ENCLOSURES 2 AND 5 CONTAIN PROPRIETARY INFORMATION WITHHOLD FROM PUBLIC DISCLOSURE IN ACCORDANCE WITH 10 CFR 2.390

Xcel Energy®

Monticello Nuclear Generating Plant
2807 W County Rd 75
Monticello, MN 55362

December 21, 2012

L-MT-12-108
10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Monticello Nuclear Generating Plant
Docket 50-263
Renewed License No. DPR-22

Subject: Maximum Extended Load Line Limit Analysis Plus License Amendment Request - Request for Additional Information Responses for TRACE/TRACG Differences (TAC ME3145)

References:
1) Letter from T J O'Connor (NSPM), to Document Control Desk (NRC), "License Amendment Request: Maximum Extended Load Line Limit Analysis Plus," L-MT-10-003, dated January 21, 2010. (ADAMS Accession No. ML100280558)
2) Email from T Beltz (NRC) to J Fields (NSPM), et al, "Monticello Nuclear Generating Plant - Draft Request for Additional Information re: MELLLA+ License Amendment Review (TAC No. ME3145)," dated October 4, 2012. (ADAMS Accession No. ML12279A224)
3) Email from T Beltz (NRC) to J Fields (NSPM), et al, "Monticello Nuclear Generating Plant - Draft Requests for Additional Information re: MELLLA+ License Amendment Request Review (TAC No. ME3145) - Revision 1," dated November 8, 2012. (ADAMS Accession No. ML12319A179)

In Reference 1, Northern States Power Company, a Minnesota corporation (NSPM), doing business as Xcel Energy, requested approval of an amendment to the Monticello Nuclear Generating Plant (MNGP) Renewed Operating License (OL) and Technical Specifications (TS). The proposed change would allow operation in the expanded Maximum Extended Load Line Limit Analysis Plus (MELLLA+) domain.

In Reference 2 the NRC provided a series of Requests for Additional Information (RAIs) pertaining to differences the NRC identified between TRACE and TRACG codes related

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to the transition to stable film boiling (the "T_{min} correlation") and the quenching methodology.

On October 16, 2012 the NRC held a conference call with NSPM and General Electric – Hitachi (GEH) concerning the RAIs provided in Reference 2. During the conference call GEH described several published reports available in the public domain that addressed many of the questions the NRC had related to these correlations. Subsequently, NSPM provided at the NRC's request, the discussed published reports.

Based on these responses, the NRC held an audit of GEH (on October 24 – 25, 2012) where further discussions were held regarding the application of these methods in the TRACG and TRACE codes.

Upon completion of the audit, the NRC issued new RAIs in Reference 3 to complete their documentation needs. The RAIs provided in Reference 3 include NRC requests for augmented information relative to the T_{min} correlation and the quenching methodology.

Enclosure 1 to the letter provides the responses to the RAIs provided in Reference 2. Specific technical documents cited in the response were provided to the NRC via email as these documents are available in the public domain. These technical documents are not reproduced in Enclosure 1. The responses to Reference 2 are non-proprietary.

Enclosure 2 to the letter provides the responses to the RAIs provided in Reference 3. These responses contain proprietary information to GEH. The response to RAI No. 5 provides a revised peak clad temperature (PCT) value for the anticipated transients without scram with instability (ATWSI) event that exceeds the PCT value previously provided to the NRC in Reference 1. The result in RAI No. 5, case No.3 represents the revised bounding PCT value for the ATWSI event under MELLLA+ conditions.

Enclosure 3 to the letter provides a non-proprietary version of the responses to the RAIs provided in Reference 3. The non-proprietary version of the RAI responses is being provided based on the NRC's expectation that the submitter of the proprietary information should provide, if possible, a non-proprietary version of the document with brackets showing where the proprietary information has been deleted.

Enclosure 4 contains an affidavit executed to support withholding Enclosures 2 and 5 from public disclosure. Enclosures 2 and 5 contain proprietary information as defined by 10 CFR 2.390. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the NRC and addresses with specificity the considerations listed in 10 CFR 2.390(b)(4). Accordingly, NSPM respectfully requests that the proprietary information in Enclosures 2 and 5 be withheld from public disclosure in accordance with 10 CFR 2.390(a)4, as authorized by 10 CFR 9.17(a)4.

Correspondence with respect to the copyright or proprietary aspects of GEH information or the supporting GEH affidavit in Enclosure 4 should be addressed to Francis T.

Bolger, Manager, New Product Introduction, GE Hitachi Nuclear Energy, 3901 Castle Hayne Road, Wilmington, NC 28401.

Enclosure 5 provides a compact disc (CD), entitled "GE-MNGP-AEP-3223, Enclosure 2" containing data requested by the NRC to support responses to RAI 4 in Enclosure 2. The entire contents of the CD are considered proprietary information. As such this information is also covered by the affidavit provided by GEH in Enclosure 4.

This letter makes no new commitments and no revisions to existing commitments. I declare under penalty of perjury that the foregoing is true and correct.

Executed on: December 21, 2012

Mark A. Schimmel
Site Vice-President
Monticello Nuclear Generating Plant
Northern States Power Company-Minnesota

Enclosures (5)

cc: Regional Administrator, Region III, USNRC (w/o enclosures)
Project Manager, Monticello Nuclear Generating Plant, USNRC
Resident Inspector, Monticello Nuclear Generating Plant, USNRC (w/o enclosures)
Minnesota Department of Commerce (w/o enclosures)

ENCLOSURE 1

RESPONSES TO NRC REQUEST FOR ADDITIONAL INFORMATION DATED OCTOBER 4, 2012

5 pages follow

REQUEST FOR ADDITIONAL INFORMATION

RELATING TO MONTICELLO LICENSING AMENDMENT REQUEST

FOR MAXIMUM LOAD LINE LIMIT ANALYSIS PLUS

NORTHERN STATES POWER COMPANY – MINNESOTA

MONTICELLO NUCLEAR GENERATING PLANT

DOCKET NO. 50-263

The NRC staff has performed a series of confirmatory calculations for ATWSI (anticipated transients without scram with instability) using the TRACE/PARCS code. These calculations have identified difference between TRACE and TRACG related to the transition to stable film boiling (the "T_{min} correlation").

TRACE uses a T_{min} correlation that predicts significantly lower temperatures for stable film boiling than the correlation used by TRACG. The impact is significant, because the TRACE confirmatory calculations for a generic BWR5 showed failure to rewet followed by fuel failure (Tclad >2200°F), while the TRACG calculations show clad rewet and that fuel integrity is maintained.

The NRC staff needs to review, in more detail, the available data supporting the applicability of the TRACG correlation. Of special interest is the range of applicability. These correlations were developed primarily to support LOCA conditions, where the power generation is minimal (decay heat) and the pressure is low. The staff needs to ensure that the correlation is applicable to power conditions at full pressure. Emphasis must be provided on the availability of data and its range of applicability.

In addition to the T_{min} correlation issue, the NRC staff's confirmatory calculations uncovered a second methodology difference related to the quenching of the vapor film after it forms. The quenching mechanism is by removing heat through axial conduction when the thermal hydraulic conditions of the coolant allow it (e.g., in the down side of the power-flow oscillations). The TRACE quenching model predicts that quenching essentially does not occur while the rods are at power and the vapor film remains stable during the oscillations. The TRACG quenching model, however, predicts that there is sufficient heat conducted axially through the clad to lower the surface temperature, thus eliminating the stable vapor film and increasing the heat transfer. As with the Tmin correlation issue, the NRC staff needs to review the available benchmark data to validate the TRACG quenching models, and the range of applicability of this data.

Based on the results of the NRC staff's confirmatory analyses, areas of concern were identified that require clarification by the Monticello Nuclear Generating Plant licensee.

1. Provide a short description of the GEH T_{min} and quenching methodology. Specifically,
   a. What correlations are used?
   b. What options can be used (e.g., void dependencies...)?
   c. How the quenching is modeled?
2. T_{min} benchmark data
   a. What experimental data supports the T_{min} correlation?
   b. What is the range of applicability?
3. Quenching benchmark data
   a. What experimental data supports the methodology?
   b. Any previous work in the open literature?
   c. What is the range of applicability?

NRC Question

1. Provide a short description of the GEH T_{min} and quenching methodology. Specifically,

   a. What correlations are used?

GEH Response

The Shumway correlation for the minimum film boiling temperature is used and is documented in NEDE-32176P, Revision 4, Section 6.6.7. See also the discussion of this model in NEDE-32906P Supplement 3-A, Revision 1, Section 4.1, and in Section 3.7 of the embedded NRC safety evaluation.

The axial conduction quenching model is documented in NEDE-32176P, Revision 4, Section 6.6.13. See also the discussion of this model in NEDE-32906P Supplement 3-A, Revision 1, Section 4.1, and in Section 3.5 of the embedded NRC safety evaluation. The model is adopted from the approved SAFER/CORCL LOCA model NEDE-30996P-A, Volume 1, Section 5.2.6.4.

NRC Question

   b. What options can be used (e.g., void dependencies...)?

GEH Response

There is an option in TRACG04 to use either the homogeneous nucleation model, the maximum of the homogeneous nucleation model and the Iloeje correlation, or the Shumway correlation for T_{min}. The Shumway correlation is the recommended model in the TRACG04 User's Manual. GEH has furthermore implemented an option in the Shumway correlation to disable the void fraction dependence due to the limited qualification of this dependence.

NRC Question

   c. How the quenching is modeled?

GEH Response

Quenching when the wall temperature drops below the minimum film boiling temperature is modeled with the transition boiling model, which is documented in NEDE-32176P, Revision 4, Section 6.6.8.

Quench front propagation is implemented by adding the heat transfer due to axial conduction as calculated from the correlation to the heat balance for the node containing a quench front.

NRC Question

2. T_{min} benchmark data

   a. What experimental data supports the T_{min} correlation?

GEH Response

The experimental data supporting the Shumway correlation are documented in EGG-RST-6781.

NRC Question

   b. What is the range of applicability?

GEH Response

The range of applicability for the Shumway correlation is documented in EGG-RST-6781. This includes pressures from 0.4 - 6.9 MPa and Reynolds numbers from 0.1 - 7.0E5. ORNL data reported in EGG-RST-6781 contained data up to 9 MPa, but were not used in the determination of the mean bias and standard deviation for the Shumway correlation due to uncertainty in the exact pressure for the data points.

NRC Question

3. Quenching benchmark data

   a. What experimental data supports the methodology?

GEH Response

The experimental data supporting the axial conduction controlled quenching model is documented in NEDE-30996P-A, Volume 1, Section 5.2.6.4.

Qualification of the rewetting model has been done primarily through transient flow oscillation tests at normal reactor operational pressure such as the tests documented in NEDE-32177P, Revision 3, Section 3.6.1, core spray heat transfer tests such as the tests documented in NEDE-32177P, Revision 3, Section 3.2.2, and Integral LOCA simulation tests such as the tests documented in NEDE-32177P, Revision 3, Sections 5.1 through 5.6.

NRC Question

   b. Any previous work in the open literature?

GEH Response

Numerous references from the open literature supporting the Shumway minimum film boiling correlation are documented in EGG-RST-6781. There are many references for axial conduction controlled quenching in the open literature including:

- Yamanouchi, "Effect of core spray cooling in transient state after loss of coolant accident", Journal of Nuclear Science and technology 5(11), p. 547-558, 1969.
- T. S. Thompson, "On the process of rewetting a hot surface by a falling liquid film", Nuclear Engineering and Design 31(1974) 234-245.
- K. H. Sun, G. E. Dix and C. L. Tien, "Effect of precursory cooling on falling-film rewetting", Journal of Heat Transfer, 1975.

NRC Question

   c. What is the range of applicability?

GEH Response

The axial conduction controlled quenching model was developed in the 1970s in support of LOCA applications and is based primarily on reflood data and top down quenching by falling liquid films at low pressure.

ENCLOSURE 3

RESPONSES TO NRC REQUEST FOR ADDITIONAL INFORMATION DATED NOVEMBER 8, 2012 – NON-PROPRIETARY

23 pages follow

REQUEST FOR ADDITIONAL INFORMATION
RELATING TO THE LICENSE AMENDMENT REQUEST
FOR MAXIMUM LOAD LINE LIMIT ANALYSIS PLUS (MELLLA+)
NORTHERN STATES POWER COMPANY – MINNESOTA (NSPM)
MONTICELLO NUCLEAR GENERATING PLANT (MNGP)
DOCKET NO. 50-263
TAC NO. ME3145

On October 24-25, 2012, the U.S. Nuclear Regulatory Commission (NRC) staff performed an audit at GE-Hitachi Nuclear Americas (GEH) with respect to T_{min} and quenching methodologies, and identified that additional information is needed for the staff to complete its review of the MNGP MELLLA+ license amendment request. The requests for additional information are provided below.

RAI 1

For a typical quench front calculated by TRACG04 for representative ATWSI [anticipated transients without scram with instability] conditions, provide the heat rate to the liquid and vapor state and the quench component of the heat rate. Compare with the measured heat rate values published by Thompson in NED 1974, "On the Process of Rewetting a Hot Surface by a Falling Liquid."

RAI 2

Provide a detailed description of the TRACG implementation of the quench front model.

Provide a numerical comparison of the heat transfer coefficients used by TRACG downstream of the front and "normal" coefficients in nucleate boiling.

RAI 3

Generate TRACG quench model inputs for a number of Halden dryout experiments and provide a comparison of the results to validate the quench front velocity model at high power and pressures.

RAI 4

Provide the TRACG input decks for the Halden experiments including the digitized data from the experiments used to compare the results. In addition, please provide the TRACG output file and CEDAR file (in ascii if possible).

RAI 5

Reproduce the ATWSI calculations for MNGP with and without applying the void and the Zr credit in the Shumway T_{min} correlation using the latest version of the TRACG code.

Provide a comparison of results.

Provide a plot that shows the hot rod clad temperature on the same plot as the calculated T_{min} as function of time.

Provide a comparison for the variables shown in Figs 9-12 through 9-14 of NEDC-33435P, Revision 1.

NRC RAI 1

For a typical quench front calculated by TRACG04 for representative ATWSI [anticipated transients without scram with instability] conditions, provide the heat rate to the liquid and vapor state and the quench component of the heat rate. Compare with the measured heat rate values published by Thompson in NED 1974, "On the Process of Rewetting a Hot Surface by a Falling Liquid."

GEH Response

The requested plots are provided based on Halden Experiment 4 TRACG run from RAI 3 (See Figure 3-3). Figure 1-1 shows the heat rate to the liquid and vapor and the quench heat rate for heated Node 36 (Location of the upper temperature measurement). [[

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The T. S. Thompson paper, listed in the RAI, evaluates the heat transfer at the quench front. Note that the paper used in this RAI (Reference 1-1) is the paper noted on the footnote on page one of the T. S. Thompson paper listed in the RAI, as a better copy of the reference paper was available. Figures 13 and 14 show the heat flux in the vicinity of the interface (quench front) for variations in pressure and downstream temperature. This shows that the quench front is a "high-heat-flux zone" with heat flux as high as 30 times the liquid heat flux just 0.12 inches (0.3 cm) from the quench front.

The TRACG quench model predicts [[

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Figure 1-1 Quench Heat Rate – Node 13

References

1-1. T. S. Thompson, AECL-4516, “On the Process of Rewetting a Hot Surface By a Falling Liquid Film,” Atomic Energy of Canada Limited, June 1973.

NRC RAI 2

Provide a detailed description of the TRACG implementation of the quench front model.

Provide a numerical comparison of the heat transfer coefficients used by TRACG downstream of the front and "normal" coefficients in nucleate boiling.

GEH Response

TRACG Quench Front Model Implementation

The TRACG model for the axial conduction controlled quench front propagation is documented in the TRACG Model Description (Reference 2-1) Section 6.6.13. It simulates the one- and two-dimensional solutions of References 2-2 and 2-3 and was retained from TRAC-P1A (References 2-4, 2-5, 2-6), which was the starting point for the development of the BWR versions of TRAC and TRACG. The model is based on a solution of the two-dimensional heat conduction in the cladding around the quench front location. Figure 2-1 is an illustration of the temperature profile and heat conduction at a quench front.

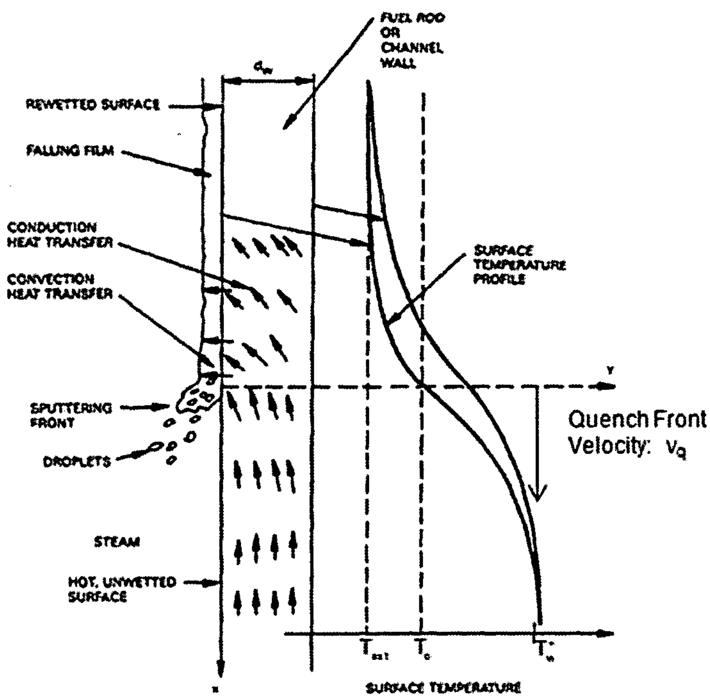

Figure 2-1. Axial Conduction Controlled Quenching

Ahead of or downstream of the quench front the wall is in film boiling at a high temperature T_w^+, the wall surface temperature is equal to the quench front temperature T_o at the quench front, and behind or upstream of the quench front, the wall temperature quickly approaches the saturation temperature. Heat is conducted axially in the wall due to the temperature gradient from the downstream to the upstream region, and outwards to the liquid in the upstream region. The quench front model correlates the total heat transfer to the liquid upstream of the quench front due to this heat transfer at the quench front. The total heat transfer per unit perimeter to the fluid behind quench front due to the two dimensional heat conduction in the cladding, axially from the dry to the quenched regions and radially to the fluid in the in the quenched region, is given by Equation 2-1.

$$q'_q = k_w (T_w^+ - T_{sat}) \left(\overline{Bi}(1 + 0.4\overline{Bi}) \right)^{0.5}, \qquad (2\text{-}1)$$

In this equation the modified Biot number $\overline{Bi}$ is given by Equations 6.6-153 – 6.6-156 in the TRACG Model Description (Reference 2-1).

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For conditions where the energy generation in the fuel rod is small, [[ ]], and the quench front propagation velocity v_q is given by:

$$q'_q = v_q \rho_w c_{pw} d_w (T_w^+ - T_{sat}) \qquad (2\text{-}3)$$

Combining Equations 2-1 and 2-3 gives:

$$v_q = \frac{k_w}{\rho_w c_{pw} d_w} \left(\overline{Bi}(1 + 0.4\overline{Bi}) \right)^{0.5}, \qquad (2\text{-}4)$$

which is identical to Equation 6.6-152 in Reference 2-1.

Equation 2-3 together with measured quench front propagation velocities for conditions where the energy generation rate is small have been used to correlate the quench front temperature T_o and the heat transfer coefficient h_q immediately behind the quench front. These values are documented in Reference 2-1.

Heat Transfer Coefficients for Halden Test 4

Halden Test 4 (Reference 2-7) is used to illustrate the heat transfer coefficients around the quench front. [[

]]. The heat transfer coefficients in the upstream and downstream of the quench front are shown in Table 2-1.

Table 2-1. Heat Transfer Coefficients in the Upstream and Downstream of the Quench Front for Halden Test 4 at t = 62.1 sec.

Node	Heat Transfer Coefficient, W/m^2-K	
32	[[ ]]	Upstream
33	[[ ]]	
34	[[ ]]	
35	[[ ]]	
36	[[ ]]	Quench Front Location
37	[[ ]]	Downstream
38	[[ ]]	

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]]. This heat transfer coefficient[1] h_q, which is used in the Biot Number given by Equation 6.6-154 of Reference 2-1, is calculated by Equation 2-5 which has been retained fromTRAC-P1A and TRAC-BD1 (References 2-4, 2-5, 2-8),

[1] In the preparation of this response to this RAI, an error in Equation 6.6-158 of Reference 2-1 was discovered. Equation 2-5 is consistent with the coding in TRACG04 and the original coding from TRAC-P1A. Equation 6.6-158 will be corrected in the next revision of Reference 2-1

which also employed Equation 2-1 for the calculation of the quench front propagation, and it is based on FLECHT reflood data:

$$h_q = \begin{cases} 4.2 \cdot 10^8 v_r^{0.992} (T_o - T_{sat})^{-0.616} & \text{for } v_r > 0.0092 \\ 1.8 \cdot 10^9 v_r^{0.56} (T_o - T_{sat})^{-1.48} & \text{for } v_r < 0.0092 \end{cases}, \qquad (2\text{-}5)$$

where v_r is the reflood velocity obtained from the liquid velocity upstream of the quench front. The high value of the quench front heat transfer coefficient is consistent with the observations in Reference 2-9. These models for the quench front heat transfer coefficient and the total quench front heat transfer have been used in the qualification against the Halden Tests as documented in the response to RAI 3.

References

2-1 "TRACG Model Description," NEDE 32176P, Revision 4, January 2008.

2-2 F. D. Shum et. al., "SAFER Model for Evaluation of Loss-of-Coolant Accidents for Jet Pump and Non-Jet Pump Plants," NEDE-30996P-A, GE Proprietary Report, October 1987.

2-3 C. L. Tien and L. S. Yao, "Analysis of Conduction-Controlled Rewetting of a Vertical Surface," Journal of Heat Transfer, May 1975, pp. 161-165.

2-4 "TRAC-P1A: An Advanced Best-Estimate Computer Program for PWR LOCA Analysis," NUREG/CR-0665, Los Alamos Scientific Laboratory, May 1979.

2-5 "TRAC-BD1: An Advanced Best-Estimate Computer Program for Boiling Reactor Loss-of-Coolant Accident Analysis," NUREG/CR-2178, October 1981.

2-6 S. S. Dua and C. L. Tien, "A generalized Two-Parameter Relation for Conduction Controlled Rewetting of a Hot Vertical Surface," International Journal of Heat and Mass Transfer, Vol. 20, pp. 174-176, 1977.

2-7 R. Ianiri, "The Third Dryout Fuel behavior Test Series in IFA-613," HWR-552, February 1998.

2-8 S. K. W. Yu, P. R. Farmer and M. W. Coney, "Methods and Correlations for the Prediction of Quenching Rates on Hot Surfaces," International Journal of Multiphase Flow, 3, 1977, pp. 415-443.

2-9 T. S. Thompson, "On the Process of rewetting a Hot Surface by a Falling Liquid Film," Nuclear Engineering and Design 31, 1974, pp. 234-245.

NRC RAI 3

Generate TRACG quench model inputs for a number of Halden dryout experiments and provide a comparison of the results to validate the quench front velocity model at high power and pressures.

GEH Response

TRACG input models were created to augment the validation basis of the TRACG quench front heat transfer model by simulating a few Halden Third-Series experiments (Reference 3-1). They are performed with actual fuel rods with Zircaloy cladding, at high power, and at high pressure (around 7 MPa). In addition, quenching is observed at temperatures above TRACG-calculated T_{min}.

The four Halden experiments that resulted in quenching from elevated temperature (>650 °C) are simulated with TRACG. They are experiments 3, 4, 11c, and 12. Unless noted otherwise, all TRACG cases are performed with the quench model on and with the modified (no void term) Shumway correlation for T_{min}. The Shumway correlation is documented in Reference 3-2.

Experiment 3

The flow input and PCT result are shown in Figures 3-1 and 3-2. The results show that the TRACG quenching occurs similar to the test. The timing of the start of boiling transition is delayed compared to the test, but this can be expected given test measurement uncertainty (power, flow, temperature, etc.). However, to assess the quench at the higher test temperatures, [[

]] The results show good agreement in the quench.

Experiment 4

The flow input and PCT result are shown in Figure 3-3 and 3-4. The results show that the TRACG quenching occurs similar to the test.

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Several cases were performed to assess the effect of turning off the TRACG quench model and lowering the T_{min} compared to the modified Shumway T_{min}. T_{min} is lowered by multiplying ($T_{min} - T_{sat}$) by 0.69, an estimated factor that accounts for Inconel wall properties rather than zircaloy. Figure 3-7 shows the PCT results. [[

]] This shows the importance of using the TRACG quench model which predicts the experimental data very well.

Experiment 11c

Experiment 11 involved a series of 6 dryout tests. Rather than attempt to model the series, only the dryout that resulted in the highest temperature is assessed. This portion of the test occurred between 900 and 1000 seconds and is called Test 11c.

[[ ]] The TRACG flow rate input is estimated to result in similar PCT heatup.

The flow input and PCT result are shown in Figures 3-8 and 3-9. The results show that the TRACG quenching occurs similar to the test.

Experiment 12

The flow input and PCT result are shown in Figures 3-10 and 3-11. [[ ]] the TRACG flow rate input is estimated to result in similar PCT heatup. The results show that the TRACG quenching occurs similar to the test.

To show the strong sensitivity of flow on the results and [[ ]] Figure 3-11 shows the assumed flow rates that resulted in the PCTs in Figure 3-10. [[ ]]

Several cases were performed to assess the effect of turning off the quench model and lowering T_{min}. T_{min} is lowered by multiplying (T_{min} – T_{sat}) by 0.69, an estimated factor that accounts for Inconel wall properties rather than zircaloy. Figure 3-12 shows the PCT results. [[ ]] Again, it shows that use of the TRACG quench model is needed for a reasonable agreement with test data.

In summary, the above TRACG comparison to the Halden experiments further validates the TRACG quench model at ATWS with instability conditions.

References

3-1 HWR-552, "OECD Halden Reactor Project – The Third Dryout Fuel Behaviour Test Series in IFA-613," February 1998.

3-2 R.W. Shumway, "TRAC-BWR Heat Transfer: Assessment of Tmin," EGG-RST-6781, January 1985.

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Figure 3-1. TRACG PCT Results Compared to Test 3

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Figure 3-2. TRACG Inlet Flow Inputs for Test 3

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Figure 3-3. TRACG PCT Results Compared to Test 4

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Figure 3-4. TRACG Inlet Flow Inputs for Test 4

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Figure 3-5. TRACG PCT Results Compared to Test 4 – Nodalization Study

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Figure 3-6. TRACG Quench Front Elevation – Nodalization Study

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Figure 3-7. TRACG PCT Results Compared to Test 4 – Effects of Quench Model and T_{min} Model

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Figure 3-8. TRACG PCT Results Compared to Test 11

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Figure 3-9. TRACG Inlet Flow Inputs for Test 11

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Figure 3-10. TRACG PCT Results Compared to Test 12

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Figure 3-11. TRACG Inlet Flow Inputs for Test 12

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Figure 3-12. TRACG PCT Results Compared to Test 12 – Effects of Quench Model and T_{min} Model

NRC RAI 4

Provide the TRACG input decks for the Halden experiments including the digitized data from the experiments used to compare the results. In addition, please provide the TRACG output file and CEDAR file (in ascii if possible).

GEH Response

The following files, which are in ASCII format, are provided on the Enclosure 2 CDROM. Descriptions of variables are contained in the TRACG User's Manual, Reference 4-1, which is also provided on the Enclosure 2 CDROM. The entirety of the content of all of the data files on the CDROM is Proprietary.

Case	Steady-State Basedeck	Transient Input File	Transient Output File	Transient Graphics File
03	RUN_SS03.BDK	TRANS_RUN03.INP	RUN_TR03.OUT	RUN_TR03-GTRAC.GRA
04	RUN_SS04.BDK	TRANS_RUN04.INP	RUN_TR04.OUT	RUN_TR04-GTRAC.GRA
11	RUN_SS11.BDK	TRANS_RUN11.INP	RUN_TR11.OUT	RUN_TR11-GTRAC.GRA
12	RUN_SS12.BDK	TRANS_RUN12.INP	RUN_TR12.OUT	RUN_TR12-GTRAC.GRA

In addition, the file PCT_Experiment.txt is provided that contains the measured clad temperatures extracted from the test report for the four experiments of interest.

The PCT is taken from 5 centimeters from the top of the heated portion of the rod. This corresponds to TRACG parameter RODT230136 for Cases 3 and 4 that use the fresh-fuel rod model and to RODT230138 for Cases 11 and 12 that use the irradiated rod model.

It is noted that the TRACG initial time corresponds to different experiment times:

- Experiment 3 test time of 15.0 seconds corresponds to a TRACG time of 0.0 seconds
- Experiment 4 test time of 30.0 seconds corresponds to a TRACG time of 0.0 seconds
- Experiment 11c test time of 930.0 seconds corresponds to a TRACG time of 930.0 seconds. However, the TRACG input conditions prior this time differ. TRACG assumes steady conditions prior to this time.
- Experiment 12 test time of 40.0 seconds corresponds to a TRACG time of 40.0 seconds. However, the TRACG input conditions prior this time differ. TRACG assumes steady conditions prior to this time.

References

4-1 TRACG04P User's Manual, eECPER 0000-0009-7189-03, December 2011.

NRC RAI 5

Reproduce the ATWSI calculations for MNGP with and without applying the void and the Zr credit in the Shumway T_{min} correlation using the latest version of the TRACG code.

Provide a comparison of results.

Provide a plot that shows the hot rod clad temperature on the same plot as the calculated T_{min} as function of time.

Provide a comparison for the variables shown in Figs 9-12 through 9-14 of NEDC-33435P, Revision 1.

GEH Response

The TRACG04 ATWSI Turbine Trip with Full Bypass calculation presented in Figures 9-12 through 9-14 of NEDC-33435P, Revision 1 is reproduced with the latest version of TRACG04. There has been a TRACG04 version change since the cases were run and the cases presented in NEDC-33435P, Revision 1 have a relatively coarse graphics interval (the time interval for graphical data output); therefore, all the comparison plots shown below are between runs made with the latest version of TRACG04. Note that a special version of TRACG04 is created to enable the requested Shumway sensitivity to be performed and all cases discussed use the [[ ]] and some form of the Shumway Minimum Stable Film Boiling Temperature (T_{min}) correlation (Reference 5-1).

Three cases are run in this sensitivity. Case 1, Shumway, is a reproduction of the case in NEDC-33435P, Revision 1. Case 2, Shumway – No Void, uses the Shumway T_{min} correlation without the void dependence term applied (See Equation 19 of Reference 5-1) and uses Zr properties in the Shumway Beta term. Case 3, Shumway – No Void, SS304 Properties, uses the Shumway T_{min} correlation without the void dependence term and uses Stainless Steel 304 (SS304) material properties in the Shumway Beta Term (See Equation 10 and 19 in Reference 5-1). Use of the SS304 properties lowers the T_{min} value relative to using the Zr material properties.

Table 5-1 shows the Peak Cladding Temperature (PCT) results for the cases run for this RAI and the result shown in Table 9-5 of NEDC-33435P, Revision 1. [[

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Table 5-1 T_{min} Sensitivity Results

Case	Case Description	Peak Cladding Temperature °F (K), Limit 2200°F
Original	NEDC-33435P	[[ ]]
1	Latest TRACG, Shumway	[[ ]]
2	Latest TRACG, Shumway – No Void	[[ ]]
3	Latest TRACG, Shumway – No Void, SS304 Properties	[[ ]]

Figures 5-1 through 5-3 show the requested T_{min} sensitivities. Figures 5-1 and 5-2 show that the [[ ]] Figure 5-3 shows that the [[ ]] The Beta term is related to the interface temperature between the liquid and wall at the conditions that maintain stable film boiling. Reference 5-2 includes several different types of wall and material properties and provides a basis for the Beta term used in Shumway. [[ ]] Given that dependence on the Beta term is supported by the data in Reference 5-2 the use of the Shumway correlation with Stainless steel material properties is considered a bounding sensitivity.

Figure 5-4 shows the fuel rod surface temperature and T_{min} at Node 13 of the hot fuel rod in Channel 112 for the three Shumway sensitivity cases. [[

]]

Figure 5-5 shows the fuel rod surface temperature and T_{min} value at Node 21 of the hot fuel rod in Channel 112 for the Shumway – No Void and the No Void, SS304 Properties cases. The figure also shows the elevation of the quench front for the hot fuel rod in the two cases. [[

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Figure 5-1 T_{min} Sensitivity Results – Core Power

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Figure 5-2 T_{min} Sensitivity Results – Hot Channel Power

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Figure 5-3 T_{min} Sensitivity Results – Channel 112 PCT

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Figure 5-4 T_{min} Sensitivity Results – Node 13

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Figure 5-5 T_{min} Sensitivity Results – Node 21

References

5-1. R. W. Shumway, EGG-RST-6781, "TRAC-BWR Heat Transfer: Assessment of Tmin," January 1985.

5-2. Robert E. Henry, "A Correlation for the Minimum Film Boiling Temperature," Heat Transfer-Research and Design, AIChE Symposium Series No. 138, Vol. 70.

ENCLOSURE 4

GENERAL ELECTRIC – HITACHI AFFIDAVIT FOR WITHHOLDING PROPRIETARY INFORMATION

3 pages follow

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Francis T. Bolger, state as follows:

(1) I am Manager, New Product Introduction, 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 Enclosures 1 and 2 (CDROM) of GEH letter GE-MNGP-AEP-3223, L King (GEH) to J Bjorseth (NSPM), Subject: Response to Monticello Nuclear Generating Plant - Draft Requests for Additional Information re: MELLLA+ License Amendment Request Review (TAC No. ME3145) - Revision 1, dated December 14, 2012. In Enclosure 1, GEH proprietary text is identified by dark red text inside double square brackets. [[This sentence is an example.{3}]] Figures and large objects containing proprietary information are identified with double square brackets before and after the object. The label of the CDROM carries the notation "GEH Proprietary Information - Class III (Confidential) {3}. Enclosure 2 (CDROM) is Proprietary in its entirety. 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;

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) is classified as proprietary because it contains a detailed description, including the process and methodology, for application of TRACG to the performance of evaluations for BWRs. The development, reporting, evaluation and interpretations of the results, as they relate to the BWR was achieved at a significant cost to GEH or its licensor.

The development of this methodology, along with the testing, development and approval of the methodology is derived from an extensive experience database that constitutes a major asset of GEH or its licensor.

(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 14th day of December 2012.

Francis T. Bolger
Manager
New Product Introduction
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