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MFN 04-113
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U.S Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20852-2738

Attention: Chief, Information Management Branch
Program Management
Policy Development and Analysis Staff

Subject: **Proprietary Content of MELLLA Plus RAIs (TAC No. MB6157)**

By Reference 1, the NRC provided requests for additional information (RAI) to support their review of the Licensing Topical Report (LTR) NEDC-33006P, Revision 1, *Licensing Topical Report NEDC-33006P, Revision 1, "General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus."* The reference letter also requested that GE review the RAIs for proprietary content pursuant to 10CFR2.790.

GE has completed its review and determined that certain information contained in the references is considered by GE to be proprietary. Enclosure 1 contains non-proprietary (redacted) versions of the RAIs. The basis for the proprietary determination is the existing affidavit provided in NEDC-33006P, Revision 1.

If you have any questions, please contact, Mike Lalor at (408) 925-2443 or myself.

Sincerely,

George Stramback
Manager, Regulatory Services

Project No. 710

D045

Reference:

1. MFN 04-111, Letter from Alan Wang (NRC) to James Klapproth (GE), *Request for Additional Information - Global Nuclear Fuel's Analytical Methods Used to Support Operation in the MELLLA+ Domain, Licensing Topical Report NEDC-33006P, Revision 1, "General Electric Boiling Water Reactor Maximum Extended Load Limit Analysis Plus" (TAC No. MB6157),* dated October 1, 2004,

Enclosure:

1. Non-Proprietary (Redacted) Version of MFN 04-111

cc: AB Wang (NRC)
JF Harrison (GE/Wilmington)
JF Klapproth (GE/Wilmington)
MA Lalor (GE/San Jose)
LM Quintana (GE/Wilmington)
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ENCLOSURE 1

MFN 04-113

Non-Proprietary (Redacted) Version of MFN 04-111

REQUEST FOR ADDITIONAL INFORMATION

LICENSING TOPICAL REPORT NEDC-33006P, REVISION 1, "GENERAL ELECTRIC BOILING WATER REACTOR MAXIMUM EXTENDED LOAD LIMIT ANALYSIS PLUS"

GE NUCLEAR ENERGY

PROJECT NO. 710

This request for additional information (RAI) pertains to the review of Licensing Topical Report (LTR) NEDC-33006P, Revision 1, "General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus," referred to as MELLLA+. In particular, this RAI relates to the review of the adequacy of Global Nuclear Fuel–Americas (GNF-A's) neutronic and thermal-hydraulic methods in simulating the core conditions for boiling water reactors (BWRs) operating in the proposed MELLLA+ domain would experience. The staff's objectives for this RAI are:

1. To document some of the June 28 to July 1, 2004, GNF-A audit material that will be used for the staff's safety findings.

2. To obtain additional high void condition core flow benchmarking data, as close to MELLLA+ condition as possible, in order to assess the accuracy of the GNF-A methods.

3. To obtain error progression analyses in order to determine the impact of errors in the neutronic parameters on the safety analysis.

4. To request the lattice benchmark data for comparison with the staff's confirmatory analyses and to obtain additional information on how GNF-A obtained specific physics parameters from the benchmarking code (MCNP) and the lattice physics code (TGBLA).

5. To obtain the sensitivity analyses that would be established if high inchannel and bypass voiding greater than 5% can be avoided for operation in the extended power uprate (EPU)/MELLLA+ domain.

6. To obtain the sensitivity analyses that would establish the impact of high bypass voiding during transient conditions on the accuracy and reliability of the neutron monitoring instrument reading and response.

7. To identify the technical conclusions in Enclosure 3 to GE Nuclear Energy (GENE) letter MFN 04-026 that the staff does not agree with and that will need additional justifications.
8. To determine the acceptability of the uncertainties currently used in the safety limit minimum critical power ratio (SLMCPR) calculations for the high void MELLLA+ condition.

9. To identify restrictions that the staff plans to add to the use of the MELLLA+ LTR in plant-specific applications.

1. MCNP Generated and Extrapolated Comparison (Section 2.1.1). Figures 2-1 to 2-9 show the extrapolation errors obtained by comparing MCNP data generated data at 90% void conditions against data obtained by extrapolation to 90% void the MCNP data fit at the three void statepoints (0%, 40%, and 70% void). The following pertains to these MCNP evaluations.

   1-1_ The MCNP extrapolation errors at 90% void are significant for some of the parameters. Evaluate the impact of these extrapolation errors on the core behavior including axial power profile and pertinent thermal limits.

   a. Migration area (Figure 2-8) with extrapolation errors [[ ]]
   b. Flux ratio (Figure 2-9) with extrapolation errors [[ ]]

   1-2 Exposure Dependency of MCNP Extrapolation Error. Figures 2-1 to 2-9 provide extrapolation errors as functions of lattice averaged exposure in order to illustrate any exposure dependence or isotopic dependence exist. In the evaluation of the MCNP results, the Enclosure states that the points with the worst agreement are either highly exposed conditions (65 GWd/ST) or controlled conditions or both. However, the biggest error seems to occur around 15 GWd/ST, where the plutonium content is highest. At high burnups there is less concern for large errors because the high burnup assemblies would not be at their peak reactivity. Discuss at what exposure the peak reactivity is expected to occur and identify the main contributors. Revise the Enclosure discussion and justify the peak error at 15 GWd/ST as opposed to 65 GWd/ST.

   1-3 Use of 40% Void TGBLA Isotopic Content. In the MCNP cases, the isotopic concentration was kept constant and the instantaneous voids changed for given exposure. For these MCNP evaluations, was the TGBLA's isotopic content at 40% void used in simulating exposed lattice? Does the depletion [[ ]] represent the worst case for the instantaneous void extrapolation or should depletion at other void fractions, [[ ]], also be considered with the corresponding TBGLA isotopic compositions used in additional MCNP calculations?

   1-4 Instantaneous Water Density Cross-section Fit Adequacy. The results discussion in Section 2.1.1 states that the fit (in instantaneous water density) is typically

made in an exposure range which itself has a quadratic functional dependency assigned to it. The exception to this is the J-factor or TIP detector response, which has a cubic dependence on exposure. Provide additional explanation on the above dependency statements.

1-5 Figures 2-1 to 2-11 do not provide means to differentiate the data for different lattices, therefore it is difficult to determine if a high Gd lattice may show more predominant exposure dependence. In addition, the data does not indicate if the result is based on controlled or uncontrolled condition. Please include this in the update.

1-6 The errors in the pin power/fission rate distribution is presented in Figures 2-21 and 2-29, which show the RMS and MAX pin power errors. Compute and include the error in the peak pin power/fission rate.

2. TGBLA/MCNP Comparisons (Section 2.1.2). Section 2.1.2 evaluates the accuracy of the TGBLA 90% void lattice physics data obtained by extrapolating a quadratic fit of the TGBLA data generated at 0%, 40%, and 70% void conditions. The TGBLA 90% void fit/extrapolation data is compared to MCNP data generated at 90% void. The depletion at high void conditions are simulated by using fixed isotopic content (at constant 40% void) at different burnups in the TGBLA and the MCNP cases. TGBLA is compared and benchmarked against MCNP for the same lattices at zero exposure and with varying isotopic content in order to simulate the exposed lattice. The following RAIs and data request pertain to the qualifications of TGBLA against MCNP at high void conditions (90% void).

2-1 Provide spreadsheets with TGBLA data at 0%, 40%, 70%, and 90% and the MCNP results used to generate Figures 2.12 to 2.28 in Section 2.1.2.

2-2 Provide a description of how all of the MCNP results were computed (cross sections, diffusion coefficient, flux ratios, migration area, and pin powers).

2-3 Explain the large discrepancies in the diffusion coefficient [[ ]] as shown in Figure 2-18 and the migration area [[ ]] in Figure 2-19. For these parameters, provide charts similar to Figure 2-22 that show the TGBLA/MCNP comparisons at 0%, 40%, 70%, and 90% void fractions.

2-4 MCNP Diffusion Coefficient and Migration Area Calculations. It is feasible that the high error in the diffusion coefficient and migration area is due to how these parameters are calculated from MCNP tally. Consider the following options, (1) develop a more accurate method of estimating the diffusion coefficient and migration area from MCNP, (2) use an alternative "trusted"code to determine the

diffusion coefficient and migration area at high void conditions, or (3) use a new technique or code to validate the extrapolated TGBLA diffusion coefficient and migration areas.

2-5 Figure 2-14 (page 2-13) shows TGBLA/MCNP extrapolation error for $\nu\Sigma_f$ for thermal group (group 3). The figure shows, (1) large error [[ ]], (2) a clear increasing error trend with voids and exposure. Why doesn't this error have more impact on kinf? Provide further explanation.

2-6 Error Acceptance Criteria. For each fuel design change, GNF-A assesses the sensitivity of the lattice physics parameters. Provide a discussion on GNF-A's current method for establishing what is an acceptable error criteria for the lattice physics parameters. Explain for which lattice parameters are these error acceptable criteria are defined. For the current review, define the acceptance criteria associated with the cross sections and lattice parameters and resolve or justify the high errors.

2-7 TGBLA Extrapolation Error Progression Analysis. Based on the current TGBLA extrapolation errors provided, identify those neutronic parameters that may have significant effect on the simulation of the core response. The large errors in the diffusion coefficient and the migration area are more likely to affect local power distribution. An error propagation analyses is necessary to assess the impact of these large errors on the safety analyses. The steady state neutronic data is used by a number of codes that are part of the GNF-A code system used to perform the SLMCPR transients and accidents. The staff is interested in assessing the propagation of the extrapolation errors in the code systems used to perform the safety analyses.

Perform a core simulations (PANAC) to evaluate the effect of the extrapolation errors in the neutronic parameters based on high void conditions at different exposures. Perturb the neutronic parameters (based on the corresponding error associated with the TGBLA fit/extrapolation) in the core simulation to establish the impact of these errors on the core wide steady-state response. Of special interest is the impact of the extrapolation error propagation on the power distribution, pin peaking factors, reactivity coefficients, calculations of the voids and other key parameters that are important to the core and fuel performance analyses (e.g., SLMCPR).

2-8 Extrapolation Errors Impact on the Dynamic Core Response: The nuclear cross-sections, dynamic parameters and state conditions from TGBLA/PANACEA steady-state physics are supplied to the transient codes. Provide an evaluation of the impact of TGBLA/PANAC extrapolation errors at high void conditions on the

dynamic core response (e.g., ΔCPR, peak pressure, core power) for operation at the high void conditions.

3. Historical Water Density Cross Section Fit Adequacy (Section 2.1.4). The extrapolation errors in the historical water density fits were demonstrated based on the use of a developmental code (LANCER).

3-1 In the conclusion provided in Section 2.1.2, it is stated that [[ ]] and in Section 2.1.4 it is stated that [[ ]]

a. Provide an explanation of the reasons for these difficulties with TGBLA.

b. New assemblies have a large number of Gd pins and therefore any inaccuracies in the Gd depletion are likely to have a larger impact on the results obtained for the higher Gd loaded bundles. Since the previous benchmarking data was based on lower Gd loading, can these benchmarking results be applied, to the current more heavily Gd loaded assemblies? Provide justification for the use of TGBLA/PANAC under the hard spectral conditions typical of the EPU/MELLLA+ operation for cores loaded with heavily Gd loaded assemblies.

3-2 Use of Developmental Code. Describe the methods and data used in the developmental code and its suitability for the task performed. Provide available verification and validation data and documentation.

3-3 Confirm the source of the data presented in Figures 2-30 through 2-39. Are all of the results in these figures based on LANCER calculations for extrapolations from 0%, 40%, and 70% void fraction as well as the reference 90% void fraction values?

3-4 TGBLA/LANCER Extrapolation Error. GNF-A used the developmental code LANCER to study the adequacy of the TGBLA depletion at 90% void condition. The LANCER calculations show significant extrapolation errors in the group 2 absorption cross section (Figure 2-31), migration area (Figure 2-37), and flux ratios (Figure 2-38). Evaluate the impact of these extrapolation errors.

3-5 Use of TGBLA 40% Void Isotopic Content in the MCNP calculation. The MCNP code was used as the reference code for the evaluation of the fit of the instantaneous cross sections and provides a comparison to address the accuracy of

the TGBLA cross sections. In the current assessment of the impact of depletion at 90% void conditions, GNF-A used the developmental LANCER code. Neither of these approaches are relevant to neutronic methods to be used in the core simulation. The following requests are intended to quantify the impact of depletion at 90% void conditions on the accuracy of the GNF-A's neutronic methods.

a. If sufficient validation data cannot be provided as requested in 3-2, confirm the LANCER results by performing MCNP calculations using the LANCER-computed isotopic compositions as a function of void and burnup.

b. Compare the results not only with LANCER, but with extrapolated TGBLA results to assess the accuracy of the extrapolated TGBLA parameters. Specifically, the pin powers are based on fission energy so it is possible that the isotopic content may have impact on the pin powers and the power distribution. Therefore, compare the LANCER/MCNP pin powers calculated using LANCER isotopic composition to the extrapolated TGBLA at 90% void fraction. Include comparisons at 0%, 40%, and 70% to assess any increase in error at 90% void fraction. This comparison is similar to that presented in Figure 2-28 but considering void history.

4. Instantaneous and Historical Water Density Pin Power Fit (Sections 2.1.3 and 2.1.5)

4-1 Error Treatment. In evaluating the errors, GNF-A uses average, RMS or maximum error. Discuss when RMS, maximum or peak error is important or appropriate for each parameter and explain why. For example, during the audit, GNF-A stated that RMS errors are more likely to be important for the bundle performance and errors associated with the hot pins are more likely to be important for the pin performance and safety analyses. For the pin powers, in addition to the RMS and maximum error, provide the extrapolation error for the peak pin.

4-2 Current Uncertainties Used. What are the uncertainties required in the pin powers for lattice methods as given in NEDC-32694-P-A and NEDO-10958-A as discussed in Section 2.1.3?

4-3 Biases in the MCNP Calculations. In determinating the pin power uncertainty, extrapolated TGBLA data is compared or benchmarked against MCNP results. Gamma scan data for bundles depleted at high 90% or greater void conditions are not available. In addition, the staff also understands from the methods audit that

GNF-A considers errors associated with Gamma scans as high and would prefer establishing the pin power uncertainties by using MCNP benchmarking. However, with this uncertainty assessment, there is no error or uncertainties assumed for the MCNP results. Provide a basis for not including MCNP errors and uncertainties in the overall assessment of pin power uncertainties.

4-4 In addition to the RMS and maximum error, provide the extrapolation error for the peak pin.

4-5 Are the pin powers provided based on energy deposited or fission energy?

4-6 Provide a discussion on how the lattice pin powers are fitted/interpolated to get each pin power distribution as a function of void fraction and exposure.

5. Plant Data, PANAC comparisons, and Applicability to MELLLA+ Conditions. Several conclusions in the Methods Enclosure 3 state that the methods are adequate and that eigenvalue tracking per standard procedures will be used. Although, there are no EPU/MELLLA+ operational data, the adequacy of the GNF-A neutronic method must be substantiated through benchmark data or through data that is as close to the EPU/MELLLA+ conditions (e.g., high in-channel void conditions 90% or greater). However, there is substantial data based on historical and current operation that are of interest. The following RAIs address benchmarking data needed to demonstrate the adequacy of the GNF-A method for the MELLLA+ conditions.

5-1 Section 2.1.2 states, [[

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5-2 Confirmation of Eigenvalues During MELLLA+ Implementation. In several sections, the conclusion states that "confirmation of thermal limits uncertainties (e.g., power distribution) should be executed for initial implementation of MELLLA+ strategy. Explain what is meant by this statement and how this confirmation is performed. As proposed, the eigenvalue tracking results and conclusions would be obtained during MELLLA+ operation after the staff's approval of plant-specific EPU/MELLLA+ application. State what process would be available to the staff for review or assessments of the eigenvalue benchmarking data after the approval of the plant-specific application. What process will this benchmarking data and the corresponding conclusions of the confirmation of the thermal limits uncertainties be provided to the staff for review and assessment?

5-3 Provide plant data and PANAC calculation results for core operating conditions that are as close to MELLLA+ operating conditions (120% power, 80% flow) as available. In this data provide:

a. Calculated radial and axial void fraction distributions. Provide plots and tabular data for comparisons with MELLLA+ conditions.

b. Measured TIP profiles and corresponding PANAC TIP predictions. Provide both plots and tabulation of the individual TIP readings and PANAC predictions and compute RMS deviations. The tabulation provides a better means to show the difference between the individual four bundle TIP reading and the associated PANAC results.

5-4 Provide the PANAC calculated data for the same parameters as requested in RAI 5-3 for a core with MELLLA+ conditions for comparison with existing plant data and corresponding PANAC predictions. Provide in plots and tabular form to be consistent with results provided in the response to RAI 5-3.

5-5 Provide a discussion of how the core follow data is used to benchmark the GNF-A analytical methods. Explain the important plant instrumentation readings that are obtained from the licensees to simulate the core response using "offline" PANAC calculations. Discuss how the data is compared to the core monitoring system predictions. Provide tabulated data (shown during the audit), comparing the PANAC calculations and the plant's core monitoring system calculational results (e.g., core thermal power, exposure, core flow, thermal limits calculations) for the given cycle data points. Use Brunswick Units 1 and 2 core follow data and a high density BWR plant operating with the highest core void conditions. Include core follow data for operation in the high power/low flow offrated conditions for a high density plant. This is of interest in order to access the GNF-A code system's accuracy under high void offrated conditions as close to the EPU/MELLLA+ condition.

6. Extension to greater than 90% void fraction. The examination of the inaccuracies of GNF-A's neutronic technique is limited to the errors associated with the extrapolation of the TGBLA fit data up to 90% void state point. [[

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For example, AOO RAI 7 response shows that the Brunswick hot channel exit voids could be as high as [[ ]] voids at steady-state. Therefore, it is feasible that a high density plant operating at EPU/MELLLA+ conditions could experience hot channel exit voids greater than 90% at steady state. It also follows that with high in-channel steady-state void conditions, the voids during transient could even be higher than 90%.

6-1 Justify operation at exit void conditions above 90% void conditions, during steady-state operation. Provide an assessment of the accuracy of the GNF-A data fit/extrapolation to higher void methods to operating conditions with voids greater than 90%, during steady-state conditions.

6-2 Similarly, provide an assessment of the hot channel exit void conditions during transient conditions for operation at the EPU/MELLLA+ upper boundary (120% power/80% CF and the 55% CF state points). The GNF-A neutronic method accuracy assessment should extend to the void conditions possible during the most limiting transient conditions, in terms of hot channel voids.

7. The Diffusion Coefficient and High Void Conditions. The accuracy of the PANAC and related codes depends upon the evaluation of the diffusion coefficient that is used as input to these codes. High-void conditions may result in neutron streaming that may not be adequately treated with a single diffusion coefficient.

7-1 Explain how the diffusion coefficient is computed in TGBLA. In addition, explain what scattering moment data (e.g., P1 angular scattering data) is available within TGBLA, the method used by TGBLA to incorporate that data into the definition of the diffusion coefficient and the migration area.

7-2 Have differences in the axial and planar diffusion coefficients ever been assessed under high void conditions? What is the ratio of the diffusion coefficients calculated at 90% and 95% void, using MCNP or other codes that can be used to generate lattice physics data at high void conditions?

7-3 In the GNF-A methods, can the directional diffusion coefficients be obtained in order to confirm if they are necessary for accurate predictions for operation in high voided conditions? Does PANAC allow for directional diffusion coefficients in its calculational method and are they used in PANAC core analysis?

7-4 Are there any benchmarking tests in these high-void conditions that have been compared against 3-D transport theory codes under these conditions?

8. 1-½ Group Diffusion-Theory Assumption (PANAC). Section 2.5 evaluates the impact of the equal buckling for all energy groups under high void conditions. The 1-½ group method in PANAC is used in the 3-D core simulator. The methods (Enclosure 3) state that the [[

]] This is a minor compensating effect in the exposure accumulation and subsequent power and void feedback, but this error indicates

a small increase of the current under-prediction of the axial power shape. An additional uncertainty in the power shape would be prudent to cover this apparent deficiency.

8-1 Provide a description of the diffusion theory, the 1-½ group assumptions, and the spectral history model implemented in PANAC10 and 11. Alternatively, refer to document submitted to the NRC that contains sufficient information.

8-2 Provide additional discussion on the specific reason for the additional uncertainties as a result of the 1-1/2 group approximation as Enclosure 3 states may be necessary. Include, if possible, comparisons with available plant data that show the under-prediction error for a plant operating in the most limiting conditions for the current operating experience data base.

8-3 Establish additional uncertainty in the power shape to compensate for the stated under-prediction for the EPU/MELLLA+ conditions. Discuss how the additional uncertainty would be established. State which calculations would the uncertainties be incorporated and what thermal limits and/or safety analyses would the increase in uncertainties affect (e.g., SLMCPR power distribution uncertainties).

8-4 The staff finds that the adequacy of the 1-½ group diffusion-theory method has not been demonstrated in the discussion in the Methods Enclosures. From the Methods audit, the staff believes that the adequacy of the 1-½ group diffusion-theory methods for operation under high void conditions should be demonstrated by comparing against higher-order multiple-group transport methods. In the GNF-A January 8, 1998 Amendment 26 submittal (MFN-003-98), "Implementation of Improved GE Steady-State Nuclear Methods," GNF-A benchmarked the PANAC11 improved 1-½ group physics methods against 3 group, fine-mesh diffusion theory and an intermediate mesh with both full 2 and 3 group solutions. Why isn't the same process used to validate the adequacy of the 1-½ group diffusion-theory method for the high void conditions application? Perform similar benchmarking to validate the impact of the equal buckling for all energy groups under high void conditions.

8-5 Does PANAC use explicitly the TGBLA calculated migration areas? If not, please explain. For example, are the "partial" migration areas used in PANAC [M2(grp1), M2(grp2), M2(grp3)] calculated independently, based solely on the group-dependent diffusion coefficients and removal cross sections, such as M2(grp2)=D(grp2)/SigR(grp2) and so on, irrespective of the total M2 computed by TGBLA?

8-6 In the PANAC method discussions focus on the "infinite" flux ratios such as [FlxInf(grp2) / FlxInf(grp1)] and [FlxInf(grp3) / FlxInf(grp2)]. However, it appears that these flux ratios are only an alternate symbolic representation of different cross-section ratios that would be available to PANAC code. Explain if PANAC "actually uses" the "infinite" flux ratios computed in TGBLA, or does PANAC "actually" use the ratio of the respective cross sections provided by TGBLA?

9. Qualification for Fuel Designs. The PANAC11 submittal (MFN-003-98) states that the improved lattice design code TBLA06 accommodates the following lattice geometry designs: 7x7, 8x8, 9x9, 10x10 and 11x11 and MOX fuel. It is also qualified for uranium enrichment of [[ ]] of U-235 and Gd rods with Gd_2O_3 concentration up to [[ ]] of the pellet material. The qualification included cycle tracking, gamma scans and benchmarking against MCNP.

9-1 For the current NRC-approved qualifications, state if other vendors' fuel with different thermal-mechanical and lattice designs (e.g., ATRIUM-10 and SVEA-96+) have been benchmarked in order to establish the calculational uncertainties and qualify the adequacy of the use of TGBLA06 for the legacy fuel designs.

9-2 The staff understands that GNF-A models other vendors' fuel as new GNF-A legacy fuel by: (1) developing new GEXL correlation for the legacy fuel, and (2) establishing the thermal-hydraulic compatibility of the legacy fuel and the GNF-A fuel designs. Since the current methods qualifications (TGBLA/PANAC) for high void applications (Enclosure 3 to NEDC-33006P) are based on GE14, discuss what regulatory process would be used for benchmarking/qualifying legacy fuel designs for the high void EPU/MELLLA+ application.

9-3 Similarly, discuss what regulatory process would be used for benchmarking/qualifying future GNF-A fuel designs for the high void EPU/MELLLA+ application?

10. NRC-approval of the Extrapolation of the Lattice Physics Parameters to High Void Conditions. The Amendment 26 to GESTAR II submittal contains discussion on PANAC using TGBLA lattice physics data that is parametrically fitted as a function of moderator density, exposure, control and moderator density history for a given fuel type. The qualification of TGBLA06/PANAC11 is based on 0%, 40% and 70% void condition. There appears to be no discussion or benchmarking on extrapolation of the parametric fit to higher void conditions (e.g. >87% for high density plants).

10-1 State where the NRC had explicitly approved extrapolation of the parametrically fitted data from the three void state points.

10-2 Also state if the GE14 qualification data presented in the fuel performance update meeting presentations (FLN-2001-004) contained discussions on the void conditions the benchmarked data were based on. Did the presentation material submitted to the NRC contain a discussion on extrapolating the lattice physics parameters to the higher void conditions for the PANAC calculations?

10-3 State if the higher 87% void conditions seen in the high density plants existed for the operation at the original licensed thermal power (OLTP) at 100 rod line, or if the high density plants operated with high void ranges after implementation of MEOD.

11. Section 2.2 - Void Quality Correlation. The section discusses the applicability of the void correlations used in the GE codes for operation in the MELLLA+ conditions.

11-1 TRACG does not use the DIX correlation. Please provide evaluation of the applicability of the TRACG's interfacial shear model.

11-2 For the new DIX correlation, what are the variables and the corresponding applicability ranges? Show where the MELLLA+ operation fits within the range of applicability.

12. Section 2.2 - (two phase pressure drop).

12-1 Update Section 2.2 by including the test bundle pressure drops test data shown in Figure 3-1 of NEDC-328774P.

12-2 For Figure 2-41 (enclosure) provide an explanation of the data ranges and how ISCOR is fine tuned to using test data. Also state what is the criteria for the pressure error.

13. Section 2.3 - Flow Distribution Models (PANAC/ISCOR). The TRACG analysis case presented was based on 105% power and 65% CF. Provide the results for the bounding conditions of 120% power and 80% CF. Update Table 2, "TRACG Steam Separator Predictions for MELLLA+."

14. Section 2.8 - Bypass Void Models (PANAC/ISCOR). AOO RAI 5 response proposes using ISCOR (4 bundle) analyses to establish if the bypass voiding remains less than 5% during steady-state. However, ISCOR is a single hot channel/average channel code and the flow distribution in the bypass flow may not be accurate.

14-1 Provide a confirmatory 4 bundle TRACG analyses for a MELLLA+ core (Brunswick) to establish what the bypass voiding would be during steady-state. Use limiting conditions in terms of operating conditions of the 4 bundles (e.g., cycle exposure, number of hot bundles in the control cell, and the initial OLMCPR. Perform the analysis at the EPU/MELLLA+ conditions that would lead to the most limiting in-channel and bypass voiding condition (e.g. 80% or 55% CF statepoints). Discuss the results and state if the ISCOR model would underpredict the potential for bypass voiding.

14-2 [[

]]

a. State what the value shown in the legend for each BWR product line is based on.

b. [[

]] Evaluate the current stability options (e.g., DSS-CD, plant-specific DIVOM curve, Option 1D, Option E1A etc) and establish if the reactor would experience 10% bypass voiding with out scram if instability does not occur . This would be true for those detect and suppress options that do not require automatic scram. Evaluate how 10% bypass voiding would affect the reliability of the neutron monitoring instrumentation under this conditions as well as the core simulator capability.

15. <u>Section 2.0, Bypass and Water Rod Voiding and [[</u>

]]

15-1 Was lattice 4981 used in the bypass voiding evaluations in Sections 2.8 and 2.9. Explain why the specific lattices were selected for this evaluation. Are the lattices

used for establishing the fitting and by bypass voiding errors limiting in terms of pin power peak and distribution and other lattice parameter?

15-2 For the same lattice designs (e.g., 5166) generate neutronic data at the three void state points of 0%, 40%, 70%, 90% with the range of bypass of 30% void and non-solid water rod. [[

]]

15-3 Provide an error analysis between [[

]]
Include in the evaluation, the progression of the neutronic parameter errors to the core-wide coupled neutronic and thermal-hydraulic response, during steady-state and transient conditions.

15-4 For the data comparison discussed in 15-1, 15-2, and 15-3 above, [[

]] In support of the staff's confirmatory analyses, provide the pin powers generated in items 2, 3, and 4 above. Include RMS, MAX, and peak pin errors.

15-5 [[

]] Are these results consistent and does the pin power error (and other lattice parameter errors) presented in Figure 2-58 include all of the possible sources of methodological error such that this would be considered the total error in the pin power and other lattice parameters? Also, provide a comparison of the overall migration area error.

15-6 Evaluate the impact [[

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Discuss the impact of this effect on the licensing basis analyses, including the SLMCPR and transient calculations.

15-7 Provide an analysis [[

]]

15-8 Figure 2-49, [[

]] For each BWR type is the value in the bracket (in the legend) the OLMCPR? If so, justify that this value would be limiting or characteristic for different BWRs operating at EPU/MELLLA+ and MELLLA condition at offrated conditions.

15-9 Figure 2-58, [[

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15-10 The staff's concern over the accuracy of the GNF-A methods stems from the fact that EPU plants have very low margins available, [[

]] The acceptability of these low margins depend on the accuracy and the robustness of the benchmarking performed under these conditions. MELLLA+ would aggravate the plant's response during events, potentially resulting in lower or no available margins (vessel and containment integrity). Therefore, if the presence of bypass and water rod voiding results in higher errors, propose solution for correcting the associated under-predictions of the core response for the EPU/MELLLA+ operation. Include in your discussion, whether an alternative method may be necessary for the EPU/MELLLA+ conditions.

16. <u>Section 3.1- Steam Separator</u>.

16-1 The section evaluates steam separator performance of models in ODYN for operation at high void conditions. Provide similar models, descriptions and evaluations for TRACG.

16-2 Compare the TRACG modeling results against the separator performance data.

16-3 Demonstrate that the variable separator inlet qualities [[ ]] would not result in adverse impact.

16-4 [[ ]] Explain the impact [[ ]]

17. Section 3.2 ODSYS. Provide additional data to justify the applicability of ODSYS for the MELLLA+ operation. For example, discuss the models used and give some justification for the application of ODSYS to MELLLA+ condition.

18. Section 3.3: Time and Depth of Early Boiling Transition.

    18-1 Provide the data ranges and the expected ranges for EPU/MELLLA+ Operation.

    18-2 Justify why the test ranges shown in Table 3 would cover the conditions expected for all BWR product line operating at EPU/MELLLA+ conditions up to GE14.

    18-3 Explain if the experimental thermal-hydraulic data ranges are checked for all new fuel product lines or for legacy fuel.

19. Section 4.0 - GEXL Correlation. Provide the data ranges and the expected ranges for EPU/MELLLA+ operation.

20. Section 2.10 - Reliability of Neutron Monitoring. Section 2.10 provides an evaluation of detector response and accuracy of the low power range monitor (LPRM) and TIP predictions with in-channel and bypass void conditions.

    20-1 In Section 2.10, paragraph 6, the [[ ]] error is discussed. The following questions are related to this [[ ]] and the calculation of the J-factors:

    a. [[ ]]

    b. Provide the methods and equations used for the calculation of the J-factor and explain how these factors are computed with MCNP and with

TGBLA/P-10 and explain the differences that result in the [[ ]] that is discussed.

c. Shouldn't 90% void fraction also be included in this figure to cover the full range of anticipated void?

d. What is the significance of the differences between P-10 and MCNP shown in Figure 2-61, which shows a difference behavior as a function of exposure for these codes?

20-2 What is the impact of [[ ]]

20-3 Figures 2-63 and 2-64 show [[ ]]

20-4 The results shown are based on P-10. Would the conclusions be the same for P-11?

20-5 Evaluate the reliability of the neutron monitoring systems (LPRMs and TIPs) under non-solid (potentially under-predicted) bypass and water rod void conditions, during steady-state at all MELLLA+ boundaries including 55% core flow state point, where the highest bypass voiding occurs.

20-6 Provide an analysis of the impact of the high bypass and water rod voiding conditions, during transient conditions (20 to 30% void condition or greater) on the reliability of the neutron monitoring systems (LPRMs and APRMs). Evaluate: (1) the impact of the high bypass voiding on the gamma and thermal tip neutron monitor response characteristics equivalent to the analysis provided in Section 2.10, (2) the impact of noise to the interpretation of instrument readings, and (3) the impact of the high temperatures on the instrumentation. Include in the evaluations the effects of high in-channel voids and transient bypass and water rod condition.

20-7 The impact of the high in-channel and bypass void conditions on the reliability and accuracy of the LPRM/APRM instrumentation readings during a transient that can lead to high bypass voiding (30% and higher).

20-8 Explain if high in-channel void conditions would increase or decrease the sensitivity of the TIP readings.

20-9 As stated in Section 2.8, [[

]] Provide an evaluation of the impact of the instrumentation noise of the results.

20-10 Provide a similar evaluation as presented in Figure 2-63 for 10% void fraction previously indicated may be observed.

21. **SLMCPR**

21-1 How is the axial power shape or distribution effect for the pin powers captured in R-factor calculational methodology?

21-2 Explain the differences between the nodal TIP RMS, bundle TIP RMS, the axial TIP RMS, and the nodal RMS.

21-3 Explain why [[

]]

21-4 Section 3.1.1, "Model Uncertainty" of NEDC-32601P-A (Methodology and Uncertainties for Safety Limit MCPR Evaluations," provides the fuel pin peaking factor uncertainties. Specifically, Table 3.1 shows the benchmarking data used to establish the fuel pin peaking factor uncertainty. The fuel designs presented [[

]] The RMS data for all of the GNF-A legacy fuel are combined in a weight average to a value of [[ ]] The staff understands that most of these GNF-A legacy fuel lattice designs had lower enrichments and Gds and less number of hot pins and no part-length rods. Therefore, the staff finds weight averaging together the response from legacy fuel cores, with the current GE14 fuel lattice designs operated under the current operating strategies and core designs, may not be the best approach to capture the actual pin peaking factors.

a. Therefore, propose pin peaking uncertainty value that accounts for the extrapolation errors, bypass voiding errors and other calculational

inaccuracies accrued such as the under-prediction of power shape in the 3-D Monicore.

b. Alternatively, propose a SLMCPR penalty that would ensure that a non-conservative SLMCPR would not be calculated until such time that the GNF-A methods are benchmarked as proposed by eigenvalue tracking during the implementation of EPU/MELLLA+.

21-5 Please explain if the SLMCPR corresponding to inchannel thermal-hydraulic condition at the natural recirculation statepoint, immediately after a RPT from the EPU/MELLLA+ statepoints would be bounded by the SLMCPR at the 55% CF state point. This is of interest because the instability detect and suppress methods ensure SLMCPR protection after an RPT is initiated. [[

]]

Provide some discussion on how the SLMCPR is protected in the offrated conditions during an RPT.

22. Bypass voiding during Transient Conditions. TRACG analyses involving 2 RPT (ATWS and 2 RPT transient) indicating bypass voiding [[

]] Evaluate other transients and confirm if bypass voiding greater than 5% would be experienced during the event. Select the transients such that would yield the most limiting conditions in terms of the potential for causing bypass voiding, including the number of hot bundles in the 4 bundle control cell and the corresponding operating limit.

23. ATWS EPGs and Reliability of Neutron Monitoring System. Evaluate the ATWS EPGs and state if further guidance would be appropriate in order to ensure that the operators are cognizant of the potential for unreliable neutron monitoring system during the ATWS transient event, including during the mitigation actions (e.g., depressurization when HCTML is reached).

24. Peak Pellet Exposure. One of the many calculations that the PANACEA code is capable of performing is the pin "Peak Pellet Exposure."

24-1 Please provide peak pellet exposure calculations-vs-cycle specific data in tabulated form or otherwise (graphical), demonstrating PANACEA's prediction capability.

24-2 Provide technical justification demonstrating that the PANACEA code predictions are conservative, in terms of pellet exposure accounting.

25. Documenting the Audit Material. Please submit the following data that was reviewed during the audit.

a. Recent exposure validation
b. Thermal.vs. date package
c. SRD-PANAC11A sheets No. 4.1-1 through 4.1-8
d. The slides showing the PANA11 TIP predictions against the TIP data