GE Nuclear Energy

Nuclear Services
175 Curtner Ave. M/C 747
San Jose, CA 95125
(408) 925-1913, Fax (408) 925-6710
E-mail: george.stramback@gene.ge.com

MFN 04-011
February 11, 2004

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 References 1 and 2, the NRC made 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 letters also requested that GE review the RAIs for proprietary content pursuant to 10CFR2.790.

GE has completed its review and determined that certain information in both references is considered by GE to be proprietary. Enclosures 1 and 2 are 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

George Stramback
Manager, Regulatory Services
GE Nuclear Energy
(408) 925-1913
george.stramback@gene.ge.com

Project No. 710

D065

References:

1. MFN 04-007, Letter from Alan Wang (NRC) to James Klapproth (GE), January 29, 2004, *Request for Additional Information - Licensing Topical Report NEDC-33006P, Revision 1, "General Electric Boiling Water Reactor Maximum Extended Load Limit Analysis Plus," (TAC No. MB6157)*

2. MFN 04-008, Letter from Alan Wang (NRC) to James Klapproth (GE), January 30, 2004, *Request for Additional Information - Licensing Topical Report NEDC-33006P, Revision 1, "General Electric Boiling Water Reactor Maximum Extended Load Limit Analysis Plus," (TAC No. MB6157)*

Enclosures:

1. Non-Proprietary (Redacted) Version of MFN 04-007
2. Non-Proprietary (Redacted) Version of MFN 04-008

cc: B Pham (NRC)
AB Wang (NRC)
JF Harrison (GE/San Jose)
JF Klapproth (GE/San Jose)
MA Lalor (GE/San Jose)
T Nakanishi (GE/San Jose)
I Nir (GE/San Jose)
LM Quintana (GE/San Jose)
PT Tran (GE/San Jose)

ENCLOSURE 1

MFN 04-007

Non-Proprietary (Redacted) Version of MFN 04-007

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

MFN:04-007

January 29, 2004

RECEIVED
FEB - 6 2004
GENERAL ELECTRIC COMPANY

Mr. James F. Klapproth, Manager
Engineering & Technology
GE Nuclear Energy
175 Curtner Avenue
San Jose, CA 95125

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION – LICENSING TOPICAL REPORT NEDC-33006P, REVISION 1, "GENERAL ELECTRIC BOILING WATER REACTOR MAXIMUM EXTENDED LOAD LIMIT ANALYSIS PLUS." (TAC NO. MB6157)

Dear Mr. Klapproth:

By letter dated August 22, 2002, GE Nuclear Energy (GENE) submitted Licensing Topical Report (LTR) NEDC-33006P, "General Electric Boiling Water Reactor Maximum Extended Load Limit Analysis Plus," Revision 1. The NRC staff has reviewed the LTR and has prepared the enclosed request for additional information (RAI) relating to core and fuel performance and emergency core cooling system-loss-of-coolant accident. The enclosure also includes the staff's positions on GENE's proposal to defer the thermal limits assessment to the reload and its "Separate Effects" approach.

Pursuant to 10 CFR 2.790, we have determined that the enclosed RAI does not contain proprietary information. However, we will delay placing the RAI in the public document room for a period of ten working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

I have discussed this with George Stramback of your staff and it was agreed that GENE will respond to the RAI by February 13, 2004.

Sincerely,

Alan Wang

Alan B. Wang, Project Manager, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 710

Enclosure: Request for Additional Information

cc w/encl: See next page

cc:

Mr. George B. Stramback
Regulatory Services Project Manager
GE Nuclear Energy
175 Curtner Avenue
San Jose, CA 95125

Mr. Charles M. Vaughan, Manager
Facility Licensing
Global Nuclear Fuel
P.O. Box 780
Wilmington, NC 28402

Mr. Glen A. Watford, Manager
Nuclear Fuel Engineering
Global Nuclear Fuel
P.O. Box 780
Wilmington, NC 28402

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 (GENE)

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+. This RAI relates to core and fuel performance and emergency core cooling system-loss-of-coolant accident (ECCS-LOCA). This RAI also includes the staff's positions on GENE's proposal to defer the thermal limits assessment to the reload and its "Separate Effects" approach.

1. Time Varying Axial Power Shapes (TVAPS)

   a. [redacted]

   b. (Based on the audit). Provide a background discussion on why the fuel channels experience axial power shape changes during pressurization transients. [redacted]

   c. What are the principal factors that control the severity of ΔCPR response to TVAPS? Does the severity of the CPR change with TVAPS increase for the extended power uprate (EPU)/MELLLA operating condition? Explain the impact of the EPU/MELLLA+ condition on the factors that control the severity of the CPR change due to TVAPS effect. Would the effect of the TVAPS on the ΔCPR be more severe for 55 percent core flow (CF), 80 percent CF, 100 percent CF along the MELLLA+ upper boundary or the EPU/ increased core flow (ICF) as an initial condition. For different pressurization transients, does the severity of the TVAPS effect on the CPR change?

   d. Amendment 27 to GESTAR II (submitted for staff review) states that "NRC-agreed upon methodology for evaluating GE11 and later fuel uses time varying axial power shape (TVAPS), thereby changing the need for assuring this check. See GENE-666-03-0393 and NRC staff agreement at meeting on April 14, 1993." Explain this statement and state if the NRC reviewed and approved the method used to check or account for the effect of TVAPS on the CPR change during pressurization transients.

e. If the method used to evaluate the effect of TVAPS during a pressurization transient was not reviewed by the staff in the supplement to Amendment 27, provide sufficient information, including sensitivity results so that the staff can review the method and the effects of TVAPS on the transient response for plants operating with the EPU/MELLLA+ core design.

2. TVAPS Effect for Brunswick. For the Brunswick EPU/MELLLA+ analyses, explain what method will be used to calculate TVAPS. According to the proposed Amendment 27 changes to Section 4.3.1.2.1 of GESTAR, the time varying axial power shape for GE 11 fuel and later products is calculated using ODYN. The staff has been informed that Progress Energy is using TRACG to perform the EPU/MELLLA+ reload analysis. As such, how does ODYN interface with TRACG? Based on the Brunswick EPU/MELLLA+ core, provide a description of how the TVAP effect on the CPR was accounted for and calculated. Provide plots of the results.

3. [redacted]

a. [redacted]

b. [redacted]

i. the performance and accuracy of the results obtained from the codes used to perform core response, during steady state, transients, and accidents (e.g., TRACG, ODYN/ISCOR/PANCEA),

ii. the CPR response for all events,

iii. the calculation of the moister carryover and carryunder, and

iv. bundle level.

c. [redacted]

Explain how this modeling technique affects the accuracy of the corresponding results. State whether the effect [redacted]

d. [redacted] detect and suppress instability response and the ATWS instability response. [redacted] please reanalyze all supporting cases.

e. [redacted] the ATWS instability, the detect and suppress instability, and the anticipated operational occurrence (AOO) analyses. For each event type, discuss what impact the water rod flow would have on the plant's response in terms of the parameters that are important in each phenomenon of interest. [redacted]

4. Effects of Bypass Voiding. The operation at higher power at reduced core flow, the flatter power profile, and the over 24 percent higher steam flow during EPU/MELLLA+ operation may result in increased voiding in the upper bypass region, which affects both the low power range monitor (LPRM) and the traversing in-core probe (TIP) detector response. The effect of bypass voiding on the instrumentation is not random (and therefore cannot be combined with random uncertainties to determine an increase in uncertainty), but rather is a systematic effect which can bias the detector response. Therefore, the effect of bypass voiding on the core performance code systems (e.g., MONICORE - minimum critical power ratio (MCPR), linear heat generation rate (LHGR) and safety systems (e.g., average power range monitor, rod block monitor) which receive input from this instrumentation should be evaluated.

   a. Provide an evaluation of the potential for bypass voiding for the EPU and EPU/MELLLA+ operation. Describe how the bypass voiding affects the accuracy of the core monitoring instrumentation.

   b. Explain the bases for the [redacted]

   c. Identify the codes and the corresponding models that would be affected by [redacted] Explain the impact of bypass voiding on the accuracy and the assumptions of the codes and the corresponding models used to simulate the boiling water reactor (BWR) response during steady state, transient, or accident conditions.

   d. [redacted] but would not be predicted by the core simulator. Evaluate the effect of potential errors introduced by [redacted]

e. Supplement the MELLLA+ application to evaluate the potential and effects of bypass voiding. The supplement should provide sufficient justification and supporting sensitivity analyses to conclude that bypass voiding for the EPU and EPU/MELLLA+ will remain within an acceptable limit.

5. Bypass Voiding for Brunswick and Clinton

a. State whether Brunswick and Clinton are gamma tip plants. Gamma tip LPRMs are sensitive to bypass voiding.

b. Based on the MELLLA+ core design and the most limiting core power profile and hot bundle power condition, determine whether Brunswick and Clinton would experience bypass voiding. [redacted] Perform the evaluation at the different statepoints on the EPU/MELLLA+ upper boundary. Specifically, demonstrate that the bypass voiding would remain [redacted]r operation at the 55 percent CF and the 85 percent core flow statepoints.

c. [redacted], justify why the predicted bypass voiding is accurate. Provide similar justifications for the TRACG analyses.

d. If the predicted bypass voiding is within the acceptable range, [redacted] Suggest procedures or methods for checking this parameter during the reload. This is particularly important [redacted] which could invalidate some of the analytical methods and affect the accuracy of the monitoring instrumentation.

6. Void Fractions Greater than 90 Percent. The Brown Ferry steady state TRACG analysis shows that the hot channel exit void fraction is greater than 90 percent. This could potentially affect the validity of the exit conditions assumed in the computational models used to perform the safety analyses. The audit documents indicates that GENE had evaluated the effect of the high exit void fraction on the analytical models, techniques and methods. However, the evaluations and the bases of the conclusions were not discussed in the MELLLA+ LTR or submitted for NRC review as an amendment to GESTAR II. The following RAIs address the effect of the high exit void fraction and quality on the EPU/MELLLA operation.

a. Provide an evaluation of the analytical methods that are affected by the hot channel high exit void fraction (>90 percent) and channel exit quality. Discuss the impact the active channel exit void fraction would have on:

i. the steady-state nuclear methods (e.g., PANAC/ISCOR),
ii. the transient analyses methods (e.g., ODYN/TASC/ODSYS),

iii. the GEXL correlation, and
iv. the plant instrumentation and monitoring.

b. Evaluate whether the higher channel void fraction would affect any benchmarking or separate effects testing performed to assess specific thermal-hydraulic and/or neutronic phenomena.

c. Include in your evaluation, the effect of the high void fractions on the accuracy and assessment of models used in all licensing codes that interface with and/or are used to simulate the response of BWRs, during steady state, transient, and accident conditions.

d. Submit an amendment to the appropriate NRC-approved codes (e.g., TRACG for AOO, ODYN/ISCOR/TASC, SAFER/GESTR/TASC, ODSYS) that updates and evaluates the impact of the EPU/MELLLA+ operating conditions such as the high exit void fraction on the computational modeling techniques and the applicability range.

e. Submit a supplement to the MELLLA+ LTR that addresses the impact of the EPU/MELLLA+ core operating conditions, including high exit void fraction, on the applicability of the currently approved licensing methods.

7. <u>Brunswick and Clinton - Effect of Void Fractions Greater than 90 Percent</u>

a. Explain how the core averaged void fraction reported in the heat balance table is computed. For example, the Brunswick MELLLA+ application reports core averaged void fractions in the range of 0.51 to 0.54 for different statepoints.

b. For the EPU/MELLLA+ core design, what is the hot channel exit void fraction for the steady state operation at the EPU 120 percent power/99 percent CF, EPU/MELLLA+ 120 percent power/85 percent CF and the EPU/MELLLA+ 77.6 percent power/55 percent CF statepoints? Use bounding conditions.

8. <u>ICF</u>: Are the shutdown margin, standby liquid control system shutdown capability and mislocated fuel bundle analyses performed at the rated conditions (100 percent EPU power/100 percent CF). If so, justify why the these calculations are not performed for the nonrated conditions such as the ICF condition. Provide supporting sensitivity analysis results for your conclusions or update the GESTAR II licensing methodology, stating that these calculations would be performed at the ICF statepoint.

9. The hot channel void fraction increases with decreasing flow along the MELLLA+ upper boundary. Therefore, the void fraction at the 55 percent CF and the 80 percent CF statepoints are higher than the void fraction at 99 percent CF. Consequently, it is feasible that the initial conditions of the hot channels could be higher at the minimum core flow statepoints or at the offfrated conditions.

a. Justify why the steady-state initial critical power ratio (ICPR) is assumed in determining the offrated AOO response, instead of the ICPR calculated from offrated conditions.

b. For the most bounding conditions, compare the steady-state ICPR calculated based on the actual conditions at the state points (rated, 80 percent CF, and 55 percent CF or offrated lower power and flow conditions).

10. <u>ISCOR/ODYN/TASC Application</u>. The transient CPR and the peak cladding temperature (PCT) calculations are performed using the ODYN/ISCOR/TASC combination. The staff understands that ISCOR calculates the initial steady-state thermal-hydraulic core calculations. ODYN (1-D code) provides the reactor power, heat flux, core flow conditions, and the axial power shapes of the hot bundle during the transient. [redacted] The ISCOR/TASC combination is also used to calculate the PCT for ECCS-LOCA and Appendix R calculations. In addition, ISCOR/TGBLA/PANAC code combinations are also used in core and fuel performance calculations.

a. ISCOR is widely used in many of the safety analyses, but the code was never reviewed by the NRC. The use of a non-NRC-approved code in a combined code system applications is problematic. Therefore, submit the ISCOR code for NRC review.

b. Although ISCOR is not an NRC-approved code, our audit review did not reveal specific shortcomings. [redacted] Therefore, include in the ISCOR submittal a description and evaluation of the ISCOR/ODYN or ISCOR/TGBLA/PANAC code combination discussed above. Provide sufficient information in the submittal, including sensitivity analyses, to allow the staff to assess the adequacy of these combined applications.

c. During the MELLLA+ audit , the staff discovered that GENE had internally evaluated a potential non-conservatism that may result from the use of the flow-driven ISOR/ODYN/TASC combination to calculate the transient ΔCPR. [redacted]

11. Plutonium Buildup. It is expected that a EPU/MELLLA+ core would produce more Pu(239). What are the consequences of this increase from a neutronic and thermal-hydraulic standpoint during steady-state, transient, and accident conditions?

12. Spectrum Hardening. How does the harder spectrum from the increased Pu affect surrounding core components such as the shroud, vessel, and steam dryer?

13. How do the thermal margins change as a function of flow and transients for a EPU/MELLLA+ cores?

14. Demonstrate that the rod withdraw error (RWE) for the EPU/MELLLA+ domain is less limiting than the non-MELLLA+ domain throughout the cycle.

15. If the axial power profile is expected to be more pronounced (more limiting) for a EPU/MELLLA+ core, demonstrate and provide a quantitative and qualitative technical justification of the effects of these more pronounced profiles on the normal and transient behavior of the core.

16. Reload Analyses. Since the startup and intermediate rod patterns are developed by the licensees and subject to change during plant maneuvers, explain how you ensure that the core and fuel assessment analyses performed during the reload are still applicable. For example, if the safety limit for minimum critical power (SLMCPR) is performed at different burnup conditions during the cycle, how do you ensure that the plant's operating history does not invalidate the reload assumptions? How are the corrections or adjustments made to the plant's core and fuel performance analyses to ensure the parameters and conditions assumed during the reload analyses remain applicable during the operation. The staff's concern stems from the additional challenges that EPU/MELLLA+ pose in terms of core and fuel performance.

17. Thermal Limits Assessment

    a. SLMCPR. It is possible that the impact on the critical heat flux (CHF) phenomena may be higher at the offrated or minimum core flow statepoints. Is the SLMCPR value provided in the SLMCPR amendment requests and reported in the TS based on the rated conditions? If so, justify why the SLMCPR is not calculated for statepoints other than the rated conditions. Quantitatively demonstrate that the SLMCPR calculated at the minimum 80 percent and 55 percent statepoints would be lower than the SLMCPR calculated at the rated conditions. Use power profiles and core designs that are representative of the EPU/MELLLA+ conditions. Discuss the assumptions made. Include the Brunswick EPU/MELLLA+ application in your sensitivity analyses.

    b. SLMCPR at EPU/MELLLA+ Upper Boundary. The SLMCPR at the nonrated conditions (EPU power/80 percent CF) could be potentially higher than the SLMCPR at rated conditions, explain how "statepoint-dependent" SLMCPR would be developed and implemented for operation at the EPU/MELLLA+ condition. Use the Brunswick EPU/MELLLA+ application to demonstrate the implementation of "statepoint-dependent" SLMCPR.

c. Exposure-Dependent SLMCPR. Discuss the development of the exposure-dependent SLMCPR calculation. State whether this is an NRC-approved method and refer to the applicable GESTAR II amendment request.

18. GEXL-PLUS Correlation. Confirm that the GEXL-PLUS correlation is still valid over the range of power and flow conditions of the EPU/MELLLA+ operations.

19. Using ATWS-Recirculation Pump Trip (RPT) for AOOs. GENE licensing methodology allows using anticipatory ATWS-RPT in some AOO transients to decrease the power and pressure response. Therefore, the anticipatory RPT is used in some plants to minimize the impact of the pressurization transient on the ΔCPR response. For the EPU MELLLA+ operation, RPT may subject the plant to instability. Evaluate the runbacks associated with the AOOs and demonstrate that the scram and the RPT timings would not lead to an AOO transient resulting in an instability.

20. Mechanical Overpower (MOP) and Thermal Overpower (TOP). Are the fuel-specific mechanical and thermal overpower limits determined based on the generic fuel design or for each plant-specific bundle lattice design? How is it confirmed that the generic MOP and TOP limits for GE14 fuel bounds the plant-specific GE14 lattice designs intended to meet the cycle energy needs at the EPU/MELLLA+ conditions?

21. Brunswick AOO. The Brunswick Units 1 and 2 are the first plants to apply TRACG for performing the reload analyses.

a. Compare the Brunswick EPU and the EPU/MELLLA+ core designs and performance.

b. State what is the benefit of using TRACG instead of ODYN for the EPU/MELLLA+ reload analyses.

c. Provide a comparison of the TRACG and ODYN AOO analyses results based on the EPU/MELLLA+ core design.

22. Brunswick AOO Data Request. Submit the following data on compact disc for the Brunswick EPU/MELLLA+ core and fuel performance analyses.

a. TRACG input file including the PANCEA wrap file for a limiting transient initiated from different statepoints along the EPU/MELLLA+ boundary, if available. Include the corresponding output file in ASCI form.

b. ODYN output file (ASCI) for the same transients and statepoints.

23. Separate Effects, Mixed Vendor Cores and Related Staff Restrictions

Separate effects: revise Section 1.0, "Introduction," of the MELLLA+ LTR and remove the list of "separate effects" changes. The MELLLA+ LTR lists plant-specific operating condition changes that could be implemented concurrently with the EPU/MELLLA+, but would be evaluated in a separate submittal. All of these lists of changes would affect the safety analyses that demonstrate the impact of EPU/MELLLA+ on the plant's response during steady-state, transients, accidents, and special events. The plant-specific EPU/MELLLA+ application must demonstrate how the plant would be operated during the implementation of MELLLA+. In addition, the EPU/MELLLA+ reduces the available plant margins. Therefore, the staff cannot make its safety finding based on assumed plant operating conditions that are neither bounding nor conservative relative to the actual plant operating conditions. Revise the MELLLA+ LTR and delete the paragraphs that propose evaluating additional operating condition changes in a separate submittal while the EPU/MELLLA+ application assumes that these changes would not be implemented.

Add the following statements in the MELLLA+ LTR to address staff restrictions including: (1) the implementation of additional changes concurrent with EPU/MELLLA+, (2) the applicability of the generic analyses supporting the EPU/MELLLA+ operation, and (3) the approach used to support new fuel designs or mixed vendor cores.

a. The plant-specific analyses supporting the EPU/MELLLA+ operation will include all planned operating condition changes that would be implemented at the plant. Operating condition changes include but are not limited to increase in the dome pressure, maximum core flow, increase in the fuel cycle length, or any changes in the currently licensed operation enhancements. For example, with increase in the dome pressure, the ATWS analysis, the American Society of Mechanical Engineers (ASME) overpressure analyses, the transient analyses, and the ECCS-LOCA analysis must be reanalyzed based on the increased dome pressure. Any changes to the safety system settings or actuation setpoint changes necessary to operate with the increased dome pressure should be included in the evaluations (e.g., safety relief valve setpoints).

b. For all of the principal topics that are reduced in scope or generically dispositioned in the MELLLA+ LTR, the plant-specific application will provide supporting analyses and evaluations that demonstrate the cumulative effect of EPU/MELLLA+ and any additional changes planned to be implemented at the plant. For example, if the dome pressure would be increased, the ECCS performance needs to be evaluated on a plant-specific basis.

c. Any generic sensitivity analyses provide in the MELLLA+ LTR will be evaluated to ensure that the key input parameters and assumptions used are still applicable and bounding. If the additional operating condition changes affects these generic sensitivity analyses, a bounding generic sensitivity analyses will be provided. For example, with increase in the dome pressure, the TRACG ATWS sensitivity analyses that model the operator actions (e.g., depressurization if the heat capacity temperature limit is reached) needs to be reanalyzed, using the bounding dome pressure condition.

d. If a new GE fuel or another vendor's fuel is loaded at the plant, the generic sensitivity analyses supporting the EPU/MELLLA+ condition will be reanalyzed. For example, the ATWS instability analyses supporting the EPU/MELLLA+ condition are based on the GE14 fuel response. New analyses that demonstrate the ATWS stability performance of the new GE fuel or legacy fuel for the EPU/MELLLA+ operation needs to be provided. The new ATWS instability analyses can be provided as supplement to the MLTR or as an Appendix to the plant-specific application.

e. If a new GE fuel or another vendor's fuel is loaded at the plant, analyses supporting the EPU/MELLLA+ application will be based on core specific configuration or bounding core conditions. In addition, any principle topics that are generically dispositioned or reduced in scope will be demonstrated to be applicable or new analyses based on the transition core conditions or bounding conditions would be provided.

f. If a new GE fuel or another vendor's fuel is loaded at the plant, the plant-specific application will reference the fuel-specific stability detect and suppress method supporting the EPU/MELLLA+ operation. The plant-specific application will demonstrate that the analyses and evaluation supporting the stability detect and suppress method are applicable to the fuel loaded in the core.

g. For EPU/MELLLA+ operation, instability is possible in the event of transient or plant maneuvers that place the reactor at high power/low flow condition. Therefore, plants operating at the EPU/MELLLA+ condition must have an NRC reviewed and approved instability detect and suppress method operable. In the event the stability protection method is inoperable, the applicant must employ NRC reviewed and approved backup stability method or must operate the reactor at a condition in which instability is not possible in the event of transient. The licensee will provide technical specification changes that specify the instability method operability requirements for EPU/MELLLA+ operation.

24. Reactor Safety Performance Evaluations. From the AOO audit, the staff determined that (1) GENE did not provide statistically adequate sensitivity studies that demonstrate the impact of EPU/MELLLA+ operation, [redacted] (3) the generic anticipatory reactor trip system (ARTS) response may not be applicable for all BWR applications, and (4) the EPU/MELLLA+ impact was not insignificant. The staff also finds that it is not acceptable to makes safety findings on two major changes (20 percent uprate based on the CPPU approach and MELLLA+) without reviewing the plant-specific results.

[redacted] EPU/MELLLA+ applications must provide plant-specific fuel thermal margin and AOO evaluations and results. The following discussion summarizes the staff's bases for concluding that the plant-specific EPU/MELLLA+ application must provide a plant-specific thermal limits assessment and plant-specific transient analyses results.

a. EPU/MELLLA+ Core Design. Operation in the MELLLA+ domain will require significant changes to the BWR core design. Expected changes include (1) adjustments to the pin-wise enrichment distribution to flatten the local power distribution, reduce the r-factor, and increase CPR margin; (2) increased gadolinium (Gd) loading in the bottom of the fuel bundle to reduce the axial power peaking resulting from increased coolant voiding, and (3) changes in the core depletion due to the sequential rod withdrawal/flow increase maneuvers expected during operation in the MELLLA+ flow window. [redacted] However, the model used for these AOO calculations is not based on a MELLLA+ core, which has been designed for reduced flow at uprated power. Therefore, none of the sensitivity analyses supporting MELLLA+ operation have been performed for a core which includes the unique features of a MELLLA+ core design. Consequently, the effect of MELLLA+ on AOO ΔCPR has not been adequately quantified.

b. Reload-Specific Evaluation of the AOO Fuel Thermal Margin. [redacted] The available data is also limited.

c. Offrated Limits. The staff determined that the offrated limits (including along the MELLLA+ upper boundary) ΔCPR response may be more limiting than transients initiated from rated conditions. Therefore, AOO results from EPU applications cannot be used as sufficient bases to justify not providing the core and fuel performance results for the plant-specific MELLLA+ applications. Moreover, it has not been demonstrated that the generic ARTS limits are applicable and will bound the plant and core-specific offrated transient response for all of the BWR fleet. Therefore, offrated transient analyses must be performed to demonstrate the plant's ΔCPR response.

d. Mixed Core. Many of the BWRs seeking to implement the EPU/MELLLA+ operating domain may have mixed vendor cores. GENE's limited (MELLLA+) sensitivity analyses were based on GE14 fuel response of two BWR plants. Additional supporting analyses and a larger MELLLA+ operating experience database will be required before generic conclusions can be reached about the impact of MELLLA+ on core and fuel performance. Specifically, there is no operating experience or corresponding database available for assessing the performance of mixed vendor cores designed for EPU/MELLLA+ operation. As such, plant-specific fuel and core performance results must be submitted until a sufficient operating experience and analyses data base is available. In addition, new fuel designs in the future may change the core and fuel performance for the operation at the EPU/MELLLA+ operation. Therefore, the staff's EPU/MELLLA+ safety finding must be based on plant-specific core and fuel performance.

e. For the CPPU applications, the core and fuel performance assessments are deferred to the reload. Therefore, MELLLA+ LTR proposes that the staff approve an EPU/MELLLA+ application without reviewing the plant's response for two major operating condition changes. This approach would not meet the agency's safety goals.

25. Large Break ECCS-LOCA

a. Mixed Core. For a plant-specific EPU/MELLLA+ application, state if equilibrium ECCS-LOCA analyses of each type would be performed or core configuration specific ECCS-LOCA analyses would be performed. If a core configuration specific ECCS-LOCA analyses will be performed, state which NRC-approved codes or methods would be used.

b. Reporting Limiting ECCS-LOCA Results. The MELLLA+ audit indicated that the rated ECCS-LOCA results are reported although it may not be for the most limiting results. For the EPU/MELLLA+ operation, the most limiting ECCS-LOCA result is at the MELLLA+ statepoint of 55 percent CF. Revise the MELLLA+ LTR to state that the ECCS-LOCA result at rated condition, minimum core flow at EPU power level and at the 55 percent CF statepoint will be reported. In addition, revise the applicable documents that specify the GENE licensing methods to state that the ECCS-LOCA result corresponding to the rated and the most limiting statepoint will be provided. Report in the supplemental reload licensing report (SRLR), the ECCS-LOCA results at the rated and the most limiting statepoints. Confirm that the steady-state initial conditions (e.g., operating limit maximum critical power ratio [OLMCPR]) assumed in the ECCS-LOCA analyses will be reported in the SRLR.

c. Adder Approach. Was the licensing bases PCT calculated by incorporating a delta PCT adder to the Appendix K PCT? If this is the method used, please justify why the 10 CFR 50.44 insignificant change criteria is acceptable.

26. Small Break ECCS-LOCA Response. [redacted] assuming high pressure coolant injection (HPCI) failure and automatic depressurization system depressurization. At the 55 percent CF statepoint (Point M), the hot bundle may be at a more limiting initial condition in terms of initial void content and the ADS would depressurize the reactor leading to core uncovery as well. Provide a sensitivity ECCS-LOCA analysis, using the bounding initial condition. Provide a small break LOCA analysis at point M (77.6 percent Power/55 percent CF), based on the bounding initial condition, worst case small break scenario and placing the hot bundle at the most limiting conditions (peaking factors). Use initial SLMCPR and OLMCPR condition that is bounding for operation at 80 percent CF or 55 percent CF statepoint.

27. Small Break Containment Response. Using the most limiting small break LOCA, in terms of containment response (possibly at rated condition if limiting), demonstrate whether the suppression pool temperature response to a design basis accident is limiting. Wouldn't a small break LOCA (e.g., assuming HPCI failure and depressurization of the reactor) be more limiting in terms of suppression pool response? Base your evaluations on the Brunswick and Clinton applications.

28. Assumed Axial Power Profile for ECCS-LOCA. [redacted] Base your discussion on the predicted response in terms of dryout times. In addition, explain what the axial power peaking would be if the fuel is placed at the LHGR limit at rated conditions, 80 percent CF and 55 percent CF condition. If the axial power peaking would be higher for the non-rated flow conditions, state what axial power peaking were used in the ECCS-LOCA sensitivity analyses reported in MELLLA+ LTR for the 80 percent and 55 percent CF statepoints.

29. Power/Flow Map. The MELLLA+ LTR states that the slope of the linear upper boundary was derived primarily from reactor operating data. Expand on this statement. Explain what operating data was used. Were all plant types represented? Was the line developed as a bounding line or as a fit to the referred reactor operating data?

30. Power/Flow Map. The MELLLA+ minimum statepoint for rated EPU power was limited to 80 percent CF. Explain what the limitations were in establishing the minimum core flow statepoint. Similarly, discuss the limitations considered in establishing the 55 percent core statepoint. Discuss why the feedwater heater out-of-service and single loop operation is also not allowed for the EPU/MELLLA+ operation.

ENCLOSURE 2

MFN 04-008

Non-Proprietary (Redacted) Version of MFN 04-008

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

MFN:04-008

January 30, 2004

RECEIVED
FEB - 6 2004
GENERAL ELECTRIC COMPANY

Mr. James F. Klapproth, Manager
Engineering & Technology
GE Nuclear Energy
175 Curtner Avenue
San Jose, CA 95125

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION – LICENSING TOPICAL REPORT NEDC-33006P, REVISION 1, "GENERAL ELECTRIC BOILING WATER REACTOR MAXIMUM EXTENDED LOAD LIMIT ANALYSIS PLUS" (TAC NO. MB6157)

Dear Mr. Klapproth:

By letter dated August 22, 2002, GE Nuclear Energy (GENE) submitted Licensing Topical Report NEDC-33006P, Revision 1, "General Electric Boiling Water Reactor Maximum Extended Load Limit Analysis Plus." In an April 14, 2003, letter, the staff issued a request for additional information (RAI) pertaining to the staff's review of the anticipated transient without scram (ATWS) analyses. As result of our review we have determined that additional information is needed. This RAI includes additional questions as result of our audit, and expands on some of the previous RAIs in order to ensure that GENE's RAI responses provide sufficient detail for the staff to make its safety findings. By a separate letter, additional RAIs will be issued on the following topics: (1) emergency core cooling-loss-of-coolant accident, (2) anticipated operational occurrence, and (3) "Separate Effects."

Pursuant to 10 CFR 2.790, we have determined that the enclosed RAI does not contain proprietary information. However, we will delay placing the RAI in the public document room for a period of ten working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

This RAI has been discussed with George Stramback of your staff and it was agreed that GENE would respond to the RAI by February 13, 2004.

Sincerely,

Alan Wang

Alan B. Wang, Project Manager, Section 2
Project Directorate IV
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 710

Enclosure: Request for Additional Information

cc w/encl: See next page

cc:
Mr. George B. Stramback
Regulatory Services Project Manager
GE Nuclear Energy
175 Curtner Avenue
San Jose, CA 95125

Mr. Charles M. Vaughan, Manager
Facility Licensing
Global Nuclear Fuel
P.O. Box 780
Wilmington, NC 28402

Mr. Glen A. Watford, Manager
Nuclear Fuel Engineering
Global Nuclear Fuel
P.O. Box 780
Wilmington, NC 28402

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 (GENE)

PROJECT NO. 710

This request for additional information (RAI) pertains to the review of Licensing Topical Report (LTR) NEDC-33006P, "General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus," referred to as MELLLA+. Some of these questions relate to an onsite audit for the review of the MELLLA+ anticipated transients without scram (ATWS)/instability assessment.

Section 9.3.1, "Anticipated Transients Without Scram"

1.0 ATWS Events

In establishing the ATWS events that would be analyzed on plant-specific bases, the MELLLA+ licensing topical report (MLTR) states that the limiting ATWS event for the containment response depends on the [redacted] The following questions address the bases for these conclusions.

1.1 LOOP

Discuss how it will be determined [redacted]

Include in the plant-specific applications, a discussion of why the RHR cooling capability does or does not affect the plant's ATWS LOOP event response. The plant-specific MELLLA+ safety analysis report (MSAR) should state the bases for confirming that the [redacted].

1.2 Inadvertent Opening of Relief Valve (IORV)

The IORV is a long-term depressurization transient that affects the long-term suppression pool heatup. This event does not result in high peak pressure in the short-term ATWS response. However, since the recirculation pump trip (RPT) and the standby liquid control (SLC) initiation occur later, the amount of energy discharged into the suppression pool in the long term could be high. The plant's response to this event may depend on the RHR cooling capability and the initial operating conditions of the plant. Considering the higher core reactivity for the extended power uprate (EPU)/MELLLA+ condition during an ATWS event and the plant's unchanged RHR cooling capabilities, explain the basis for concluding that the IORV event would not result in a limiting suppression pool temperature during the long-term ATWS recovery period. Justify why this conclusion holds for all of the BWR fleet.

2.0 Determining the Peak Clad Temperature (PCT)

The MLTR states that [redacted] The following questions are related to the PCT.

2.1 Explain how, during an ATWS event, the hot bundle operation will be constrained by the same operating thermal limits as at the maximum core flow condition. Wouldn't the fuel experience thermal overpower conditions that are higher than the peak design limits?

2.2 Provide a table showing the previous PCT results used to make the assessment. List the MELLLA+ PCT sensitivity analyses the MLTR is referring to. Describe the key assumptions used for the PCT calculations (BWR type, fuel type, rodline and power level, etc.). Identify if ODYN/ISCOR/TASC combination or TRACG was used in calculating the PCT.

2.3 Justify why the sensitivity results, based on performance of GE fuel (up to GE14), form the bases for [redacted] Alternatively, state that the coolable geometry (e.g., PCT) and the 17 percent local cladding oxidation acceptance limit for the ATWS analyses would be demonstrated on a plant-specific basis, if another vendor's fuel, new GNF fuel, or mixed vendor cores are involved. In the latter case, revise the MLTR and include a specific applicability statement.

2.4 Explain why the ATWS analysis performed at the minimum core flow statepoint is more limiting than the analysis performed at the maximum achievable core statepoint for the EPU/MELLLA+ operation.

3.0 Applicability of the ODYN Licensing Methodology to ATWS Analyses

The Emergency Procedure Guidelines (EPGs) require a number of operator actions, and they allow a range of water level control strategies during isolation ATWS events, from 2 feet below the feedwater spargers to the minimum steam cooling water level (MSCWL). However, limitations in the approved ODYN methodology only allows for an ATWS calculation with a minimum water level of top-of-active (TAF+5 ft), and do not allow for accurate modeling of all required operator actions (such as depressurization when the heat capacity temperature limit (HCTL) is reached). The relevant question is whether the approved ODYN ATWS methodology provides conservative results that can be used to evaluate the impact of MELLLA+ operation on ATWS performance.

3.1 Provide a description of the approved ODYN ATWS methodology and its limiting assumptions (e.g., control level at TAF+5, do not depressurize). Provide a description of the treatment of uncertainties in approved ODYN licensing calculations.

3.2 Provide the exact numerical values of the boron-mixing correlation used by TRACG and ODYN for ATWS calculations and their basis.

3.3 Provide the results of a set of TRACG calculations to evaluate the effect of the ODYN modeling limitations. Compare the TRACG results to the ODYN licensing calculation, including the PCTs. At a minimum, provide TRACG calculations based on limiting conditions that follow the EPGs (i.e., depressurization if HCTL is reached) at the three water level setpoints: TAF+5, TAF, and MSCWL and compare to the ODYN licensing methodology results.

3.4 Based on the data provided above, demonstrate whether the approved ODYN ATWS methodology is conservative relative to TRACG analyses following the emergency operating procedures (EOPs). Compare the results of the ODYN and TRACG (at different water levels) in terms of meeting the ATWS acceptance criteria. Demonstrate that: (1) the TRACG sensitivity analyses and results are bounding or conservative for all the BWR fleet for EPU/MELLLA+ operating conditions, or (2) that the plant-specific ODYN analyses based on the TAF+5 water level strategy would bound the TRACG sensitivity analyses for all of the BWR fleet, or (3) propose a margin criteria for the ATWS acceptance criteria such that a TRACG analyses following the EOP would be performed for the plant-specific application if the margin criteria is not met.

3.5 What are the remaining limitations of the ODYN ATWS calculations (e.g., ATWS/stability)? How will those limitations be addressed (e.g., use of TRACG for ATWS/stability)?

4.0 <u>ATWS/Stability Analyses</u>

A major concern for the nonisolation turbine trip ATWS is the presence and impact of unstable large power oscillations, which occur when the flow is reduced and the feedwater temperature cools down as a result of the turbine trip. To manage the consequences of these large power oscillations, the EPGs prescribe a number of mitigation actions intended primarily to suppress these oscillations, including reduction of water level below the feedwater sparger and early boron injection. MELLLA+ operation increases the operating control rod line and increases the likelihood and the resulting amplitude of large power oscillations during ATWS events. The relevant question is whether the EPG mitigation actions are still effective under MELLLA+ conditions.

4.1 Provide the results of a TRACG calculation for a nonisolation ATWS with the prescribed mitigation actions. Compare to the TRACG results without mitigation actions. Provide the fraction of the core that reaches PCT limits during the nonisolation ATWS with and without mitigation actions.

4.2 Provide the results of a TRACG calculation for a full-isolation ATWS with depressurization using the TRACG stability numerics.

4.3 Are the mitigation actions prescribed by the EPGs effective to manage ATWS/Stability concerns under MELLLA+ operating conditions?

5.0 Impact of Depressurization During ATWS Events on Containment and Core-Integrity

When following the EPGs, operators are required to depressurize the reactor if the HCTL is reached during the transient. The approved ODYN licensing methodology does not reflect this operator action (the suppression pool continues to heat up after HCTL is reached and the depressurization is ignored). Even though the ODYN licensing methodology may be conservative, ODYN results cannot determine whether the reactor fuel reaches PCT limits that may affect long-term coolability. Thus, TRACG calculations are required to evaluate the impact on fuel PCT limits of depressurization.

5.1 Provide detailed results of core variables during TRACG calculations for ATWS events with depressurization, including at least core and vessel void fractions, fuel temperature profiles and time evolution, boron concentrations at several elevations in the lower plenum, recirculation flow, pressure, and power levels.

5.2 Describe the stages and timing of the depressurization event that was modeled. Is boron mixing enhanced by this event using TRACG as opposed to the ODYN licensing methodology?

5.3 Provide a series of steady-state sensitivity analyses to demonstrate that the core will remain subcritical following depressurization. Provide the core average void fraction at decay heat levels and approximately 100 psi pressure for a range of core flows (e.g., 5 percent to 15 percent core flow) that could be possible depending on the water level control strategy.

6.0 Containment Performance During Isolation ATWS at MELLLA+ Conditions

6.1 Provide a comparison of ODYN results of isolation ATWS simulations at MELLLA+ and original licensed thermal power (OLTP).

6.2 For the above cases, provide the sequence of events (system and equipment actuation and operator actions for the mitigated cases) and the corresponding times. For example, for the MSIVC mitigated case, tabulate when the high pressure ATWS setpoint is reached, main steam isolation valve (MSIV) closes, ATWS-RPT occurs, peak vessel pressure is reached, feedwater (FW) reduction is initiated, boron injection initiation temperature (BIIT) is reached, SLC pumps starts, and water level increases.

6.3 For all BWRs, tabulate the ATWS results (e.g., peak pressure, suppression pool temperature) before the 5 percent power stretch (if available), after the 5 percent power stretch (if applicable), and after EPU and EPU/MELLLA+. Include in the table the results from the initial GENE generic ATWS analyses. Since the initial plant licensing, many BWRs have adopted range-of-operating condition changes that affect their ATWS response. These changes include increases in the fuel cycle length (cycle extension from 18 months to 24 months), power (from 5 percent to 20 percent uprates above the original licensed thermal power), and licensed operating domain (LLLL, ELLLA, MELLLA, maximum core flow). The objective of this table is to assess how the previous changes in the operating conditions affected BWR plants' ATWS margins. This would also serve as a means to evaluate the capability of BWRs to meet the vessel and containment response with the additional EPU/MELLLA+ changes. The staff acknowledges that GENE may not have access to the plant-specific ATWS analysis-of-record for plants with other reload vendors.

7.0 LTR Section 10.9, "Emergency and Abnormal Operating Procedures"

Section 10.9 states: "The plant EOPs will be reviewed for any effect of MELLLA+, and the EOPs updated if necessary."

7.1 Provide some specific examples where the EOPs would be affected by MELLLA+ operation. For example, a cursory review of the EPG/severe accident guidelines (SAGs) are examples of areas that need further evaluation and update for determining limiting values. Other variables not mentioned here may be affected.

a. Maximum Pressure for Heat Capacity Temperature Limit Plot (Section 17.5). Section 17.5 defines the procedure for calculation of the HCTL. In the example plots (Figures B-17-5 and B-17-6), a maximum pressure of 1100 psig is used. However, TRACG calculations show that the pressure during MSIV ATWS is consistently above 1100 psig. Should the EPG/SAGs be modified for EPU/MELLLA+ operation to require calculation of the HCTL at the expected higher pressures?

b. Hot Shutdown Boron Weight (HSBW) (Section 17.6). The first assumption is that the reactor is operating on the maximum extended operating domain. Clearly this assumption should be changed to the corner of the MELLLA+ domain. Assumption #6 specifies an operating pressure of 1100 psia. However, TRACG calculations show that during ATWS from EPU/MELLLA+ the expected pressures are significantly higher than 1100 psia.

c. Boron Injection Initiation Temperature. The BIIT is defined as the suppression pool temperature that will allow for injection of the HSBW without reaching the suppression pool HCTL. Should the BIIT curve be modified under MELLLA+ operation?

d. Minimum Number of Safety Relief Valves (SRVs) Required for Decay Heat Removal (Section 17.21). With EPU/MELLLA+, the expected decay heat levels should be higher. Will the minimum number of SRVs change? Will this number affect any other variables?

e. Minimum Number of SRVs Required for Emergency Depressurization (Section 17.22). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum number of SRVs change? Will this number affect any other variables?

f. Minimum Steam Cooling Pressure (Section 17.23). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum steam cooling pressure be higher? If the pressure is higher, will this affect any other variables?

g. Minimum Steam Cooling Reactor Pressure Vessel (RPV) Water Level (Section 17.24). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum steam cooling RPV water level change? If the level does change, how does it affect any other variables?

h. Minimum Zero-Injection RPV Water Level (Section 17.25). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum zero-injection RPV water level change? If the level does change, how does this affect any other variables?

7.2 Since most of these parameters are likely to be affected by MELLLA+ operation in all plants, provide the justification why the LTR does not provide generic guidance on these parameters.

Section 9.3.3, "ATWS with Core Instability"

1.1 Table 9-5 lists the fuel response for the set of ATWS instability analyses. Figures 9-5 to 9-11 show the fuel response for the high-powered bundles. For clarity, add sub-titles or footnotes to the figures that identify the statepoints and the initial power to flow conditions. Otherwise, label Table 9-5 and the corresponding figures by case numbers. Expand Table 9-5 to include event type (turbine trip or MSIVC) and the mitigated cases. Footnote the mitigation strategy used in each case.

1.2 Footnote 2 to Table 9-5 states: [redacted] Please, explain this statement. [redacted]

1.3 Since for EPU/MELLLA+ core design, the number of high-powered bundles will increase, provide an estimate of the percent of the core that may experience PCT greater than 2200°F for the unmitigated cases. Compare this with the conclusions reached from the original ATWS instability evaluations in Reference 14 of the MLTR.

1.4 Please provide the results of a calculation similar to the unmitigated ATWS/stability case, but following the EOP mitigation actions. For this case, the condenser and feedwater should be assumed to be available. The purpose of this calculation is to demonstrate that the mitigation actions prescribed in the EOPs are still effective in suppressing the oscillations during operation under the EPU/MELLLA+ initial conditions. Provide a discussion of the result of this calculation.

1.5 Considering the variation that exists through the BWR fleet, explain why the [redacted]

1.6 Discuss the scoping criteria, if any, used to select the combination [redacted] physical configuration characteristics and operating parameters. [redacted] was selected for performing the ATWS instability analyses. Include [redacted] bases [redacted] terms of bypass, FW capacity and type, SRV capacity, and fu[redacted]. Explain how the limiting power distribution (radial and axial), core loading pattern and core exposures, and the initial minimum critical power ratio were selected in order to analyze the bounding ATWS instability cases for the MELLLA+ operation.

1.7 [redacted] Compare the instability response of the different GE fuel product line.

1.8 Provide the bases and technical justifications that demonstrate that th[redacted] response to an ATWS instability event will be bounding in comparison [redacted]e for cores loaded with non-GE fuel, new GE fuel, or mixed cores. Alternatively, provide the licensing restriction that would be necessary for operation along the MELLLA+ boundary, unless specific ATWS instability analyses are provided for cores loaded with non-GE fuel or new GE fuel. Explain what analyses would be required if a plant licensed for operation along the MELLLA+ rodline, was loaded with non-GE fuel (e.g., SVEA 96 or ATRIUM 10) or new Global Nuclear Fuel (GNF) fuel.

1.9 Were the fuel debris filters modeled in the ATWS analyses? If the fuel debris filters were not included in the analyses supporting MELLLA+ ATWS, explain the reason why the debris filters and the corresponding pressure drops were not included in the analyses. Justify why the results are acceptable. Alternatively, please provide the results of sensitivity analyses that demonstrate the impact of the debris filters on the plant's response to an ATWS. Similar effects should be described for transient analyses.

1.10 The WNP-2 (Columbia) instability event was caused primarily by an extremely skewed radial power distribution, which was achieved by withdrawing most of the hot-channel control rods early during the startup process. Following the instability event, GENE recommended that hot-channel control rods not be withdrawn fully until after the pump upshift maneuver, when the reactor is more susceptible to startup instabilities. In consideration that a MELLLA+ design core will have significantly more hot channels, two issues need to be addressed:

a. Are the radial power distributions likely to be more skewed during startup (as in the Columbia event) because there are so many hot channels that the operator will have to withdraw the control rods?

b. Will guidance be provided to utilities and operators that startup control rod patterns that have worked in the past may result in instabilities during normal control rod maneuvers?

Safety Systems Actuation Limits

1. What are the net positive suction head (NPSH) limits for safety systems that depend on suppression pool water (e.g. RHR, high pressure cooling injection (HPCI) ¼)?

2. The pressure during ATWS events oscillates as high as 1200 psi for long periods (>20 minutes). Is HPCI capable of injecting sufficient volume with such high backpressure? Are any other safety systems affected by a 1200 psi backpressure?

3. The STEMP results show containment pressurizations as high as 12 psig. Do such high containment pressures affect the actuation of any safety grade systems in the containment such as air-actuated valves?

Questions Related to ODYN Calculations

The staff has reviewed ODYN data for ATWS events for three plants (Brunswick, Browns Ferry, and Clinton) at two operating conditions (100 percent OLTP, 75 percent flow, and 120 percent OLTP, 85 percent flow). The following RAIs address the key assumptions and system actuations used for these analyses.

1. The Brunswick MELLLA+ LTR (NEDC-33063P) states that the peak vessel pressure for an MSIV isolation ATWS is 1457 psig. [redacted] Please answer the following questions:

   a. What is the difference between the two calculations?

   b. What is the applicable peak pressure limit?

   c. If the applicable limit is 1500 psig, is it violated by the ODYN calculation results provided?

   d. Give what the peak pressures are for other analyzed ATWS cases, including PRFO.

e. Provide the ODYN results as a function of time for the limiting ATWS event for Brunswick.

2. It is customary in safety calculations to allow some time for operator actions. It is apparent from a review of the ODYN results that operator actions occur in very short timeframes. [redacted] Explain the assumptions used for operator actions during these analyses.

3. In the Brunswick calculation, the water level is raised at [redacted] According to the EPGs, the water level is supposed to be raised when the HSBW has been injected into the core. What is the basis for the [redacted] used? Shouldn't the time when the HSBW is reached be dependent on the SLC injection initiation time?

4. Because MELLLA+ operation occurs at a higher control rod line, one would expect the HSBW to increase over the baseline. The analysis assumed the same HSBW value for both MELLLA+ and the previous baseline condition. Under MELLLA+, the HSBW may be higher, leading to a longer time of suppression pool heating before the water level is raised to remix the boron at the bottom of the vessel, which achieves the hot shutdown condition. What is the effect of using a MELLLA+ specific HSBW value on ultimate suppression pool temperature?

5. The EPGs instruct the operator that a number of SRVs should be locked open to prevent cycling (and prevent possible mechanical failures). By allowing the SRVs to cycle, the core flow oscillates wildly because of the SRV-induced pressure transients. By increasing the flow values over the non-mixing stagnation flow value in the Boron correlation, these wild flow oscillations promote Boron mixing that otherwise would not happen. Explain why it is conservative to allow these wild flow oscillations to continue, thus increasing the amount of boron mixed with the core inlet coolant and reducing the reactor power.

6. Section 9.3.1 of the Brunswick MELLLA+ LTR (NEDC-33063P) states that the MELLLA+ analysis was performed with 10 percemt SRV tolerance rather than the normally assumed 3 percent tolerance. Provide an explanation of the detailed SRV lifting pressures (including the tolerance) and the percent of nameplate flow used for the calculations.

7. Provide the sequence of events (including SLC injection and water level reduction times) for these calculations. Specify the actuation setpoints and initiation times. What are they based on?

Clinton Specific Questions

The reference analysis for the EPU/MELLLA+ plant [Clinton] specific calculation (NEDC-33057P) states that the ATWS suppression pool temperature limit is 185 (see table in Section 9.3.1 of NEDC-33057P).

1. Justify the use of the 185°F ATWS suppression pool temperature limit for the EPU/MELLLA+ ATWS analysis. Specifically, justify why the suppression pool temperature limit is higher than the temperature limit required for depressurization.

2. The peak suppression pool temperature for EPU/MELLLA+ reported in NEDC-33057P is 171°F. While this number is below the reported 185°F limit, the reactor is still at full pressure. Thus, the reported 171°F is not the peak temperature, but the initial condition prior to depressurization. It would appear that following a depressurization (which is required by the EOP at this temperature), the suppression pool temperature would be greater than 185°F. Please provide the actual peak suppression pool temperature when the ATWS transient is followed to completion according to the EOPs.

3. Provide the assumptions used in the ATWS analysis for the EPU/MELLLA+ pilot plant [Brunswick] specific calculation (NEDC-33063P). Specifically, what type of ATWS transient is limiting? What are the initial conditions, including power, flow, suppression pool level ¼? What operator actions are assumed? What ATWS mitigation actions are implemented during the transient? What values are used for EOP variables (e.g., HCTL, HSBW,¼)?

4. The effect of EPU/MELLLA+ on EPG/SAGs. Provide a critical review of the EPGs/SAGs to determine which variable definitions and calculations are affected by EPU/MELLLA+. The following sections provide some examples of areas that need further evaluation and update for determining limiting values. Other variables not mentioned here may be affected.

    a. Maximum Pressure for Heat Capacity Temperature Limit Plot (Section 17.5). Section 17.5 defines the procedure for calculation of the HCTL. In the example plots (Figs. B-17-5 and B-17-6) a maximum pressure of 1100 psig is used. However, TRACG calculations show that the pressure during an MSIV ATWS is consistently above 1100 psig. Should the EPG/SAGs be modified for EPU/MELLLA+ operation to require calculation of the HCTL at the expected higher pressures?

    b. Hot Shutdown Boron Weight (Section 17.6). The first assumption is that the reactor is operating on the maximum extended operating domain. Clearly, this assumption should be changed to the corner of the MELLLA+ domain. Assumption #6 specifies an operating pressure of 1100 psia. However, TRACG calculations show that during ATWS under EPU/MELLLA+ conditions the expected pressures are significantly higher than 1100 psia.

    c. Minimum Number of SRVs Required for Decay Heat Removal (Section 17.21). With EPU/MELLLA+, the expected decay heat levels should be higher. Will the minimum number of SRVs change? If the mininum of SRVs does change, will this affect any other variables?

    d. Minimum Number of SRVs Required for Emergency Depressurization (Section 17.22). With EPU/MELLLA+, the expected ATWS power levels should be higher.

Will the minimum number of SRVs change? If the minimum number of SRVs does change, will this affect any other variables?

e. Minimum Steam Cooling Pressure (Section 17.23). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum steam cooling pressure change? Will this pressure change affect any other variables?

f. Minimum Steam Cooling RPV Water Level (Section 17.24). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum steam cooling RPV water level change? If the level does change, will this affect any other variables?

g. Minimum Zero-Injection RPV Water Level (Section 17.25). With EPU/MELLLA+, the expected ATWS power levels should be higher. Will the minimum zero-injection RPV water level change? If the water level changes, will this affect any other variables?