GE-Hitachi Nuclear Energy

Proprietary Notice
This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 1, the balance of this letter may be considered non-proprietary.

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MFN 07-445
August 15, 2007

U.S Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: Partial Response to Request for Additional Information RE: GE Topical Report NEDE-32906P, Supplement 3, *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*, (TAC No. MD2569)

In Reference 1, the USNRC provided a Request for Additional Information (RAI) regarding the subject topical report. This transmittal provides the requested responses to RAIs 1-10, 12, 14, 15, 24, 25, 28, 29, and 33.

Please note that Enclosure 1 contains proprietary information of the type that GE-Hitachi Nuclear Energy (GEH) maintains in confidence and withholds from public disclosure. The information has been handled and classified as proprietary to GEH as indicated in the enclosed affidavit. The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GEH. GEH hereby requests that the information in Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17. Enclosure 2 is a non-proprietary version of Enclosure 1.

If you have any questions, please contact, Jim Harrison at (910) 675-6604 or me.

Sincerely,

Richard Kingston

Richard Kingston
Project Manager, Regulatory Affairs

Project No. 710

D065
NRR

Reference:

1. Letter, M. C. Honcharik (USNRC) to R. E. Brown (GE- Hitachi Nuclear Energy Americas), "Request for Additional Information RE: General Electric Nuclear Energy (GENE) Topical Report (TR) NEDE-32906P, Supplement 3, *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*, (TAC No. MD2569)" March 5, 2007

Enclosures:

1. Partial Response to USNRC Request for Additional Information RE: GE Topical Report NEDE-32906P, *Supplement 3, Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*, Proprietary version

2. Partial Response to USNRC Request for Additional Information RE: GE Topical Report NEDE-32906P, Supplement 3, Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients, Non-proprietary version

3. Affidavit, Richard E. Kingston, dated August 15, 2007

cc: FT Bolger (GEH/Wilmington)
RE Brown (GEH/Wilmington)
PL Campbell (GEH/Washington)
MJ Colby (GEH/Wilmington)
MC Honcharik (NRC)
JF Klapproth (GEH/Wilmington)
MA Lalor (GEH/San Jose)
GB Stramback (GEH/San Jose)
PT Tran (GEH/Vallecitos)
eDRF 0000-0059-4157

ENCLOSURE 2

MFN 07-445

Partial Response to USNRC Request for Additional Information RE: GE Topical Report NEDE-32906P, Supplement 3, *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*

Non-Proprietary Version

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1 to MFN 07-445, which has the proprietary information removed. Portions of the enclosure that have been removed are indicated by an open and closed brackets as shown here [[ ]]

NRC- RAI 1

Do you intend to use TGBLA06-Modified as part of this application?

GEH Response

The codes used to generate NEDE-32906P, Supplement 3 are consistent with the current NRC approved methodologies. In particular, the version of TGBLA06 applied does not contain the resonance modeling modification discussed in responses to NRC questions on the ESBWR docket [1] and extended operational ranges [2]. The modified TGBLA06 will be applied once the quality assurance procedures for the error correction are complete and the final determinations of any impacts are assessed in accordance with 10 CFR 50.59 rules.

[1] Letter from George Stramback to US NRC Document Control Desk, " Response to Portion of NRC Request for Additional Information Letter No. 53 Related to ESBWR Design Certification Application – DCD Chapter 4 and GNF Topical Reports – RAI Numbers 4.2-2 through 4.2-7, 4.3-3, 4.3-4, 4.4-2, 4.4-5, 4.4-6, 4.4-15 through 4.4-17, 4.4-19, 4.4-24, 4.4-27, 4.4-31 through 4.4-34, 4.4-36, through 4.4-38, 4.4-42 through 4.4-50, 4.4-52 through 4.4-56, 4.8-1 through 4.8-16",MFN-06-297, August 23, 2006. (See response to RAI 4.3-3.)

[2] Letter from George Stramback to Herbert Berkow (NRC), "Responses to RAIs - Methods Interim Process (TAC No. MC5780)", MFN-05-022, May 31, 2005. (See response to RAI 3-1.)

NRC RAI 2

Provide a qualitative discussion on the differences seen in the transient analysis time traces between TRACG02/PANAC10 and TRACG04/PANAC11 in the thermal hydraulic parameters such as pressure, core flow, inlet subcooling, etc.

GEH Response

To some extent, this qualitative comparison has already been provided in a general sense in Section 8.2 on Page 8-37 for the case where the nuclear kinetics differences were removed from the equation. However, this general description of the calculated trends will be further detailed here describing the effects of the nuclear kinetics on the overall transient response comparisons.

The turbine trip no bypass (TTNB) calculation comparison found in Section 8.1.1.1 will be used here for illustrative purposes. The same trends can be observed when looking at the TRACG04/PANAC11 (T4/P11) calculations in comparison to the TRACG02/PANAC10 (T2/P10) calculations for the other pressurization events.

The pressure responses of T4/P11 and T2/P10 track in quite good agreement until the peak pressure is achieved at around [[ ]] (Figure 8-9). However, the power response (Figure 8-5) does not track quite so closely. The power trends are the same, but the magnitudes of the peaks are very different. For T4/P11, the first power peak is found to be [[ ]] at [[ ]], while the T2/P10 power peak is found to be [[ ]] at [[ ]].

This deviation in peak powers is a direct result of using the P11 kinetics rather than the P10 kinetics. For a similar pressure transient, the P11 kinetics produce a much more responsive neutronic feedback. With this increased nuclear feedback, the extra power is deposited in the fuel and subsequently the coolant and manifests in an internal energy increase in the bulk coolant thereby yielding higher transient CPR values (Figure 8-12) and higher system pressures (Figure 8-9) downstream of the peak powers for T4/P11.

As the pressures are higher in T4/P11, these higher pressures result in higher inlet subcooling (Figure 8-8) for a given fluid temperature, because the saturation temperature at the inlet of the core has been increased.

In the case of TTNB, the two transient peaks in ΔCPR/ICPR are found at roughly [[ ]]. Because T4/P11 results in higher integrated power responses in these time periods, the ΔCPR/ICPR values are found to be higher in both instances as compared to the results using T2/P10.

In general, the core flow responses (Figure 8-7) are quite similar between T4/P11 and T2/P10. (See also the discussion on Page 8-41 and Figure 8-53.) Core flow is generally more controlled by the forced flow from the recirculation system and less by the more responsive P11 neutronic feedback. The feedwater flow (Figure 8-6), on the other hand, is more dynamic in its response. As the pressure in the vessel increases, the feedwater system is less capable of delivering flow at this higher backpressure. Additionally, the feedwater flow is modulated based upon the transient level response, which in turn is dependent upon the pressure in the vessel. As the pressure responses diverge between T4/P11 and T2/P10, the feedwater flow will potentially deviate in a manner consistent with the transient pressure and level differences.

NRC RAI 3

(RAI 21.6-78 on the Economic Simplified Boiling Water Reactor (ESBWR) DCD Docket) On Page 7-47 of NEDE-32176P, Revision 3 (Reference 1), you state: "Two options exist for the calculation of the CPR [critical power ratio] for transient conditions." Why do you have two options for calculation of transient CPR? Is one method more conservative than the other? What are your guidelines for when to use which method for transient CPR calculations? Which method is used during an anticipated operational occurrence (AOO) calculation and during an anticipated transient without scram (ATWS) calculation? On Page 7-48 of the same document you state: "The assessment of the critical power calculation can be found in Section 3.6 of the TRACG Qualification LTR." The NRC staff has not received Revision 3 of the TRACG Qualification LTR which you state was to be published in June 2006. Provide the information from this document that may answer the above questions on the CPR calculation options for transient conditions.

GEH Response

Two options exist for the calculation of the transient CPR response in TRACG. In the first option the transient CPR are calculated using the traditional [[ ]]. In the second option the transient CPR is calculated by performing an [[ ]] in the calculation. The second method is [[ ]], but is also more compute intensive. The two transient CPR methods are both approved and are described in detail in the approved LTR supplement "TRACG Application for Anticipated Operational Occurrences Transient Analyses", NEDE-32906P Supplement 2-A, March 2006.

NRC RAI 4

(RAI 21.6-80 on the ESBWR DCD Docket) The variable f in Equation 9.3-2 in NEDE-32176P, Revision 3, is described as the sum of the five decay heat group fractions, f_k. However, in the preceding paragraph you state that TRACG04 allows for a variable number (N_d) of decay heat groups. Please update your documentation to reflect this change.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 07-352

NRC RAI 5

(RAI 21.6-81 on the ESBWR DCD Docket) Please address the following questions related to distribution of channel power:

a. Equation 9.4-11 in NEDE-32176P, Revision 3, includes Fco, which is the fraction of direct moderator heating that appears in the coolant in the bypass, water rod, and bundle coolant. In TRACG, the water rod coolant, the core bypass coolant, and the bundle coolant are simulated as separate flow paths. How is the direct moderator heating associated with Fco split up for these three different coolant regions within the boiling water reactor core? Please describe the basis of the model.

b. Page 62 of NEDC-32965P, Revision 0 (Reference 2) describes the user input fractions for fission power and decay heat for direct moderator heating, fuel clad gamma heating and water rod(s) clad gamma heating as described in Reference 1, Page 9-35. The description for FDMN2 (direct moderator heating fraction for decay heat power) states: "The prior practice of setting FDMH2=FDMH1 is discouraged since it is non-conservative with respect to post-scram evaluations of peak clad temperature." Where FDMH1 is the direct moderator heating fraction for fission power. Please explain why you have set FDMH1=FDMH2 for all of the CHANs in the ESBWR TRACG decks for loss-of-coolant accident (LOCA), AOO, ATWS, and Stability given this statement in the user's guide.

c. [[

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d. How does the direct moderator heating model change based on the control fraction for a given CHAN component? How specifically is the user input for bypass area per channel (BPAPC) used in the direct moderator heating model?

e. The fission power distribution model presented in Section 9.4 in Reference 1 appears to assume no gamma heat of the pressure vessel walls. Explain how gamma heating of the pressure vessel walls is considered.

f. In Equation 9.4-13 of Reference 1 a and b are assumed constant for calculating the fractional deposition of fission power in the fuel clad, water rod clad, control blades, and channel wall. [[

]]

g. What is the normalization formula used to normalize Equation 9.4-11 in Reference 1? If the energy distribution fraction Fco is decreasing, because the moderator density is decreasing, how are the other fractions in Equation 9.4-11 in Reference 1 adjusted to ensure that they sum to one?

h. Does the TRACG uncertainty analysis include uncertainty associated with a and b for c, f, w, bl, ch, and co?

GEH Response

The letters denoting the paragraphs in this response correspond to the paragraphs in the RAI.

a. Additional detail for the direct moderator heating (DMH) model is available in subsection C3DX of Section 5.1 of NEDE-32906P-A, Revision 3. The total DMH fraction for a kinetics node kij is calculated from Equation (9.4-14) of NEDE-32176P, Rev. 3 using a nodal density ρ_m that is calculated in the way indicated in the response to RAI 21-b for NEDE-32906P-A, Revision 3. Each node can contain three regions J denoted by the subscripts AC for active channel, BP for bypass, and WR for water rod. The defining equation for ρ_m is repeated here.

$$\rho_m = F_{AC}\rho_{AC} + F_{BP}\rho_{BP} + F_{WR}\rho_{WR} \quad (21.6\text{-}81.1)$$

where

$$\rho_J = \left[(1-\alpha)\rho_\ell + \alpha\rho_v\right]_J \quad \text{for } J \in \{AC, BP, WR\}, \quad (21.6\text{-}81.2)$$

and F_J is the volume fraction in region J,
α_J is the void fraction in region J,
ρ_ℓ is the liquid density in region J,
ρ_v is the vapor density in region J.

When the dynamic water rod model is active, the value for ρ_{WR} is calculated from the TRACG hydraulic solution, otherwise $\rho_{WR} = \rho_{BP}$ for each axial location. For all cases, all quantities are defined for each kij kinetics node. For each such node the volume fractions satisfy the relationship

$$F_{AC} + F_{BP} + F_{WR} = 1.0 \quad (21.6\text{-}81.3)$$

Equations (21.6-81.2) and (21.6-81.3) apply for either a controlled or uncontrolled node since the value of F_{BP} depends on the whether a control blade is present or absent in determining the nodal values for ρ_m used to drive the cross section model.

Using ρ_m from Equation (21.6-81.1), the total DMH fraction $F_{co}(t)$ is calculated from Equation (9.4-14) of NEDE-32176P, Rev. 3 and then split among the three regions proportional to the water density fraction from the uncontrolled condition so that

$$F_{co} = \left[\gamma_{AC} + \gamma_{BP} + \gamma_{WR}\right]_{uncontrolled} \quad (21.6\text{-}81.4)$$

where $$\gamma_J = \frac{\rho_J}{\rho_m}[F'_J]_{uncontrolled} \quad \text{for } J \in \{AC, BP, WR\}. \qquad (21.6\text{-}81.5)$$

Please see the response to part h for additional discussion related to controlled conditions.

The TRACG DMH model is based on the fact that the largest component of DMH is due to neutron scattering off of hydrogen atoms in water molecules and that this effect is proportional to the number density of hydrogen atoms and thus proportional to the water density. This fact was supported by detailed MCNP analyses that assessed both the neutron and photon components of DMH in each of the three regions for different fuel types. The results are shown in Figures 5-11, 5-12 and 5-13 of NEDE-32906P-A, Revision 3.

b. The context for which setting FDMH2=FDMH1 is nonconservative is with respect to calculating the peak clad temperature (PCT) during a LOCA event in an operating BWR. That was the purpose for which the comment in the User's Manual (UM) was made. The UM comment does not apply for AOO, ATWS and stability scenarios. For a postulated LOCA in an operating BWR, it would be conservative to assume that most or all of the DMH component attributed to decay heat is due to gamma heating in the fuel since this will result in the maximum heat flux through the cladding and maximize the calculated PCT. In other words, with respect to impact on the calculated PCT, setting FDMH2=0.0 is the most conservative choice. PCT is not a key parameter except for LOCA scenarios in operating BWRs. For LOCA scenarios in the ESBWR, PCT is only nominally a key parameter since fuel heatup does not occur for the design basis accident; therefore, setting FDMH1=FDMH2 is acceptable.

c. [[

]]

d. [[

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e. TRACG does not explicitly account for gamma heating in the vessel wall.

f. The constants *a* and *b* are used to account for the fact that fission gammas and decay heat gammas have different energies that may impact how their energies are deposited. Gamma energy is primarily deposited into materials with larger atomic numbers like fuel and structural materials so their deposition is insensitive to the moderator density. In any case, gamma energy primarily gets redeposited into the fuel itself. The other major component of directly deposited energy is energy from neutrons. Unlike gamma energy, neutron energy is primarily deposited in the moderator as neutrons scatter with hydrogen in water. Eventually most of the neutrons are moderated to thermal energy and end up being absorbed in the fuel. [[

]] simulations confirm that total energy deposition in the moderator is modeled well within an uncertainty of [[ ]] as indicated in Figure 5-11 of NEDE-32906P-A, Revision 3.

g. The value for $F_f(t)$ is calculated as unity minus the sum of all the other fractions. As $F_{co}(t)$ decreases the value of $F_f(t)$ increases. Similarly, changes in the other fractions with time will also result in a change in $F_f(t)$ so that all the fractions will continue to sum to unity.

h. The TRACG uncertainty does not explicitly consider the uncertainties in all the components of the model. The total uncertainty of [[ ]] in the total DMH is sufficient to encompass all of these other minor uncertainties. To put everything in the correct perspective, a [[ ]] change in the total DMH results in less than a [[ ]] impact in the calculated ΔCPR/ICPR. A change of [[ ]] in CPR is considered to be negligible.

NRC RAI 6

(RAI 21.6-82 on the ESBWR DCD Docket) Section 9.1.3 in Reference 1 indicates that at the beginning of the calculation with the PANCEA Wrap up, that the TRACG cross sections include the presence of xenon. However, the transient calculation procedure does not indicate that the xenon concentration is updated. The NRC staff is aware that TRACG is capable of simulating transients with transient xenon conditions but is unable to locate any details about your models and calculation procedures. Please provide these details. Are transient xenon conditions used in the simulation of any AOO and ATWS events? Include information on how the treatment of xenon is conservative for these events.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 07-352

NRC RAI 7

(RAI 21.6-84 on the ESBWR DCD Docket) In discussing the biases and uncertainties for the void coefficient in NEDE-32906P, "TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses," in response to NRC staff RAI 12 you state: "When the PANAC11 model is implemented in TRACG it will be necessary to make a similar assessment TGBLA06 and MCNP and change the TRACG void coefficient model accordingly." Please state if this has been done and provide the NRC staff with the documentation that includes the details of the new evaluation.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 07-352

NRC RAI 8

(RAI 21.6-85 on the ESBWR DCD Docket) Describe the computational procedure used to generate a PANACEA Wrap up file for use with TRACG. Specifically explain what calculations are performed with PANAC11 and how these results are captured numerically in the PANACEA Wrap up file.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 07-347

NRC RAI 9

(RAI 21.6-86 on the ESBWR DCD Docket) The isotopic tracking in the PANAC11 code is discussed in NEDC-33239P (Reference 4). Please provide a prototypical calculational model (e.g., the differential equations) for the determination of plutonium content based on the nodal power, exposure, and moderator density history.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 06-467. After the review of RAI 21.6-86, additional information was requested by the NRC under RAI 21.6-86 S01 and RAI 21.6-94. Both of these RAIs have been addressed respectively in MFN 06-467, Supplement 1 and MFN 07-079.

NRC RAI 10

(RAI 21.6-87 on the ESBWR DCD Docket) PANAC11 uses the GEXL correlation to determine critical quality for the purpose of calculating the minimum CPR. Describe how PANAC11 calculates the bundle power where boiling transition occurs.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 06-467

NRC RAI 11 (Deleted)

NRC RAI 12

(RAI 21.6-68 on the ESBWR DCD Docket) On Page 6-135 of Reference 1, should the reference to Figure 6-34 actually be to Figure 6-37?

GEH Response

Yes. This will be corrected in the next revision of the TRACG Model Description (NEDE-32177P). This was also answered on ESBWR Docket, GEH Letter MFN 07-352.

NRC RAI 14

(RAI 4.3-3 on the ESBWR DCD Docket) In DCD Tier 2, Page 4.3-3, reference is made to the lattice code TGBLA06, which has recently been modified to accommodate a minor correction in the programming of analytical formulation in the code. Please submit the modification(s) to TGBLA06. The submittal should include the changes made to the code and validation of the code as it pertains to recent application(s) since the modification of the code, and any natural circulation database, as it pertains to the analysis of the ESBWR steady-state neutronic performance. The contents of the submittal should include before and after calculational results with technical justification(s) in support of the changed results. Also provide a comparison between the modified TGBLA and MCNP results in Section 1.3 of NEDC-33239P, "GE14 for ESBWR Nuclear Design Report" (Reference 4).

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 06-297, Supplement 1

NRC RAI 15

(RAI 4.3-4 on the ESBWR DCD Docket) Discuss any recent changes made to PANACEA since the NRC staff's last approval. Provide similar information to that requested in RAI 4.3-3. It is presumed that this version of the code is the NRC-approved version of record.

GEH Response

Answered on the ESBWR DCD Docket, GEH letter MFN 06-297. Additional information in response to NRC questions wal provided in MFN 06-297 Supplement 2, and Supplement 8.

NRC RAI 18-20 (Deleted)

NRC RAI 24

In the TRACG04 application for ESBWR AOO's (Reference 6), you increased the uncertainty in interfacial shear based upon comparisons to the Toshiba data (PIRT Item C2AX in Table 4.4-1, Reference 6, PIRT22 in TRACG04). This value was increased from the value for BWR/2-6 AOO's cited in Table 5-5 as PIRT item C2AX in Reference 3, which was based upon comparisons to FRIGG data. In addition, in the ESBWR application (Reference 6) you included an uncertainty for the entrainment multiplier to account for the data in the transition and annular flow regimes (included with PIRT Item C2AX in Table 4.4-1, Reference 6, PIRT52 in TRACG04). Explain why you do not increase/include these uncertainties in the TRACG04 application for BWR/2-6 AOO events.

GEH Response

The report "TRACG Application for ESBWR", NEDE-33083P-A, March 2005 (Reference 6) in the request for additional information describes the TRACG application for ESBWR LOCA. The Toshiba tests were added to the TRACG qualification basis in order to expand the void fraction qualification for low pressures. The Toshiba tests were conducted at pressures of 0.5-1 MPa. The increased uncertainty in the interfacial shear (PIRT22) and the added uncertainty in the entrainment (PIRT52) were introduced to cover the larger uncertainty observed in the comparison to void fraction data at low pressure and to cover the wider pressure range needed for LOCA applications.

The uncertainty in the void fraction is essentially unchanged for applications at rated pressure such as anticipated operational occurrences. The basis for the void fraction uncertainty for AOO applications is the comparisons to the FRIGG tests. The qualification of TRACG02 (NEDE-32177P, Revision 2, January 2000) against the FRIGG data at pressure of [[ ]] showed a mean error of [[ ]] and a standard deviation of [[ ]]. The qualification of TRACG04 against the same data shows a mean error of [[ ]] and a standard deviation of [[ ]]. The uncertainty is unchanged and the bias has increased by [[ ]] for typically limiting AOO events. Therefore the same void fraction uncertainty as documented in the LTR for the TRACG02 application to AOOs (NEDE-32906P-A, Revision 3, September 2006) can be applied for TRACG04.

NRC RAI 25

Provide the implementation details of the optional 6-cell jet pump model. Please update the TRACG04 User's Manual (Reference 2) and the TRACG Model Description (Reference 1) with these details.

GEH Response

The following sentence will be added to Section 7.6.1 in the next revision of TRACG Model Description (NEDE-32176P, revision 3, April 2006):
"The TRACG jet pump model uses a standard nodalization with 3 or 4 nodes in the primary branch consisting of the region from the suction inlet to the end of the diffuser and 2 nodes in the secondary branch simulating the nozzle. Figure 7-22 shows the nodalization with 3 nodes in the primary branch. For applications where two-phase conditions may exist in the jet pump and where an accurate characterization of the void profile is important, the first node in the primary branch may be subdivided into two nodes."

The TRACG04 Users Manual (UM-0136, December 2006) correctly describes the jet pump nodalization options.

The extra node in the primary branch was introduced to get a more accurate characterization of the void profile and static head in the jet pump for scenarios such as a LOCA where two-phase conditions may exist in the jet pump. For applications to AOOs where single-phase conditions exist in the jet pump, the extra node is not needed and the two options produce similar results.

NRC RAI 28

Provide additional information on the procedures for selecting the pump homologous curve input into TRACG.

GEH Response

The selection of the pump curves is performed as part of the initial base deck creation for a plant-specific application. Each plant has a plant specific TRACG base model. Pertinent pump data (e.g. rated head, torque, and speed) is used in the development of the plant-specific model. A generic set of pump homologous curve data is used. The generic pump curve data represents full scale test data that is appropriate for BWR recirculation pumps. When the TRACG basedeck is generated, the pump inertia is set to represent the plant. This, along with the input for the rated conditions, are the key inputs for AOO application.

NRC RAI 29

The void reactivity coefficient bias and uncertainties in TRACG must be representative of the lattice designs of the fuel loaded in the core. State the lattices used to generate the void reactivity coefficient response for TRACG04/PANAC11. Include the restriction that Reference 7 is only applicable for these lattice designs.

GEH Response

The void coefficient was developed based on data for 8x8, 9x9, and 10x10 fuel, representative of GE9, GE10, and GE14 fuel, respectively. To address the restriction in this RAI, the void coefficient bias and uncertainties will be confirmed for new fuel (lattice) types.

NRC RAI 33

Section 7.5.2.7, "High Worth Scram Rods for Pressurization event OLMCPR," of NEDC-32906P (Reference 3) describes the initial conditions used to minimize the worth of the scram reactivity. Section 8.0 in Reference 3, "Demonstration Analysis," covers the bases for application of TRACG for AOO, using sensitivity analyses to establish the initial conditions and assumptions that will be applied on plant-specific bases. Section 8.2 in Reference 3, "Initial Conditions and Plant Parameter Review," defines the initial conditions that are demonstrated to have an impact the AOO response.

Table 8-9 in Reference 3, "Allowable Operating Range Characterization Basis," lists the key parameters that influence the AOO response. For the axial power shape, the table states that the cases are analyzed at nominal (top-peaked) end-of-cycle (EOC) conditions and at EOC bottom peaked conditions. For the control rod pattern, Table 8-9 of Reference 3 states that cases are analyzed at middle-of-cycle (MOC) with a nominal rod pattern and with a conservative black and white rod pattern.

From this discussion, it is not apparent that for EPU and MELLLA+ operation, the assumed axial power shapes with exposure will be conservative relative to the nominal or planned operating control rod and core flow strategies. Specifically, considering the impact of TVAP, Reference 3 did not discuss why bottom and middle peaked or double hump power profile early in the cycle will not result in higher transient response. The following RAIs relate to the use of TRACG for EPU/MELLLA+ applications.

1. For the plant-specific EPU/MELLLA+ application of TRACG04 to AOOs (References 3 and 5), demonstrate that the limiting control rod patterns assumed in the power history envelops and bounds the axial power peaking the plant will experience at different exposure ranges.

2. Discuss how the limiting control rod patterns assumed as the core depletes minimizes the scram reactivity worth.

3. Provide an assessment of TVAP that would result from the scram during power profiles other than top-peaked.

GEH Response

Response # 33-1

It should be noted that the approach for dealing with analysis of AOOs for plants operating at EPU and MELLLA+ conditions is the same for TRACG04 / PANAC11 as compared to that which is currently approved for analysis of AOOs using TRACG02 / PANAC10. Nothing in the transition of codes is expected to invalidate the approach used. The general trend for the calculated results for TRACG04 / PANAC11 is conservative with respect to results calculated by TRACG02 / PANAC10.

With respect to the limiting control rod patterns assumed as a function of cycle exposure, a conservative approach is used in TRACG04 / PANAC11 as is already done using TRACG02 / PANAC10 and consistent with the ODYN basis described in Reference 11.

Pressurization events are most limiting at EOC where control rods are full-out and scram reactivity is minimized. The EOC condition is evaluated using a variation in the axial power shape at EOC through two burn strategies – a Hard Bottom Burn (HBB) and an Under Burn (UB). The main reason UB power shapes are considered is the potential effect from the Time Varying Axial Power Shape (TVAPS).

This range of exposure-dependent operational strategies (HBB to UB) is expected to bound intermediate burn strategies such that the effect of power shape deviations on the EOC power shape will be explicitly verified at both ends of the spectrum if the limiting shape can not be clearly established.

Response # 33-2

At any given exposure point, there are many control rod patterns which will render the core critical and within thermal limits. To ensure that conservative values of the important dynamic parameters are calculated, it is necessary to select special control patterns. Conservative values of both the scram reactivity and dynamic void coefficient result when "black-white" control patterns are used. A black-white control pattern is one in which control rods are either fully inserted (black), or fully withdrawn (white).

The scram reactivity is minimized with black-white patterns because:

1. the fully inserted control rods provide no contribution to the scram reactivity,
2. the fully withdrawn control rods begin their insertion in a region of zero power; thus, their impact during the early portion of the scram is minimized; and
3. there are no partially inserted control rods, which generally provide a major contribution during the early portion of the scram.

The assumption of the black-white control pattern adds significant conservatism to the results. Note, the HBB strategy normally produces a more bottom peaked power shape at MOC compared to the EOC exposure. Control rod configurations with rods in the core at MOC may produce a double humped axial power shape. From review of a number of cores, it was found that double humped axial power shapes occurred for conditions with partially inserted control blades. Potentially limiting double humped power shape bundles are those very near partially inserted rods where local scram reactivity is maximized for transients. However, demonstration analyses have been performed where the partially inserted control rods are in the core and compared to the standard analysis where the "MOC" point uses the HBB with a black-white pattern. For TRACG, the results in Reference 12 Table 8-10 indicate a significant difference in the ΔCPR/ICPR between the standard analysis method (black and white control rod pattern) and the nominal case with partially inserted rods was about 0.05 for a Turbine Trip with No Bypass. Therefore, the standard process of using the HBB burn strategy with the black-white is very conservative compared to the smaller difference that would be observed between the HBB and UB with nominal rod patterns. The process of analyzing exposure dependent limits is conservative.

Response # 33-3

The principal factors controlling the severity of the TVAPS transient CPR effect are: (a) initial axial shape, (b) initial flow, and (c) plant specific MCPR timing. Cases with a more bottom peaked initial power shape will show a more severe TVAPS effect. However, the resulting operating limit is usually insensitive to the initial power shape because of the compensating effect of the increase in scram worth. Studies documented Reference 12 (see Table 8-10) show the axial power shape sensitivity (axial power shapes shown in Figure 8-35 of Reference 12). This study showed that the sensitivity was very small (0.002 ΔCPR/ICPR). As discussed in

Response 33-1 and 33-2, The TRACG04/PANAC11 analysis will include consideration of both the HBB and UB axial power shape when performing the cycle specific analysis.

REFERENCES

1. NEDE-32176P Revision 3, "TRACG Model Description," April 2006

2. NEDC-32596P, Rev. 0 "TRACG04A,P User's Manual," eECPER 0000-0009-7162-00, UM-0136, Rev 0 Class 3, July 2005

3. NEDE-32906P Revision 2, "TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses," February 2006

4. NEDE-33239P, "GE14 for ESBWR Nuclear Design Report," February 2006

5. NEDE-32177P, Revision 2, "TRACG Qualification," January 2000

6. NEDC-33083P-A "TRACG Application for ESBWR," March 2005

7. NEDE-32906P, Supplement 3, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients," May 2006

8. Vermont Yankee Nuclear Power Station – Draft Final Safety Evaluation for the Proposed Extended Power Uprate (TAC No. MC0761) October 21, 2005

9. BVY 05-088 Letter, J. Thayer (Vermont Yankee) to NRC, "Vermont Yankee Nuclear Power Station, Technical Specification Proposed Change No. 263, Supplement No. 35, Extended Power Uprate - Response to Request for Additional Information" September 28, 2005. ADAMS Accession No. ML052770039

10. NEDC 33173P, "Applicability of GE Methods to Expanded Operating Domains," February 2006

11. NEDC-33173P, "Applicability of GE Methods to Expanded Operating Domains", February 2006.

12. NEDE-32906-P-A, "TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses," Revision 3, September 2006

ENCLOSURE 3

MFN 07-445

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Richard E. Kingston, state as follows:

(1) I am Project Manager, Regulatory Affairs, GE-Hitachi Nuclear Energy Americas LLC (GEH), 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 1 of GEH's letter, MFN 07-445, Richard Kingston to US Nuclear Regulatory Commission, entitled "Partial Response to Request for Additional Information RE: GEH Topical Report NEDE-32906P, Supplement 3, *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*, (TAC No. MD2569), August 13, 2007. The proprietary information in the Enclosure 1, which is entitled "Partial Response to USNRC Request for Additional Information RE: GE Topical Report NEDE-32906P, Supplement 3, *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*", is delineated by a [[dotted underline inside double square brackets[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 or licensee, GEH 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 2.390(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, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 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 GEH's competitors without license from GEH 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 GEH customer-funded development plans and programs, resulting in potential products to GEH;

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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 2.390(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 GEH, 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 GEH, 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, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH 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 for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH 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 including the process and methodology for application of TRACG to the performance if evaluations of AOOs for GEH BWRs. This TRACG code has been developed by GEH for over fifteen years, at a total cost in excess of three million dollars. The reporting, evaluation, and interpretations of the results, as they relate to the BWR, was achieved at significant cost to GEH.

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 GEH asset.

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(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH'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 GEH.

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.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH 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 GEH 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 GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining 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 15th day of August, 2007.

Richard Kingston

Richard E. Kingston
GE-Hitachi Nuclear Energy