a bounding multiplier to the nameplate FLA prior to determination of cable ampacity margins. Additionally, the 48% ampacity derating assumed for one of the affected trays has been determined to be 44% based on industry information, rather than the overly conservative 48% as previously docketed by GGNS. The ampacity derating determinations for the other raceway remains unchanged.

The recalculated ampacity derating determination is based on a analytical methodology. This represents a deviation from our previously utilized similarity analysis approach, however, the resulting ampacity derating margin determination is consistent with ampacity margins that have been analytically developed and supported by empirical testing. All other GGNS installed Thermo-Lag raceway are bound by corresponding empirical tests that have been previously reviewed by the Staff.

Question 3 requested that the appropriate engineering report(s) previously docketed by GGNS be revised to reflect a level of detail consistent with information docketed in our December 20, 1996 submittal with regards to ampacity derating for cables encased in Flexi-Blanket 330-660 material. This revision as well as other needed revisions to Engineering Reports GGNS-96-0006 and GGNS-96-0032 as delineated in the responses provided in Attachment 1 are planned to be completed by March 31, 1998. We understand, based on the February 20, 1996 conference call referenced above that revisions to the applicable engineering reports is primarily focused on facilitating historical record keeping purposes and that resubmittal of the revised report(s) for NRC review is not required.

We acknowledge receipt of the Staff letter dated April 21, 1997 which finds the GGNS program plan for resolution of GL 92-08 issues acceptable. Your letter confirms that the attached clarifications to our December 20, 1996 RAI response and any future interactions regarding ampacity derating of Thermo-Lag 330-1 raceway will be coordinated separately from Generic Letter 92-08 activities.

This information is being submitted under affirmation in accordance with 10 CFR 50.54(f)(Attachment 2).

Please contact Charles E. Brooks at (601) 437-6555 should you have any questions, or require additional information.

Your truly,

JJH/CEB/

attachments: 1. GGNS response to the NRC Request for Additional Information, dated February 26, 1997

2. Affirmation, per 10 CFR 50.54(f) of the GGNS Response to 92-08 RAI Item 2(c), dated February 26, 1997

cc: Mr. R. B. McGehee (w/a)
Mr. R. S. Reynolds (w/a)
Mr. J. H. Dixon (w/a)
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Attachment 1 to

GNRO-97/00022

Grand Gulf Nuclear Station
Response to Generic Letter 92-08 Item 2(c) RAI
dated February 26, 1997

The following items require clarification as delineated in the Staff's RAI dated February 26, 1997. These items were identified as a result of the Staff's review of the GGNS response to the GL 92-08 Request for Additional Information, dated December 20, 1996.

1. In the first part of the licensee's response to Question 1 (attached to the submittal of December 20, 1996) regarding Multiple Conduits in a Common Enclosure, it is not clear whether the grouping factors given in Table IX of ICEA Standard P-46-426 are part of the design calculations for plant electrical raceways independent of the derating factor for the Thermo-Lag fire barrier installations and simply omitted from the subject calculations or are the subject grouping factors being commingled into the overall derating factor for the Thermo-Lag installations. If the latter case is true, clarify which factor applies for the Thermo-Lag contribution versus the grouping derating factors when the spacing between the conduit surfaces is not greater than the conduit diameter or less than 1/4 of the conduit diameter. Also, discuss the applicability of industry standard grouping factors in the subject calculations which were submitted in the licensee's letter of June 28, 1996.

   In the second part of the licensee's response to Question 1 regarding Individually Enclosed Conduits, it is not clear whether a conduit grouping factor will be applied to all applicable cables and applicable design calculations will be revised to reflect these derating factors. Clarify the licensee's commitment in its submittal dated December 20, 1996.

   GGNS Response:

   Grouping factors given in Table IX of ICEA Standard P-46-426 are utilized in the original design calculations for plant electrical raceway and cable installations, which were performed by the AE to support original plant construction. The evaluations documented in Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0., are independent of the original design calculations, and the scope of the evaluations documented in these Engineering Reports is limited to ampacity derating for only those raceways that are protected by Thermo-Lag fire barrier installations.

Multiple conduits in a common enclosure

An ampacity derating factor of 48% was used for GGNS configurations where two horizontal conduits (1 x 2) are enclosed within a common enclosure fabricated by installing Thermo-Lag 330-1 nominal 1-¼" thick panels directly on the surface of these conduits. The basis for utilizing this derating factor is documented in Engineering Report GGNS-96-0032 Revision 0, and reiterated within GGNS' December 20, 1996 submittal. Application of the 48% derating to collectively account for conduit grouping as well as for the Thermo-Lag installation does commingle the two factors. Individual accounting of the two derating factors will require application of a Thermo-Lag installation derating factor, and an appropriate conduit grouping factor separately. GGNS considers it overly conservative to apply an additional conduit grouping factor to the 48% derating. However, GGNS will conservatively apply an additional conduit grouping factor to the 48% derating. Although a factor of 0.94 (6% derating) would appropriately account for the conduit grouping configuration for the two cases at GGNS, a conduit grouping factor of 0.91 (9% derating) will be conservatively utilized to account for the conduit grouping in this configuration. The minimum ampacity margin for cables within conduits enclosed in common enclosures discussed above after application of separate derating factors to individually account for Thermo-Lag installation and conduit grouping, is approximately 10%. This ampacity margin determination includes an ampacity correction factor of 1.09 to account for the actual ambient temperature within the room where these Thermo-Lag installations are located, as well as a 1.15 multiplier to nameplate FLA values to account for variations between nameplate FLA and actual in-situ currents drawn by the loads. The bases for the latter two factors are discussed under GGNS' response to question 2 of this Request for Additional Information.

GGNS considers it prudent to apply conduit grouping factors for all applicable conduits within the scope of Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0. Absent Staff guidance to the contrary, these reports will be revised to address conduit grouping factors within the body of the reports as well as to reflect the application of these factors on the derated cable ampacities documented within Attachment I to these reports. The appropriate revisions are planned to be incorporated by March 31, 1998.

Individually enclosed conduits

In response to the second part of Question 1, GGNS confirms that a conduit grouping factor of 0.91 will be applied to all applicable individually wrapped Thermo-Lag clad conduits. Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0 will be revised to reflect these changes. The appropriate revisions are planned to be incorporated by March 31, 1998.

2. In the licensee's response to Question 2. the licensee stated the following: "Continuously energized constant KVA loads powered by cables within the scope of this evaluation are sized to drive no more than 100% of their horsepower. Therefore, overloading of cables connected to constant KVA loads, due to continuous operation

at 115% of rated horsepower, does not require additional ampacity derating consideration."

The staff believes that ampacity margin determinations should be based on worst case continuous ampere loading, instead of using equipment nameplate data which may not reflect actual field conditions. This question is not intended to address ampacity derating due to transient voltage conditions. The staff's concern pertains to the potential understatement of final ampacity margins (i.e., after derating for Thermo-Lag and other typical design factors (e.g., cable fill, temperature) based on the use of non-conservative ampere loading values (i.e., using equipment nameplate data when the load is operated above its full load ampere rating). The licensee is requested to clarify its December 20, 1996, response in terms of the above stated concern.

The worst-case non-transient condition is having the voltage at the load terminals at 90% of rated voltage because the current will then be at its highest for the load. This condition is not a concern to the staff if the licensee can verify that the voltage at the load terminals will never be below 100% of rated voltage. The staff requests if the licensee can verify that this is true for the unit.

GGNS Response:

In order to adequately address the concerns raised by the NRC Staff in question 2 of the RAI dated February 26, 1997, GGNS performed current and voltage measurements on constant KVA loads within the scope of Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0, that had margins of less than 15%. Power circuits with less than 15% margin were targeted since that bounds the 11% increase in FLA corresponding to having 90% of rated voltage at constant KVA load terminals. Measurements were taken on a total of eight dual speed motors. These dual speed motors are part of two redundant 100% capacity ventilation trains that provide cooling to Emergency Switchgear and Battery Rooms (Z77 system). Each train is designed to operate at either the low speed or the high speed settings, depending on temperature permissives. Therefore, each motor has two sets of power cables, one for low speed operation and another for high speed operation. As a result of the system operation described, these cables experience a duty cycle of significantly less than 100%.

Of the 16 cables providing power to the Z77 System motors, eight have less than 15% margin based on the evaluations documented in Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0. Note that these eight circuits constitute the total population of power cables that have less than 15% margin within the population of cables evaluated within Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0. These circuits have at least two points of commonality:

- These eight circuits are enclosed in Thermo-Lag clad trays located in Room OC302.

- Seven of the eight circuits are connected to the low speed windings of the dual speed Z77 system ventilation motors. One of the eight circuits is connected to the high speed windings of one of the dual speed Z77 system ventilation motors. Note the cable connected to the high speed winding has a margin of approximately 10%, and the other cables connected for high speed operation of the dual speed Z77 system ventilation motors have margins in excess of 15%.

The measured data revealed that in some cases the current drawn by these motors varied from the nameplate FLA for the respective motor. This confirms the impact of configuration variations contributing to constant KVA devices drawing currents that are different from their nameplate FLA on a steady state basis, and it also validates the Staff position that these variations should be explicitly accounted for. In view of these results, GGNS considers it appropriate to apply a bounding multiplier to the nameplate FLA, to account for configuration variations, prior to the determination of cable ampacity margins.

In addition to the results discussed above, GGNS revisited the development of derating contributors in order to achieve conservative but realistic ampacity margin determinations. One of the factors that GGNS has not taken credit for within the evaluations documented in Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0 is ambient temperature. Base cable ampacities utilized in these reports implicitly assume an ambient temperature of 40°C, which bounds the temperatures typically experienced in rooms containing Thermo-lag clad raceways at GGNS, under normal operations. However, Room OC302 has an average temperature of approximately 80°F and is typically at a temperature of less than 86°F (30°C). Coincidentally, this room has the bulk of Thermo-Lag clad raceways, including the Thermo-Lag clad cable trays, as well as the two installations of multiple conduits within single enclosures (discussed under GGNS' response to question 1 of the RAI).

Therefore, the ampacity evaluations will be revised to take credit for the lower ambient temperature in this room, which translates into an ampacity correction factor of 1.09 for cables within the raceways within this room versus the factor of 1.0 implicitly assumed in Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0.

The other derating contributor revisited is the 48% derating utilized for the one GGNS tray clad with Thermo-Lag 330-1 nominal 1-¼" thick panels. This 48% derating factor is overly conservative since it is based on a tested configuration of Thermo-Lag 330-1 nominal 1-¼" thick panels with two complete overlays of Thermo-lag 770-1 as compared to the GGNS design which utilizes Thermo-Lag 330-1 nominal 1-¼" thick panels with reinforcement of joints with ¼" of trowel grade material and wire mesh. To re-evaluate this overly conservative derating factor, GGNS again canvassed individuals within the nuclear utility industry (including test facilities and industry coordinating organizations) who are knowledgeable on Thermo-Lag issues, and in some cases have been at the forefront of both, the testing and analytical approaches to the resolution of these issues. This effort brought to GGNS' attention an industry paper entitled ''Fire Endurance And Ampacity Testing Of One And Three-Hour Rated Thermo-Lag Electrical Raceway Fire Barrier Systems'', authored by Messrs. Mark H. Salley and Kent W. Brown, both of the Tennessee Valley Authority when the paper was presented. The Salley-Brown paper is relevant to this discussion because one of its topics is an analytical model which predicts derating factors for Thermo-Lag clad cable tray installations. The analytical model discussed within the Salley-Brown paper is built upon work previously done by Messrs. Phil Save and Gary Engmann (presented in their paper entitled ''Fire Protection Wrapped Cable Tray Ampacity'').

The Salley-Brown paper lists comparisons between the original Save-Engmann analysis, the Modified Analysis (Save-Engmann with Salley-Brown modifications), and available test results. Table 18 of the paper shows that the Modified Analysis model yields an ACF of 0.67 versus the 0.68 ACF based on TUE's tested configuration. This comparison demonstrates that the model yields a more conservative derating than the actual test. Note that this model utilized the actual TUE heat intensities rather than heat intensities derived from ICEA P-54-440. When heat intensity values derived from ICEA P-54-440 were substituted, the model yielded an ACF of 0.7, which is less conservative than the actual TUE test results by 2%.

Table 19 of the Salley-Brown paper, which is calculated with heat intensity values from ICEA P-54-440 shows that the comparable ACF to TVA's upgraded Three-Hour configuration is 0.55 versus the 0.52 ACF yielded by the tested configuration. However, review of the tested configuration shows that the minimum measured thickness of the configuration is 2.56" versus the 2.0" assumed by the model. When the model was re-analyzed with a thickness of 2.56", it yielded an ACF of 0.5, which is more conservative than the actual tested data by 2 %. Table 19 shows that the worst case ACF based on the Modified Analysis for 1.25" thick 330-1 Thermo-Lag is 0.58 (42% derating). Addition of a 2 % margin to account for variations in the model, based on discussions in the previous paragraph, yield an ACF of 0.56. It is GGNS' position that in the absence of actual test data for cable trays enclosed solely in Thermo-Lag 330-1 nominal 1-¼" thick panels, the 44% derating figure obtained analytically, and including an error margin of 2% represents a realistic approach.

Affected cable ampacities were recalculated, taking credit for the 30°C ambient temperature within Room OC302, and incorporating the more realistic 44% derating in place of the overly conservative 48%. Additionally, as discussed earlier, a factor of 1.15 was applied to all power cable (nameplate) FLA values to account for variations between in-situ FLA and nameplate FLA values. Ampacity margin determinations based on the above revisions revealed that eight circuits have ampacity margins below 10%, with the minimum margin being 2.27%. As a comparison, ampacity margin determinations factoring in the ambient temperature correction and revised Thermo-Lag installation derating factor compared to the in-situ FLA (measured) was performed. This determination indicated that only two circuit had a margin below 10% (9.24%), as opposed to eight circuits falling under 10% when utilizing an FLA correction factor of 1.15%. This comparison shows that the 1.15 factor is appropriate and allows a conservative and bounding evaluation.

The Staff stated their belief that ampacity margin determinations should be based on worst case continuous loading, instead of using equipment nameplate data which may not reflect actual field conditions. By performing final ampacity margin determinations on corrected FLA values obtained by applying an FLA correction factor (1.15) which bounds measured FLA values for the seven worst case circuits, GGNS believes that the concerns raised by the NRC Staff regarding overstatement of final ampacity margins have been addressed.

In order to evaluate the worst case non-transient conditions for constant KVA loads, GGNS performed evaluation to calculate the FLA that would be drawn by constantly energized constant KVA loads at the lowest anticipated grid voltage, based on measured currents for the worst case circuits. The GGNS UFSAR provides 496 kV (0.992 Per Unit) as the minimum anticipated grid voltage on the 500 KV grid. This revealed that at the lowest anticipated grid voltage, the loading on one cable could exceed its derated ampacity by approximately 2%. If the grid voltage were to consistently be at 496 kV for the life of the plant, and if the motor fed by this cable (Q1Z77C001AA - low speed) had a 100% duty cycle for the life of the plant, the cable may experience thermal damage towards the end of its life. However, the nominal voltage on the grid is 510 KV (1.02) per unit, and any excursions to the lowest anticipated grid voltage are expected to be of a temporary nature. Additionally, this motor has a duty cycle of significantly less than 100% due to the fact that it is the low speed application of the two redundant 100% capacity ventilation trains that provide cooling to Emergency Switchgear and Battery Rooms, as discussed earlier.

The above evaluation supports the conclusion that even with the minimum anticipated steady state voltage (which would represent a ''transient'' from the nominal grid voltage) the worst case cable should support the required operation of its respective motor for the design life of the plant. In order to ascertain the physical condition of cables in trays, GGNS performed a visual inspection on cables within one of the trays while modifications were being made to GGNS' Thermo-Lag installations during Refueling Outage 8 (fall 1996). Each cable within the tray segment available for inspection was individually inspected, and all cables within the inspected tray section were pliable and their insulation showed no signs of hardening or cracking, confirming the conclusion reached by the above evaluation.

Absent Staff guidance to the contrary, appropriate changes to document the revised evaluation within Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0, are planned to be incorporated by March 31, 1998.

3. In the licensee's response to Question 6, a technical rationale was presented by the licensee to explain how the installed configurations are bounded by referenced ampacity derating tests. The staff requests that the applicable engineering reports be revised to reflect the use of the Thermo-Lag Flexi-Blanket 330-660 fire barrier material and the associated technical justification for the its ampacity derating factor.

GGNS Response:

As previously stated, Engineering Reports GGNS-96-0006 Revision 0 and GGNS-96-0032 Revision 0 will be revised to reflect a level of detail consistent with information docketed in our December 20, 1996 submittal with regards to the Flexi-Blanket 330-660 material. The needed revisions are planned to be incorporated by March 31, 1998.

References:

1. Letter J. J. Hagan to the U. S. Nuclear Regulatory Commission, dated December 20, 1996 Response to the ''Request for Additional Information Related to Ampacity Derating issues for Thermo-Lag Fire Barriers for Grand Gulf Nuclear Station''.

2. Engineering Report No. GGNS-96-0006 Revision 0, ''Grand Gulf Nuclear Station Engineering Report for Evaluation of Ampacity Deratings for Thermo-Lag Fire Barrier Enclosed Cables in Fire Areas/Zones OC202, OC402, OC702 and 1A316''.

3. Engineering Report No. GGNS-96-0032 Revision 0, ''Grand Gulf Nuclear Station Engineering Report for Evaluation of Ampacity Deratings for Thermo-Lag Fire Barrier Enclosed Cables in Fire Areas/Zones OC214, OC302, OC308 and 1A539''.

4. Letter C. R. Hutchinson to the U. S. Nuclear Regulatory Commission, dated June 28, 1996 Response to the ''Request for Additional Information Regarding Generic Letter 92-08 (GL) Item 2(c): Thermo-Lag Fire Barriers'' dated November 6, 1995.

5. Letter U. S. Nuclear Regulatory Commission to J. J. Hagan, dated February 26, 1997 ''Request for Additional Information Related to Ampacity Derating issues for Thermo-Lag Fire Barriers for Grand Gulf Nuclear Station''.