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MFN 04-082

August 31, 2004

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

Attention: Mel B. Fields

Subject: Transient CPR Calculation for TRACG (TRACG Model Description, NEDE-32176P, Rev. 2, Supplement 1, August 2004).

GE Nuclear Energy (GENE) hereby submits a change to the process used by TRACG for the calculation of critical power ratio (CPR) during transients. During recent applications of TRACG it was discovered that TRACG would conservatively overpredict the transient change in CPR when applied to transients that are initiated with CPR substantially above the operating limit. This conservatism is in addition to the conservatism that is already included in the approved application methodology for TRACG. The improved process for the calculation of the transient CPR removes this additional conservatism.

Reference 1 describes the approved process for the application of TRACG to anticipated operational occurrences transient analysis. The details of the process for the calculation of the CPR during transients are described in Reference 2, which is also referenced by Reference 1. The improved process for the calculation of transient CPR is described in the enclosure.

GE plans to use the improved process for the evaluation of end of cycle limits for Brunswick 1 Cycle 16 and the upcoming Brunswick 2 Cycle 17 reload. Therefore, it is requested that the NRC complete the review within a three-month time frame, which would result in an approval by the end of November 2004.

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Enclosure 1 contains GE proprietary information as defined by 10 CFR 2.390. GE customarily maintains this information in confidence and withholds it from public disclosure. A non-proprietary version of the information contained in Enclosure 1 is provided in Enclosure 2.

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GE. GE hereby requests that the information of Enclosures 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

If you wish further information on this submittal, please contact me at (408) 925-1913, or Jens Andersen at (910) 675-6083.

Sincerely,

James J Harrison for

George B. Stramback
Manager, Regulatory Services
GE Nuclear Energy

Project No.710

References: 1. TRACG Application for Anticipated Operational Occurrences Transient Analysis, NEDE-32906P-A, Revision 1, April 2003.
2. TRACG Model Description, NEDE-32176P, Revision 2, December 1999.

Enclosures:

1. Transient CPR Calculation for TRACG (TRACG Model Description, NEDE-32176P, Rev. 2, Supplement 1, August 2004) - GE Proprietary Information - Compact Disk
2. Transient CPR Calculation for TRACG (TRACG Model Description, NEDE-32176P, Rev. 2, Supplement 1, August 2004) – Non Proprietary Version
3. Affidavit, Jason S. Post, dated August 30, 2004.

cc: Frank Akstulewicz USNRC (with enclosures)
JF Klapproth GE (without enclosures)
LM Quintana GE (without enclosures)
Margaret Harding GNF (without enclosures)
Jens Andersen GE (with enclosures)
eDRF 0000-0032-2034

ENCLOSURE 2

MFN 04-082

Transient CPR Calculation for TRACG (TRACG Model Description, NEDE-32176P, Rev. 2, Supplement 1, August 2004) -

Redacted and Non-Proprietary Information

TRACG Transient CPR Calculation

1. Introduction

GNF has developed an improved process for use in TRACG for the calculation of the critical power ratio (CPR) during AOO transients. The improved process leads to more consistent results for the change in critical power ratio over initial critical power ratio (ΔCPR/ICPR) as function of ICPR. The impact of the change in numerical method is insignificant for transients where the minimum critical power ratio (MCPR) approaches the safety limit (SL).

The purpose of this paper is to describe the background material that prompted the development of the improved method, to describe the current and improved process for the calculation of the transient CPR, and to show the testing of the improved process.

Finally, a licensing evaluation of this change in the process for the calculation of transient CPR has shown that the change is within the constraints and limitations of the approval of TRACG [1]. The impact of the change is insignificant for events where the MCPR equals the SL. The impact, however, can be significant for events where the MCPR is greater than the SL.

2. Background

In the application methodology for TRACG described in Reference 1, [[

{3}]].

Recent sensitivity studies with TRACG have shown that the ΔCPR/ICPR can vary when the ICPR is increased above the operating limit. An example of this is shown in Table 2-1.

Table 2-1. ΔCPR/ICPR Sensitivity to ICPR

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[3]]]

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[3]]]

[[

{3}]]

Figure 2-1. Typical Relationship Between TM and CPR

Details of the definition of TM and the current numerical method for the calculation of the CPR during transients are given in Section 3.

3. Current Calculation for Steady-State and Transient CPR

The critical power is calculated from the GEXL correlation [2,3]. The GEXL correlation calculates the critical quality as function of pressure, mass flux, boiling and annular lengths, R-factor and thermal diameter:

$$x_c = x_c(P, G, L_B, L_A, R, D_Q) \qquad (3\text{-}1)$$

Critical power or boiling transition is then determined as the condition where the equilibrium quality equals the critical quality:

$$x_e = x_c \qquad (3\text{-}2)$$

For a bundle with a power Q a typical equilibrium quality and critical quality as function of axial elevation may look as shown in Figure 3-1.

[[

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{3}]]

Figure 3-1. Typical Equilibrium Quality and Critical Quality for a Fuel Bundle

The critical power is then determined by increasing the power or heat flow to the fluid while all other parameters such as pressure, inlet fluid conditions and power shapes are kept constant. The equilibrium quality will increase as the heat flow to the fluid is increased. As a result of the increased quality, the boiling boundary, defined as the point where the equilibrium quality equals zero (x_e = 0.0) is reached at a lower elevation in the bundle. Similarly, the transition to annular flow, which is determined from the [[{3}]] correlation, will move downwards in the bundle as the heat flow and equilibrium quality is increased. Consequently, for a given elevation z, the boiling and annular lengths will increase, and there will be a corresponding increase in the critical quality. The power or heat flow to the fluid is increased until, at some point in the bundle, the equilibrium quality equals the critical quality. The power Q_c at this condition is the critical power. For a bundle with a critical power of Q_c, a typical equilibrium quality and critical quality as function of axial elevation may look as shown in Figure 3-2.

[[

{3}]]

Figure 3-2. Typical Equilibrium Quality and Critical Quality at Critical Power

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[[

{3}]]

It is convenient to introduce the following parameters: critical power ratio (CPR) and thermal margin (TM):

$$CPR = \frac{Q_c}{Q} \qquad (3\text{-}4)$$

$$TM = \frac{x_c + \frac{\Delta h_s}{h_{fg}}}{x_e + \frac{\Delta h_s}{h_{fg}}}, \qquad (3\text{-}5)$$

where Δh_s is the inlet subcooling. Note: $x_{inlet} = -\frac{\Delta h_s}{h_{fg}}$

From the above equations it is seen that critical power corresponds to CPR=1 and TM=1.

During a transient, the CPR is calculated as described in the TRACG Model Description, Section 7.5.5 [4]. [[

{3}]]

[[

[3]]]

Figure 3-3. Typical Relationship Between TM and CPR for Pressurization Transient

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[3]]]

4. Improved Process for the Calculation of Transient CPR

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{3}]]

An improved process for the calculation of the transient CPR has been developed for TRACG in order to reduce this error.

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5. Qualification

The improved process for the calculation of transient CPR has been extensively tested by comparisons to transient ATLAS tests and by comparison to the current method for typical plant cases.

Transient ATLAS tests

The transient ATLAS tests are designed to simulate the transient response of a fuel bundle during a typical pressurization event such as a turbine trip. [[

[3]]]

[[

[3]]]

Figure 5-1. Transient ATLAS Test ATA 127B R61 – GE11

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{3}]]

Figure 5-2. Transient ATLAS Test ATA 231C3 R209 – GE9

The MCPRs from the associated transient CPR calculations are shown in Table 5-1.

Table 5-1. MCPR for transient ATLAS Tests

[[

{3}]]

[[

{3}]]

Peach Bottom Turbine Trip 1.

Peach Bottom turbine trip 1, conducted at 47% power and 100% flow, is the test with the lowest power to flow ratio and, therefore, also the test with the highest ICPRs for the fuel bundles. Comparisons of the transient CPRs, calculated using the current process and the improved process for three different powered channels (ICPRs ranging from 2.4 to 3.8) are shown in Figures 5-3 to 5-4 and Table 5-2.

[[

{3}]]

Figure 5-3. Peach Bottom Turbine Trip 1 – Transient CPR

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{3}]]

Figure 5-3 Peach Bottom Turbine Trip 1 – ΔCPR/ICPR

Table 5-2 Peach Bottom Turbine Trip 1

[[

{3}]]

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{3}]]

TRACG AOO Application Methodology, NEDE32906P-A

A turbine trip event for Hatch 1 Cycle 14 was evaluated as a demonstration case in the TRACG AOO Application Methodology LTR [1]. The results are shown in Table 8-1 of Reference 1. This case has been repeated here and the results are shown in Table 5-3

Table 5-3 Hatch 1 Cycle 14 TTNB – Channel 27

[[

{3}]]

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{3}]]

Brunswick 1 Cycle 15

The sensitivity studies that led to the discovery of the sensitivity of the ΔCPR/ICPR to the ICPR for large ICPR have been repeated with the improved process for the transient CPR. These results are shown in Table 5-4.

Table 5-4. ΔCPR/ICPR Sensitivity to ICPR with Improved Process

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Comparing these results to Table 2-1, which contains the same cases for the current process, shows:

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{3}]]

6. Licensing Evaluation

The major conclusions from the previous sections are:

- [[
-
{3}]]

It is desirable to implement the improved process as an optional method for the transient CPR calculation due to the more consistent results obtained with this method. However before the improved process can be implemented, it must be determined whether review and approval by the USNRC is needed. A licensing evaluation following the 10CFR50.59 rules [8] and the NEI guidelines [9] is given in the following paragraphs. This licensing evaluation consists of a three-step process containing a determination of applicability, a screening, and an evaluation for NRC review.

Applicability

This step determines if an NRC approved methodology is involved. The TRACG application methodology is NRC approved and documented in Reference 1. Therefore the 10CFR50.59 rules apply.[1]

[1] If another regulation applied, such as 10CFR50.46 for loss of coolant accident analysis, the evaluation would have to be performed according to these rules. This is not the case for the TRACG application to AOO transients.

Screening

The screening is done to determine if the change is adverse and requires evaluation for NRC review. This screening consists of two parts.

Is the change within the constraints and limitations associated with the approved methodology? Section 2.6 In Reference 1, as approved by NRC, describes what changes can be made to TRACG without NRC review and what changes require NRC review and approval before they are implemented. This section is included in Appendix A.

Section 2.6.1 of Reference 1 states that changes to basic models may not be used in AOO licensing calculations without NRC review and approval, but changes to the numerical methods to improve code convergence may be used without NRC review and approval.. The improved process is considered a change to the numerical method, since the improved process does not involve a change in the critical power correlation, but only a change in the calculational process to determine the transient CPR. Therefore, the change is considered to be within the constraints and limitations of the approved methodology.

The second part involves a determination of whether the change has an adverse impact on critical safety parameters and if an evaluation for NRC review is required. Since the improved numerical method for the transient CPR calculation will change the results, no matter how small this change is, an evaluation for NRC review is required.

Evaluation

The evaluation involves a determination if the change is conservative or essentially the same. [[

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Consequently, it is concluded that the change in the process for the calculation of the transient CPR cannot be implemented without NRC review and approval.

7. Summary and Conclusion

An improved process for the calculation of transient CPR has been developed for TRACG. [[

{3}]]

A Licensing evaluation of the change has been performed, and it has been determined that the change cannot be implemented without NRC review and approval.

8. References

1. TRACG Application for Anticipated Operational Occurrences Transient Analysis, NEDE-32906P-A, Rev. 1, April 2003.

2. General Electric Thermal Analysis Basis (GETAB): Data Correlation and Design Application, NEDE-10958_PA, January 1977.

3. Letter, A. C. Thadani (NRC) to J. S. Charnley (GE), Acceptance for Referencing of Application of Amendment 15 to GE LTR NEDE-24011-P-A, "GE Standard Application for Reactor Fuel", MFN-47-87, March 14, 1988.

4. TRACG Model Description, NEDE-32176P, Rev 2, December 1999.

5. Qualification of the One-Dimensional Core Transient Model for Boiling Water Reactors, NEDE-24154-P-A, Volume 1, August 1986.
Qualification of the One-Dimensional Core Transient Model for Boiling Water Reactors, NEDE-24154-P-A, Volume 2, August 1986.
Qualification of the One-Dimensional Core Transient Model for Boiling Water Reactors, NEDE-24154-P-A, Volume 3, August 1988.

6. TASC03A, A Computer Program for Transient Analysis of a Single Channel, NEDC-32084P-A, July 2002.

7. TRACG Qualification, NEDE-32177P, Rev 2, January 2000.

8. NRC Regulations, Title 10, Code of Federal regulations Part 50, Section 59, "Changes, Tests and Experiments", 10CFR50.59 December 14, 2001.

9. Guide Lines for 10CFR50.59 Implementation, NEI 96-07, Revision 1 [Final Pre-Publication Draft], September 22, 2000.

10. Methodology and Uncertainties for Safety Limit SMLCPR Evaluations, NEDC-32601P-A, August 1999.

Appendix A. NEDE-32906P-A, Section 2.6

2.6 Review Requirements For Updates

In order to effectively manage the future viability of TRACG for AOO licensing calculations, GE proposes the following requirements for upgrades to the code to define changes that (1) require NRC review and approval and (2) that will be on a notification basis only.

2.6.1 Updates to TRACG Code

Modifications to the basic models described in Reference 4 may not be used for AOO licensing calculations without NRC review and approval.

Updates to the TRACG nuclear methods to ensure compatibility with the NRC-approved steady-state nuclear methods (e.g., PANAC11) may be used for AOO licensing calculations without NRC review and approval as long as the ΔCPR/ICPR, peak vessel pressure, and minimum water level shows less than 1 sigma deviation difference compared to the method presented in this LTR. A typical AOO in each of the event scenarios will be compared and the results from the comparison will be transmitted for information.

Changes in the numerical methods to improve code convergence may be used in AOO licensing calculations without NRC review and approval.

Features that support effective code input/output may be added without NRC review and approval.

2.6.2 Updates to TRACG Model Uncertainties

New data may become available with which the specific model uncertainties described in Section 1 may be reassessed. If the reassessment results in a need to change specific model uncertainty, the specific model uncertainty may be revised for AOO licensing calculations without NRC review and approval as long as the process for determining the uncertainty is unchanged.

The nuclear uncertainties (void coefficient, Doppler coefficient, and scram coefficient) may be revised without review and approval as long as the process for determining the uncertainty is unchanged. In all cases, changes made to model uncertainties done without review and approval will be transmitted for information.

2.6.3 Updates to TRACG Statistical Method

Revisions to the TRACG statistical method described in Section 1 may not be used for AOO licensing calculations without NRC review and approval.

2.6.4 Updates to Event Specific Uncertainties

Event specific ΔCPR/ICPR, peak pressure, and water level biases and uncertainties will be developed for AOO licensing applications based on generic groupings by BWR type and fuel type. These biases and uncertainties do not require NRC review and approval. The generic uncertainties will be transmitted to the NRC for information.

ENCLOSURE 3

MFN 04-082

AFFIDAVIT

General Electric Company

AFFIDAVIT

I, Jason S. Post, state as follows:

(1) I am the Manager, Engineering Quality & Safety Evaluations, 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 the attachment, TRACG Model Description, NEDE-32176P Rev. 2, Supplement 1, August 2004. The proprietary information is indicated by enclosing it inside double square brackets. Figures and large equation objects are identified with double square brackets before and after the object. 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 2.390(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 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 2.390 (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 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 of analytical models, methods and processes, including description of computer codes which would provide other parties, including competitors, with information related to GE analytical methods, analysis results and potential commercial offerings for the BWR plant design, which were developed at a considerable expense to GE.

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 31 day of August 2004.

Jason S. Post

Jason S. Post
General Electric Company

ENCLOSURE 1 - Compact Disk

MFN 04-082

Transient CPR Calculation for TRACG (TRACG Model Description, NEDE-32176P, Rev. 2, Supplement 1, August 2004) - GE Proprietary Information

PROPRIETARY INFORMATION NOTICE

This enclosure contains proprietary information of the General Electric Company (GE) and is furnished in confidence solely for the purpose(s) stated in the transmittal letter. No other use, direct or indirect, of the document or the information it contains is authorized. Furnishing this enclosure does not convey any license, express or implied, to use any patented invention or, except as specified above, any proprietary information of GE disclosed herein or any right to publish or make copies of the enclosure without prior written permission of GE. The header of each page in this enclosure carries the notation "GE Proprietary Information."

GE proprietary information is identified by double square brackets. In each case, the superscript notation{3} refers to Paragraph (3) of the affidavit provided in Enclosure 4, which documents the basis for the proprietary determination. [[This sentence is an example.{3}]] Specific information that is not so marked is not GE proprietary.