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MFN 04-020
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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: **Response to MELLLA Plus AOO RAIs (TAC No. MB6157)**

By Reference 1, the NRC requested additional information (RAI) in order to support their review of the Licensing Topical Report (LTR) NEDC-33006P, Revision 1, *General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus.* The RAIs addressed by Reference 1 related to core and fuel performance and loss of coolant accident (ECCS-LOCA). The responses to a majority of these RAIs are contained in enclosures 2, 3 and 4. The remainder of the responses will be provided at a later date as indicated in the enclosed document.

A non-proprietary version of the RAI responses is provided in Enclosure 1. The responses with the proprietary information, as defined by 10CFR2.790, are provided in Enclosures 2, 3 and 4. . GE customarily maintains this information in confidence and withholds it from public disclosure.

The affidavit contained in Enclosure 5 identifies that the information contained in Enclosures 2, 3, and 4 has been handled and classified as proprietary to GE. GE hereby requests that the information of Enclosure 2, 3, and 4 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and 9.17.

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

Sincerely,

George Stramback

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D065

Project No. 710

Reference:

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)*

Enclosures:

1. Response to NRC MELLLA+ AOO RAIs – Non-Proprietary Information
2. Response to NRC MELLLA+ AOO RAIs – Proprietary Information
3. Applicability of NRC Approved Methodologies to MELLLA+ - Proprietary Information
4. Brunswick TRACG MELLLA+ Analyses - Compact Disk - Proprietary Information
5. Affidavit, George B. Stramback, dated February 27, 2004

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)
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ENCLOSURE 5

MFN 04-020

AFFIDAVIT

General Electric Company

AFFIDAVIT

I, George B. Strambach, state as follows:

(1) I am Manager, Regulatory Services, General Electric Company ("GE") and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 2, 3 and 4 to GE letter MFN 04-020, George Stramback to NRC, *Response to MELLLA Plus AOO RAIs (TAC No. MB6157)*, dated February 27, 2004. The proprietary information in Enclosure 2, *Response to NRC MELLLA+ AOO RAIs*, is identified by a double underline inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. The proprietary information in Enclosure 3, *Applicability of NRC Approved Methodologies to MELLLA+*, is the entirety of each page of the enclosure; therefore, the header of each page in this enclosure carries the notation "GE Proprietary Information. {3}." The proprietary information in Enclosure 4, *Brunswick TRACG MELLLA+ Analyses, COMPACT DISK* is the entirety of the enclosed compact disk. The disk in this enclosure carries the notation "GE Proprietary Information{3}." In each case, the superscript notation{3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.790(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, <u>Critical Mass Energy Project v. Nuclear Regulatory Commission,</u> 975F2d871 (DC Cir. 1992), and <u>Public Citizen Health Research Group v. FDA,</u> 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, resulting in potential products to General Electric;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a., and (4)b, above.

(5) To address 10 CFR 2.790 (b) (4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it contains detailed results and conclusions from evaluations, including some in the form of computer files, of the safety-significant changes necessary to demonstrate the regulatory acceptability for the expended power/flow range of MELLA+ for a GE BWR, utilizing analytical models and methods, including computer codes, which GE has developed, obtained NRC approval of, and applied to perform evaluations of transient and accident events in the GE Boiling Water

Reactor ("BWR"). The development and approval of these system, component, and thermal hydraulic models and computer codes was achieved at a significant cost to GE, on the order of several million dollars.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 27th day of February 2004.

George B. Stramback

George B. Stramback
General Electric Company

ENCLOSURE 1

MFN 04-020

Response to NRC MELLLA+ AOO RAIs

Redacted and Non-proprietary Information

NRC RAI 1, Time Varying Axial Power Shapes (TVAPS)

a. [[

]]

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

]]

c. What are the principle factors that control the severity of ΔCPR response to TVAPS. Does the severity of the CPR change with TVAPS increase for the 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 TVAPS on the ΔCPR be more severe for 55% CF, 80% CF, 100% CF along the MELLLA+ upper boundary or the EPU/ICF as an initial condition. Does the severity of the TVAPS effect on the CPR differ for different pressurization transient?

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.

Response

a. [[

]] This is described in GESTAR, Section 4.3.1.2.1.

b. Channels experience TVAPS primarily due to the reactor scram that occurs coincident with the power increase that occurs during a pressurization transient. This effect is described in GENE-666-03-0393. The ΔCPR result is a function of both the trend in the ODYN integral power or heat flux and TVAPS. [[ ]] The dominant effect will dictate the ΔCPR.

c. [[ ]] The sequence of events and resulting affect on steam quality is shown in GENE-666-03-0393.

[[ ]]

d. To be provided at a later date

e. To be provided at a later date

NRC RAI 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.

GE Response

The Brunswick-1 TRACG model includes a hot channel. NEDC-32906P-A, Revision 1,*TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analysis*, Section 8.1 describes the channel grouping process. Since the hot channel is integral to the TRACG 3D-Kinetic method, the hot channel includes all same boundary conditions that are used in the ODYN/TASC method (although the TRACG hot channel flow is driven from the plenum-to-plenum pressure drop). The TVAPS is obtained from the 3D prediction of the hot channel power. Figures AOO-2-1 through AOO-2-4 provides the same time histories as provided in Figure 8-3 through 8-6 in NEDC-32906P-A but for Bunswick-1 Cycle 15 at MELLLA+ conditions.

[[

]]

Figure AOO-2-1. TRACG M+ Power and Flow Response for TTNB Event

[[

]]

Figure AOO-2-2. TRACG M+ CPR Response for TTNB Event

[[

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Figure AOO-2-3. TRACG M+ Pressure and Relief Valve Response for TTNB Event

[[

]]

Figure AOO-2-4. TRACG M+ Vessel Inlet and Exit Flow for TTNB Event

NRC RAI 3, [[

a.

]]

GE Response

a. To be provided at a later date

NRC RAI 3, [[
b.

]]

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.

GE Response
The impact of [[

]] The response to RAI #5 has shown that bypass voiding is not significant for the MELLLA+ region of operation. Therefore, the water rod modeling assumptions are not challenged for steady-state and transient calculations, CPR response, and bundle level. The accuracy of moisture carryover and carryunder are related to steam separator performance and not directly related to bypass and water rod flow modeling.

However, the following information is provided to clarify the water rod and out channel flows modeling assumptions:

a. [[

]] The effects of MELLLA+ on bypass voids as simulated by ISCOR is provided in the response to RAI 5b.

b. [[

]]

e. TRACG has a large degree of modeling flexibility. In particular, [[

]] In particular, the TRACG analysis for the Brunswick MELLLA+ evaluations model [[ ]]

NRC RAI 3. [[
c.

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

]]

GE Response
See the response to RAI 3b.

NRC RAI 3, [[

d.]] detect and suppress instability response and the ATWS instability response. [[

]] please reanalyze all supporting cases.

GE Response

d. To be provided at a later date

NRC RAI 3. [[

e.]] 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. [[ ]]

GE Response

e. To be provided at a later date

NRC RAI 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 [[ ]]

c. Identify the codes and the corresponding models that would be affected by [[ ]] 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. [[ ]] but would not be predicted by the core simulator. Evaluate the effect of potential errors introduced by [[ ]]

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.

<u>GE Response</u>

4a. Please see the response to RAI 3a and RAI 5b for the magnitude of impact of MELLLA+ on bypass voiding. The impacts of bypass voiding on core monitoring uncertainties are covered in the Response to RAI 6e.

4b. LPRM uncertainty increases with increasing void. LPRM specifications limit the presence of void to [[ ]]

4c. See the response to RAI 6e.

4d. The validity of assumptions regarding [[ ]] is discussed in the response to RAI 3b.

4e. For additional information on the sensitivity of bypass voiding on analyses for MELLLA+ are discussed in the response to RAI 6e.

NRC RAI 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. [[ ]] Perform the evaluation at the different statepoints on the EPU/MELLLA+ upper boundary. Specifically, demonstrate that the bypass voiding would remain below [[ ]] for operation at the 55 percent CF and the 85 percent core flow statepoints.

c. [[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, [[ ]] Suggest procedures or methods for checking this parameter during the reload. This is particularly important [[ ]] which could invalidate some of the analytical methods and affect the accuracy of the monitoring instrumentation.

GE Response

5a. Both Brunswick units (BWR/4) use gamma sensitive TIPs while Clinton (BWR/6) use thermal neutron TIPs.

5b The following are bounding (based on 4 bundle average power) ISCOR results for Brunswick and Clinton at the two points:

[[		
		]]

The predicted bypass voids are within [[ ]].

5c. As demonstrated in the response to RAI 5(b), the assessment of bypass voiding at the MELLLA+ condition has been performed using ISCOR, [[ ]] This assessment has shown that any significant bypass voiding will not occur in the MELLLA+ condition. Therefore, the validity of the [[ ]] models for PANACEA or TRACG application is not challenged. For more information, please see the responses to RAI 3(b) and RAI6(e).

5d. The plant specific applications performed thus far indicate that bypass voiding exceeding [[ ]] will not occur at the MELLLA+ boundary. For safety and licensing analysis verification, a check on bypass voiding will be implemented. However, as indicated in the response to RAI 6(e), methods adequacy will be confirmed following plant application of MELLLA+.

NRC RAI 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.

GE Response

6 a, b, c Please see the documentation associated with the response to RAI 6e.

6d Licensing topical reports for NRC approved methodologies such as ODYSY (NEDC-32992P-A, July 2001) were submitted as generic methods reports and remain correct as written. MELLLA+ is an expansion of the range of application of these methodologies,. Therefore, the methods were examined and documented collectively, not individually, per common practice for new applications. Evidence of this examination is provided in the response to RAI 6e.

6e Enclosure 3, Applicability of NRC Approved Methodologies to MELLLA+, has been provided which supplies technical evaluation of key technical models used within the NRC licensed methodologies as well as summary statements on the NRC licensed methodologies themselves. This information has been provided to demonstrate the applicability of the GE methodology to the MELLLA+ operating range.

Tables 6-1 and 6-2 summarize the evaluations performed and the conclusions reached. The "Steady-State Nuclear Methods" items are fundamental models, which may affect all methods employed by GE. The other items are more specific in their scope to transient analysis, GEXL, and SLMCPR.

Table 6-1		
Enclosure Section	**Item**	**Assessment**
	Steady-State Nuclear Methods	
2.1	Extrapolation of lattice parameters to in-channel 90% Void Fraction	The technique of fitting the lattice physics data [[ ]] There is no substantial change of this assumption for MELLLA+ operating strategies. [[ ]] For these reasons, confirmation of eigenvalue tracking will be executed for the plants operating with MELLLA+ per standard procedure. Confirmation of thermal limits uncertainties (e.g., power distribution) will be executed for initial implementation of MELLLA+ strategy. See item 2.5 for disposition of derivative parameters.
2.2	Void-Quality Correlation	The use of the GE standard model is adequate for modeling pressure drop for the MELLLA+. The database supporting the void correlation in use by the ECPs sufficiently covers the MELLLA+ operating range.
2.3	Flow Distribution Models	The upper plenum pressure is nearly uniform at MELLLA+ such that steady-state bundle flow will not be impacted. The database supporting the pressure drop in use by the ECPs sufficiently covers the MELLLA+ operating range.
2.4	Diffusion Theory	The method is adequate. Confirmation of eigenvalue tracking will be executed for the plants operating with MELLLA+ per standard procedure. Confirmation of thermal limits uncertainties (e.g., power distribution) will be executed for initial implementation of MELLLA+ strategy.

Table 6-1

Enclosure Section	Item	Assessment
2.5	1 ½ Group Assumption	The method is adequate. There is no substantial change of this assumption in going from MELLLA to MELLLA+ operating strategies. [[ ]] Confirmation of eigenvalue tracking will be executed for the plants operating with MELLLA+ per standard procedure. Confirmation of thermal limits uncertainties (e.g., power distribution) will be executed for initial implementation of MELLLA+ strategy.
2.6	Spectral History Impacts of Extended High Void Operation	The method is adequate. The dominant spectral effect in MELLLA+ of physical void history is included in PANACEA. The use spectral history model of PANAC11 is an additional improvement since it makes a correction to the nuclear library lookup process to account for effects due to hardened spectrum separate from void history.
2.7	Direct Moderator Heating Model	The method is adequate. MCNP calculations show that [[ ]] Additionally, the [[ ]] of the current model is confirmed at the higher void fractions associated with MELLLA+.
2.8	Bypass Void Models	The method is adequate for MELLLA+ application. Even if [[ ]] were to occur at the D level LPRM, the resulting nodal power error is about [[ ]] and the impact on bundle power is negligible. Confirmation of eigenvalue tracking will be executed for the plants operating with MELLLA+ per standard procedure. Confirmation of thermal limits uncertainties (e.g., power distribution) will be executed for initial implementation of MELLLA+ strategy.

Table 6-1		
Enclosure Section	**Item**	**Assessment**
2.9	[[ ]]	[[ ]]
2.10	TIP/LPRM Correlations	The method is adequate. Use of TIP/LPRM correlations at high in-channel void conditions or with known bypass voiding up to 5% does not introduce errors in the instrument interpretation larger than that already in the experience base.
	Transient Analysis Methods	
3.1	Steam separator model performance at high qualities	Adequacy of the current transient analysis methodology with respect to steam separator performance is acceptable for MELLLA+ conditions. Continued use of conservative assumptions regarding carryunder and carryover fractions is recommended.
3.2	High power/low flow ratio	The method is adequate based on evaluations of 2.2, 2.4, 2.7, 2.8, 2.9, and 3.1.
3.3	Time and Depth of Boiling Transition	The method is adequate. The accuracy is acceptable.
	GEXL Correlation	
4.0	Database may not have data to support over 90% void fraction operation. Significant operation may occur at off-rated conditions	The method is adequate. The GEXL correlation application range concern covers MELLLA+ conditions. The correlation is based on a range of power shapes that cover the expected range of application for MELLLA+.
	Plant Instrumentation & Monitoring	
5.1	D Level LPRM Void will cause reading uncertainty	The method is adequate for licensing. See 2.8 and 2.10. Confirmation of thermal limits uncertainties (e.g., power distribution) will be executed for initial implementation of MELLLA+ strategy.

Table 6-1		
Enclosure Section	**Item**	**Assessment**
5.2	Review GETAB and Reduced SLMCPR Uncertainties	The method is adequate for licensing. Confirmation of thermal limits uncertainties (e.g., power distribution) will be executed for initial implementation of MELLLA+ strategy.

For additional clarification, the following table provides a cross reference of applicable NRC approved methodologies (Reference 1) and the areas of concern for MELLLA+ operation.

Table 6-2

IMPACT AREA\ METHODOLOGY	TGBLA	PANACEA	ISCOR	ODYN	TASC	ODYSY	SAFER	TRACG	SLMCPR
Steady State Nuclear Methods	[[								
Extrapolation of XS to 90% Void									
Void Quality Correlation									
Flow Distribution Models – Pressure Drop									
Diffusion Theory									
1.5 Group Assumption									
Spectral History Impacts									
Direct Moderator Heating Model									
Bypass Void Models									
[[ ]]									
TIP/LPRM Correlations									
Transient Analysis Methods									
Steam Separator Model									
High Power/Low Flow Ratio									
Time/Depth of Early BT									
GEXL Correlation									
Database over 90% Void									
Off-rated Conditions									
Plant Instrumentation & Monitoring									
D LPRM Level Void Uncertainty									
SLMCPR Uncertainties									]]

The final technical conclusion is that GE has systematically examined its NRC approved methodologies with regard to operation in the MELLLA+ domain. GE has found that these methods are adequate.

However, GE believes that methodology performance within the MELLLA+ operating domain be examined carefully once a significant set of plant data is available. [[

]] In addition, while no licensing issues have been determined to be outstanding regarding the methods and their application ranges, a recommendation that the thermal limits uncertainties be confirmed for the initial implementation of the MELLLA+ strategy applies to the technology areas. This confirmation should include [[

]] in NEDC-32694P-A. Also at the time of implementation, the [[ ]] will be reviewed as per the NRC instruction in NEDC-32601P-A.

NRC RAI 7, Brunswick and Clinton - Effect of Void Fractions Greater than 90 Percent

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.

GE Response

This value is the active coolant average void fraction. The bypass and unheated regions are not included in this average.

$$<VF>=\frac{\sum_{i=1}^{\#\,each\,type} n_i \frac{\sum_{k=1}^{24} VF_k FlowArea_k}{24<FlowArea>}}{Total\ \#\ of\ Bundles}$$

, where i is the ISCOR channel types and k is the axial nodes.

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

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.

<u>GE Response</u>

The following are results for Brunswick 1, Cycle 15 at the MOC transient point.

Note, values at 120% / 104.5% are provided instead of 120% / 99% to provide the full range of void fractions with licensed core flow.

NRC RAI 8, ICF

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 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.

GE Response

These analyses are performed for each reload core design to confirm that the acceptance criteria documented in GESTAR-II is met.

a. SDM and SLCS

These analyses confirm that acceptable reactivity margins exist in the core throughout the cycle. [[

]] The analyses are not performed at rated conditions.

b. Mislocated Bundle

This analysis confirms that the fuel thermal margins for the worst postulated fuel load mislocation are within those acceptable for AOOs. [[

]] The analysis is not performed at rated conditions.

NRC RAI 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 offrated 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.

GE Response

[[

]]

NRC RAI 9

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).

GE Response

The ICPR associated with the results in Table 9-2 of the M+ LTR is as follows:

[[		
		]]

The offrated ICPR at 55% core flow is as follows:

[[Event	Power (% OLTP) / Core Flow (% rated)	ICPR
BWR/4 LRNBP	93 / 55	1.28 (TASC) 1.62 (PANACEA)
BWR/4 FWCF	93 / 55	1.23 (TASC) 1.62 (PANACEA)
BWR/4 Flow Runout	93 / 55	1.59 (PANACEA)
BWR/6 TTNBP	93 / 55	1.32 (TASC) 1.43 (PANACEA)
BWR/6 FWCF	93 / 55	1.25 (TASC) 1.43 (PANACEA)
BWR/6 Flow Runout	93 / 55	1.44 (PANACEA)[3]]]

[[

]]

NRC RAI 10, ISCOR/ODYN/TASC Application

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. [[

]] 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. [[

]] 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. [[

]]

GE Response

To be provided at a later date

NRC RAI 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?

GE Response

The core simulator will properly capture any resulting increase of plutonium from high void operation. Additionally, the cycle specific transient analyses consider variation on the burn strategy and Pu production by varying the degree at which the bottom of the core is burned early in the cycle. Therefore, any changes in isotopic inventory because of MELLLA+ operation will be explicitly modeled for the purposes of determining cycle specific analyses including selection of rod patterns, safety evaluations (SDM), transient evaluations, as well as others.

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

GE Response
The hardening of neutron spectrum from the increased Pu mainly affects the thermal and epi-thermal energy regions and has insignificant effect on fast neutrons with energy greater than 1 MeV. Since the damage effect of neutron irradiation on the surrounding core components such as the shroud, vessel, and steam dryer is based on fast neutron (E > 1 MeV) fluence, the increased Pu does not have significant effect on the surrounding core components. [[

]] The increased void fraction does affect the flux distribution near the top of the core and beyond. The extent of impact could vary from plant to plant and requires plant specific evaluation. [[

]]

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

GE Response
The only EPU/MELLLA+ core is Brunswick-1 Cycle 15. The ΔCPR/ICPR is determined with TRACG. The following table provides ΔCPR/ICPR as a function of power and flow.

[[			
			]]

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

GE Response
[[

]] The following are the results of this study:

[[		
		]]

The following is a similar study for Brunswick-1 Cycle 15 at MELLLA+. The following are the results of this study:

[[		
		]]

[[ ]]

NRC RAI 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.

GE Response

[[

]]

NRC RAI 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.

GE Response

To be provided at a later date

NRC RAI 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.

GE Response

To be provided at a later date

NRC RAI 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.

GE Response

See the response to RAI 6(e) for justification of adequacy of the GEXL+ correlation for MELLLA+ conditions

NRC RAI 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.

GE Response

[[

]]

NRC RAI 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?

GE Response

[[

]]

NRC RAI 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.

GE Response

a. [[

]]

b. [[

]]

c. Figures AOO-21-1 through AOO-21-5 provides the comparison

[[

]]

Figure AOO-21-1. TRACG vs ODYN Neutron Flux TTNB Event at M+

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Figure AOO-21-2. TRACG vs ODYN Core Flow TTNB Event at M+

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Figure AOO-21-3. TRACG vs ODYN Vessel Stream Flow TTNB Event at M+

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Figure AOO-21-4. TRACG vs ODYN Vessel Pressure TTNB Event at M+

[[

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Figure AOO-21-5. TRACG vs ODYN SRV Flow TTNB Event at M+

NRC RAI 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.

GE Response
The requested information is provided in Enclosure 4.

NRC RAI 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. <u>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.</u> 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. <u>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.</u> For example, if the dome pressure would be increased, the ECCS performance needs to be evaluated on a plant-specific basis.

c. <u>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.</u> 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.

GE Response
To be provided at a later date

NRC RAI 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, [[

]] (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. [[

]] 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. [[

]] 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. [[

]] 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.

GE Response

The plant-specific EPU/MELLLA+ application will provide plant-specific thermal limits assessment and transient analyses results.

<u>NRC RAI 25, Large Break ECCS-LOCA</u>

a. <u>Mixed Core</u>. 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. <u>Reporting Limiting ECCS-LOCA Results</u>. 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. <u>Adder Approach</u>. 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.

<u>GE Response</u>

To be provided at a later date

NRC RAI 26, Small Break ECCS-LOCA Response

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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.

GE Response

To be provided at a later date

NRC RAI 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.

GE Response
The peak suppression pool temperature for the SBA with vessel depressurization is not expected to exceed the peak suppression pool temperature for the DBA-LOCA. The key energy sources that affect the peak suppression pool temperature are the vessel decay energy and the initial vessel sensible energy.

The decay energy is determined by the decay power time-history and the initial power level. These parameters are the same for both events.

For a DBA-LOCA, the initial vessel sensible liquid energy is rapidly transferred to the suppression pool during the initial vessel blowdown period. The liquid break flow from the vessel during the blowdown period partially flashes in the drywell, resulting in a homogeneous mixture of steam and liquid in the drywell. This mixture is forced rapidly from the drywell, through the vent system, to the suppression pool. The vessel is depressurized to the ambient drywell pressure within a few minutes of the start of the event. This effectively transfers the initial vessel liquid sensible energy to the pool within minutes of the start of the event. [[

]] After the vessel blowdown period, relatively cold ECCS liquid from the suppression pool enters the vessel. The ECCS flow floods the vessel to the break elevation and delivers a stream of liquid from the vessel to the drywell. [[

]] After vessel depressurization is completed for the SBA, decay energy continues to produce steam in the vessel. This decay energy is transferred to the suppression pool via intermittent SRV discharges to the suppression pool, which maintains the vessel at low pressure. This process produces a slow heat up of the suppression pool. As with the DBA-LOCA, the peak pool temperature occurs when the energy removal rate by the RHR system equals the energy addition rate to the suppression pool.

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Analysis Confirmation

To confirm the discussion provided above, the results of SBA containment analyses were compared to the results of DBA-LOCA containment analyses. Sensitivity analyses of the SBA event were performed for Brunswick with EPU conditions. SBA containment analyses were not available for the Clinton EPU application. However, the results of SBA analyses performed with EPU conditions for another, non-US, BWR/6-218 plant with a Mark III containment (similar to Clinton) were reviewed for the evaluation.

The Brunswick EPU SBA sensitivity analyses assumed HPCI failure and vessel depressurization. The analyses included cases where vessel depressurization with ADS was modeled and cases where manually controlled vessel depressurization was modeled. The peak suppression pool temperature obtained for the analysis with ADS modeled was 204.4°F. The peak suppression pool temperature with controlled vessel depressurization modeled was 206.9°F. In both cases the peak suppression pool temperatures were similar to but not higher than the peak suppression pool temperature obtained from the DBA-LOCA value of 207.7°F.

The SBA analysis performed for the BWR/6-218 plant assumed manually controlled vessel depressurization. The peak suppression pool temperature obtained from the SBA analysis was slightly higher than the peak DBA-LOCA suppression pool temperature but only by 0.8°F.

These results confirm that the SBA event does not produce more limiting conditions with respect to peak suppression pool temperature.

NRC RAI 28, Assumed Axial Power Profile for ECCS-LOCA
[[

]] 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.

GE Response
Previous studies of the BWR LOCA methodology showed that axial power profile did not have a strong impact on the LOCA performance, so a mid-peak shape was used as a best estimate parameter. Recent studies of the power shape have been performed, and these studies indicate that the axial power shape is bottom-peaked when the bundle is LHGR-limited and top-peaked when the bundle is MCPR-limited. Additional studies have been performed to assess the impact of the axial power shape on the LOCA performance using the SAFER methodology. These studies focused on the effect of a top-peaked power shape because the top-peaked profile is expected to have a more adverse impact on the LOCA performance than the bottom-peaked profile; the top nodes are more likely to experience early dryout and reflood later in the event.

Since SAFER places the peak node on the target PLHGR, the axial power distribution is used to achieve a hot bundle power that puts the bundle on the MCPR target. Based on operating plant data, a top-peaked profile was selected for these studies that places the peak power node at about 75% of the length from the bottom of a full-length rod; this places the peak node above the partial length rods. These studies were performed for the Brunswick plant at EPU conditions, and include analyses of a mid-peak profile so that the results are consistent for comparison purposes. The comparison is performed at 120% Power / 100% Core Flow (120P100), 120% Power / 80% Core Flow (120P80), and 100% Power / 55% Core Flow (100P55) using Appendix K assumptions. The 100% Power / 55% Core Flow case reduces the PLHGR and increases the MCPR to reflect the power / flow dependent MCPR and MAPLHGR multipliers. The table below shows the effect of the power / flow (P/F) and power profile on the dryout times of the peak power node of the hot bundle.

Dryout Times of Peak Power Node for Various P/F Conditions and Power Shape

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The axial peaking factors (APFs) in the table below are the factors needed to place the hot bundle on the PLHGR target when the bundle power places the bundle on the MCPR target. These APFs are much larger than would be expected to occur during plant operation. It is also unlikely that a top peak shape would be on the PLHGR target and MCPR target at the same time.

Axial Peaking Factors for Various P/F Conditions and Power Shape

	[[	
		]]

The effect of the power profile on the PCT is shown in the table below. The effect of the power profile on the PCT is small. The impact of the power profile is larger on 1st Peak PCT than on the limiting 2nd Peak PCTs. [[

]]

Appendix K PCTs for Various P/F Conditions and Power Shape

	[[			
				]]

The following table provides the axial peaking factors used in the analyses supporting the MELLLA+ LTR. The analyses supporting the LTR used a slightly different approach than the above analyses in setting the hot bundle on the MCPR target. In the above analyses, the limiting R-factor based on the specific fuel bundle type (GE14) is used and the bundle power is varied to place the bundle on the MCPR limits; this results in different radial and axial peaking factors for each case. Using a fixed limiting R-factor gives more representative trends.

In the analyses supporting the LTR, the bundle power is fixed at a value higher than expected during operation and the R-factor is varied to place the bundle on the MCPR target as long as it remains above a minimum value. If the minimum is reached, the bundle power is reduced to obtain the MCPR target. This approach results in the same peaking factors except at low core flow.

Axial Peaking Factors Used in the Analyses Supporting the LTR

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In conclusion, the dryout times of the peak power node for the mid-peaked profile are about the same or earlier than those of the top-peaked profile. [[

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NRC RAI 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?

GE Response

One of the goals for the MELLLA+ project was to incorporate utility input as to the characteristics of the region to be used for the analyses. The general utility input was that the MELLLA+ upper boundary should be more representative of plant performance, in contrast to the MELLLA upper boundary bias toward a steep load line. Recent operating plant data from 4 BWRs with newer fuel designs was extrapolated to higher load lines to derive the analytical upper boundary for the MELLLA+ operating region. While a specific load line is influenced by some plant specific factors, such as feedwater temperature and core size, the variation of load line due to changing core characteristic factors, such as reactivity coefficients and power distribution, indicates that a few typical plants with different core characteristics will be representative. The resulting MELLLA+ upper boundary represents a nominal power to flow load line. The MELLLA+ upper boundary line represents the analyzed operating region and it is therefore a requirement for normal operation. The evaluations performed to justify operation in the MELLLA+ region assure that all operating condition within the MELLLA+ upper boundary are acceptable.

NRC RAI 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.

GE Response

Both the minimum core flow of 80% of rated for 100% power and the minimum core flow of 55% of rated for the low boundary represent the practical limitations of normal BWR operation. [[

]] Thus the 80% of rated core flow was selected. [[

]]

(a) FWHOOS; The establishment of the MELLLA+ region included considerations of practical application, as well as limiting adverse consequences in plant safety analyses. [[

]] However, this feedwater temperature reduction would need to be evaluated on a plant specific basis and is not part of the standard MELLLA+ evaluation. Finally, it should also be noted that operation in FWHOOS is considered only a contingency option, for temporary feedwater heater equipment deficiency therefore, this limitation is not expected to impose a significant limitation to plant availability.

(b) SLO; The core flow attainable with a single recirculation pump is typically 50% of rated, and not expected to be higher than 60% of rated. Then it follows that since the MELLLA+ region is limited to a minimum flow of 55% of rated, it would be extremely difficult for a

BWR to maneuver into the high power condition corresponding to the MELLLA+ region, where little flow margin for operation exists. Therefore, there is no incentive to operate in SLO at higher power in MELLLA+.

ENCLOSURE 2

MFN 04-020

Response to NRC MELLLA+ AOO RAIs

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ENCLOSURE 3

MFN 04-020

Response to NRC MELLLA+ AOO RAIs

GE Proprietary Information

APPLICABILITY OF NRC APPROVED METHODOLOGIES TO MELLLA+

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ENCLOSURE 4

MFN 04-020

Brunswick TRACG MELLLA+ Analyses

Compact Disk

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