UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

September 10, 2001

MEMORANDUM TO: ACRS Members

FROM: Paul Boehnert, Senior Staff Engineer
Thermal-Hydraulic Phenomena Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE MEETING ON THE THERMAL-HYDRAULIC PHENOMENA, AUGUST 22 - 23, 2001, ROCKVILLE, MARYLAND

The minutes of the subject meeting, issued on August 28, 2001, have been certified as the official record of the proceedings of that meeting. A copy of the certified minutes is attached.

Attachment: As stated

cc via e-mail:

J. Larkins
H. Larson
S. Bahadur
R. Savio
S. Duraiswamy
ACRS Fellows and Technical Staff

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
ADVISORY COMMITTEE ON NUCLEAR WASTE
WASHINGTON, D.C. 20555

OFFICE OF
ACRS/ACNW

August 28, 2001

MEMORANDUM TO: Paul Boehnert, Senior Staff Engineer

FROM: T. Kress, Acting Chairman
Thermal-Hydraulic Pheomena Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE ACRS SUBCOMMITTEE MEETING, AUGUST 22-23, 2001 - ROCKVILLE, MARYLAND

I hereby certify that, to the best of my knowledge and belief, the Minutes of the subject meeting issued August 28, 2001, are an accurate record of the proceedings for that meeting.

T. Kress, Acting Chairman

Sept. 7, 2001
Date

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

August 28, 2001

MEMORANDUM FOR: T. Kress, Acting Chairman, Thermal-Hydraulic Phenomena Subcommittee

FROM: P. Boehnert, Senior Staff Engineer

SUBJECT: MINUTES OF THE ACRS THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING, AUGUST 22-23, 2001 - ROCKVILLE, MARYLAND

A Working Copy of the subject meeting minutes is attached. I would appreciate your review and corrections as soon as possible. Copies are being sent to all ACRS members, and the Subcommittee Consultant for their information.

Attachment: As Stated

cc: ACRS Members
V. Schrock
R. Savio

cc via E-Mail:
J. Larkins
S. Bahadur
R. Savio
H. Larson
S. Duraiswamy
ACRS Staff Engineers
ACRS Fellows

DRAFT COPY - PREPARED FOR INTERNAL COMMITTEE USE

CERTIFIED BY: T. Kress, September 7, 2001
ISSUED: August 28, 2001

CERTIFIED

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING MINUTES:
GE NUCLEAR ENERGY TRACG CODE APPLICATION TO AOOs
EPRI REPORT - RESOLUTION OF GL 96-06 WATERHAMMER ISSUES
AUGUST 22-23, 2001
ROCKVILLE, MARYLAND

INTRODUCTION:

The ACRS Subcommittee on Thermal-Hydraulic Phenomena held a meeting on August 22-23, 2001 with representatives of the NRC Office of Nuclear Reactor Regulation, GE Nuclear Energy and the Electric Power Research Institute (EPRI). The purpose of this meeting was for the Subcommittee to review the (1) GE Nuclear Energy TRACG realistic thermal-hydraulic code version and its application to evaluation of anticipated operational occurrences; and, (2) resolution of issues associated with the Electric Power Research Institute (EPRI) Report, TR-113594, "Resolution of Generic Letter 96-06 Waterhammer Issues". Portions of the meeting were closed to the public to discuss GE Nuclear Energy and EPRI proprietary information. Mr. P. Boehnert was the cognizant ACRS staff engineer and Designated Federal Official (DFO) for this meeting. The meeting was convened by the Subcommittee Chairman at 8:30 a.m., August 22, 2001, recessed at 2:40 p.m. that day; convened at 8:30 a.m, August 23, 2001 and adjourned at 1:10 p.m. that day.

ATTENDEES

ACRS Members/Staff:

T. Kress, Acting Chairman
F. Peter Ford, Member
J. Sieber, Member
V. Schrock, Consultant
P. Boehnert, DFO

NRC Staff:

R. Caruso, NRR
R. Landry, NRR
T. Ulses, RES[1]
Y. Orechwa, NRR
J. Tatum, NRR
G. Hubbard, NRR

GE Nuclear Energy

J. Klapproth
J. Andersen
F. Bolger
C. Heck

EPRI

V. Wagoner, CP&L
T. Essleman, Altran
G. Zysk, Altran
P. Griffith, MIT
F. Moody, Cons.

A list of public attendees is attached to the Office Copy of these Minutes.

[1] Formally of NRR and a reviewer for the TRACG code review

The presentation slides and handouts used during this meeting are attached to the Office Copy of these Minutes. The presentations to the Subcommittee are summarized below.

GE NUCLEAR ENERGY TRACG "BEST ESTIMATE" CODE AND APPLICATION TO ANTICIPATED OPERATIONAL OCCURRENCES

Introduction (**Open**)

T. Kress, Acting Subcommittee Chairman, convened the meeting. Referring to the GE TRACG code review, he noted some previous concerns/issues that were cited by the Subcommittee as a result of past reviews. V. Schrock opined that the staff's Safety Evaluation Report (SER) on TRACG was a disappointment, in that he felt that it did not address many of the issues raised by himself and by the Subcommittee in the past. He also indicated that many of the issues discussed by the staff in the document were handled in a superficial manner.

F. Peter Ford declared himself in conflict of interest with GE Nuclear Energy, and, therefore, indicated that he will not advise the Committee on this matter.

NRC Staff Presentation (**Open**)

R. Landry, NRR, discussed the following topics with regard to the NRC staff's review of the TRACG code for application to Anticipated Operational Occurrences (AOO's):

- Review Timeline
- Staff Approach to Review
- Code Applicability
- Code Assessment
- Staff Evaluation
  - Thermal-Hydraulics
  - Neutron Kinetics
  - Statistical Methodology
  - Code User Experience
- Conditions and Limitations on Code Use
- Conclusions

Key points regarding the review included the following:

- The staff's emphasis for this review focused on the neutron kinetics and statistical methodology employed to determine code uncertainty (required for a "best-estimate" code). The staff built on the prior review of the code's thermal-

hydraulics, performed for the (subsequently terminated) Simplified BWR plant design review.

- Details of the neutron kinetics review were discussed by Mr. T. Ulses, RES. He detailed the review areas and methods, conclusions, and lessons learned. By exercising TRACG, he was able to resolve a concern with the code and identified an issue that will require GE's attention if the code is to be applied to reactivity initiated accident analysis. It was also noted that TRACG cannot predict the SPERT reactor transient test well, whereas NRR's methods provide a good match to this data. NRR found the kinetics model acceptable for application to AOOs.

- A detailed review of the statistical methodology employed to evaluate the code uncertainty shows that the necessary uncertainties are captured, and the method is adequate to apply to AOO transients.

- NRR said that the quality of its review was significantly enhanced by having a copy of the code in-house to examine and to perform its own analyses.

- Overall, NRR finds the TRACG code acceptable for application to AOOs, subject to five conditions. Four of these conditions are "place holders", in that they will require attention when the code is applied to applications other than AOO analyses.

Subcommittee Comments

- V. Schrock noted a concern with use of the May-Whitt decay heat model in this TRACG application. Mr. Ulses stated that decay heat is a second-order effect for AOOs, but he also said that the SER will be revised to clarify this matter.

- V. Schrock noted that the SER did not address how "beta" (delayed neutron fraction) is calculated for fissile fuel. NRR said that GE employs a previously-approved code for this matter, thus NRR did not address it here.

- In response to Dr. Kress, NRR noted that GE's documentation was not sufficiently detailed for public use, but was considered adequate for GE's internal use.

- In response to Mr. Schrock, NRR said that GE has a data bank of 500-1000 data points for each of its fuel types for CPR calculations.

- NRR said that the level tracking model in TRACG will need to be throughly evaluated when the code is applied to LOCA analyses.

GE Nuclear Energy Presentation (**Open/Closed**)
Mr. J. Andersen, Global Nuclear Fuels[2], provided a presentation on the following topics:

- Introduction/Overview
- Scope of Code Application to AOOs
- Development/Review Time Line
- NRC Review
- Response to Subcommittee Comments (11/13-14/01 Meeting)
  - o The momentum equations do not appear to properly account for Reynolds stress.
  - o The origin of the equations are not clearly specified pursuant to the regulatory position in the draft regulatory guide on code submittals.
  - o Partition of wall shear stress in not treated consistently in the documentation
  - o The modeling of Tee components is not clearly explained and its adequacy is not apparent.
  - o There is no definitive modeling of flow regime transition, and the logic of this modeling is not clear.
  - o Regarding the interfacial shear model, key terms in the equations are not explained, in particular the relationship between the "c_i" and "c_0" terms needs to be clarified.
  - o GE has an inconsistent treatment for modeling of interfacial area and the heat transfer coefficients.
- Comments on NRC TRACG SBWR Review
- Concluding Remarks

Subcommittee Comments

The Subcommittee had no specific comments on the GE presentation material. V. Schrock opined that the codes' capabilities tend to be "oversold"; GE agreed, noting that for the most part, the code models are empirically based. In response to P. Ford, GE said that they have tested and quantified the uncertainties associated with calculation of the CPR for power uprate conditions, as well as for other key parameters.

Subcommittee Caucus (**Open**)

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[2] Global Nuclear Fuels, a wholly owned subsidiary of GE Nuclear Energy

V. Schrock indicated that many of his initial concerns relative to the quality of the staff's review have been addressed, and that his early comments relative to the staff's SER were too severe. He will provide a written report clarifying his comments. The Subcommittee agreed that this matter should be brought to the full Committee for review. T. Kress provided direction to the staff and GE Nuclear Energy relative to the content of their presentations to the ACRS.

ELECTRIC POWER RESEARCH INSTITUTE REPORT - RESOLUTION OF GENERIC LETTER 96-06 WATERHAMMER ISSUES

CHAIRMAN'S COMMENTS (**Open**)

Dr. T. Kress, Acting Subcommittee Chairman, convened the meeting at 8:30 a.m. He stated that the Subcommittee last discussed this issue on January 16, 2001. The Subcommittee and the NRC staff have previously raised concerns regarding the scope and content of the EPRI Topical Report (TR-113594), "Resolution of Generic Letter 96-06 Water hammer Issues".

NRC Opening Comments (**Open**)

Mr. J. Tatum, NRR, provided brief opening remarks regarding the background of this issue. He noted that about 24 plants (12 Utilities) have participated in this program and elected to pursue a less conservative approach to the resolution of GL 96-06 water hammer issue than was provided in NUREG/CR-5220.

Previously, the ACRS T/H Subcommittee has identified three concerns:

- Limitations of air release fraction test apparatus
- Determination of "h" for condensing heat transfer
- Sensitivity of "Scaling-up" test data to plant design

In addition, NRR has the following concerns:

- Pressure rise time plot with and without air in void
- Plant design vs. test apparatus for air release
- Pulse rise time used in the EPRI report
- Single vs. multiple waterhammer pulses

- Fluid structure interaction–attenuation

- Structural damping value used for analyzed loads vs. measured loads

On July 10, 2001, EPRI submitted a revised Section 6 of the Technical Basis Report (TBR) and responded to the ACRS concerns, and on August 9, 2001, a letter from EPRI was received responding to the NRR concerns. The NRR staff noted that EPRI's efforts are good with notable strengths in the areas of PIRT, testing and data collection, and endorsement by expert panel members. However, there are areas of continuing review for determination of air release fraction, scaling of heat transfer surface area, and pressure limitations associated with condensation-induced waterhammer (CIWH) data.

EPRI Presentations (**Open/Closed**)

Messrs. V. Wagoner, T. Esselman, F. Moody, P. Griffith, B. Wylie, and G. Zysk discussed the issues raised by the ACRS thermal-hydraulics Subcommittee during the January 16, 2001 meeting, namely:

- Test apparatus for determination of air release fraction

- Determination of the "h" in the "hA" term

- Scale-up of the column closure waterhammer (CCWH) test data.

Mr. G. Zysk noted that the test apparatus was modified to address the ACRS issues. The investigation considered two scenarios for the fan cooler heat exchanger tubes. Test Sequence 1 provides for an initially full heat exchanger tube that drains and ejects water as it boils. Test Sequence 2 provides for a heat exchanger tube that is connected to a full vertical header.

Mr. G. Zysk stated that condensing surfaces of the water is irregular but is taken to be the projected flow area of the water (A). Using the constant (A), heat transfer coefficients (h) were determined from the test data to be up to 64,000 BTU/hr ft^2 F. The h coefficient was increased to 72,000 BTU/hr ft^2 F for Rigid Body Model (RBM) predictions. The value of h was varied from 32,000 to 150,000 BTU/hr ft^2 F in the method of characteristics (MOC) analysis and the water hammer pressure was calculated. The test data is compared to that of MOC calculations. EPRI concluded that as h is increased, the column closure event becomes less dependent on the heat transfer at the steam/water interface, and the event becomes inertially dominated.

Therefore, the heat transfer to the water tends to occur as a uniform heat flux, which also is independent of pipe flow area.

Subcommittee Comments

During the above discussions, Members of the Subcommittee noted the following points:

- Dr. Ford questioned the integrity of carbon steel piping to withstand water hammer effects, and noted that consideration should be given to the aging of some plants. V. Wagoner noted that this piping is included in the plant's ISI program.

- Dr. Kress expressed concern regarding the lack of knowledge of the amount of steam entrained in the testing. He noted that the amount of steam is important to determine the cushioning effects.

- Dr. Kress expressed concern regarding the lack of scaling and quantified analysis from the testing to be applicable to commercial power plants. He noted that most of the analyses that were presented were performed qualitatively.

- Dr. Kress said that EPRI should indicate how much boiling was assumed in the testing, and report the specifics of the boiling rate.

- Mr. Schrock expressed concern that EPRI did not sample the fluid in the Lexan header.

- Mr. Schrock pointed out that the EPRI's results are dependent on the test apparatus, and it could be misleading to apply for commercial power plants.

- Mr. Schrock noted that he is convinced that the EPRI's testing is conservative with respect to the containment.

- Dr. Kress indicated that NRR should not rule out the plant-risk argument in its safety evaluation report.

- Dr. Kress noted that he is not completely convinced regarding the "hA" argument.

Subcommittee Caucus (**Open**)

The Subcommittee agreed that this matter should be reviewed by the ACRS during its September 5-8, 2001 meeting . T. Kress provided direction to the staff and the EPRI relative to the content of their presentations to the ACRS.

FOLLOW-ON ACTIONS

No specific follow-on actions were identified during this meeting.

BACKGROUND MATERIAL PROVIDED TO THE SUBCOMMITTEE PRIOR TO THIS MEETING

Memoranda dated August 8, 2001, from P. Boehnert, ACRS, to T/H Phenomena Subcommittee Members containing:

- NRR (draft) Safety Evaluation Report by the Office of Nuclear Reactor Regulation for NEDE-32906P "TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analysis (**Contains Proprietary Information**).

- Report to Dr. G. Wallis, from V. Schrock, ACRS Consultant, Subjects: Review of Documentation for the TRACG Best Estimate Code and its Application to Operational Transients in Boiling Water Reactors, and, Review of RES T/H Research Activities, dated November 28, 2000.

- Excerpt of (draft) Minutes of the ACRS Thermal-Hydraulic Phenomena Subcommittee, November 13-14, 2000, Rockville, Maryland, dated January 12, 2001

- EPRI Letter transmitting EPRI Report, "Resolution of Generic Letter 96-06 Waterhammer Issues", TR-113594, Volumes 1&2, dated December 15, 2000 (Proprietary).

- EPRI Letter to J. Tatum, NRR, dated July 10, 2001, Subject: Resolution of Generic Letter 96-06 Waterhammer Issues, EPRI Report TR-113594, Volumes 1&2, Revised Sections

- Excerpt from draft Minutes of January 16-17, 2001 Thermal-Hydraulic Phenomena Subcommittee meeting on EPRI Report on Resolution of NRC Generic Letter 96-06 Waterhammer Issues, dated January 24, 2001.

- E-Mail from G. Wallis, Comments on "New Section 6 on Air Release", dated July 23, 2001

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NOTE: Additional details of the open portions of this meeting can be obtained from a transcript of this meeting available for downloading or viewing on the Internet at "http://www.nrc.gov/ACRSACNW", or can be purchased from Neal R. Gross & Co., Inc., 1323 Rhode Island Ave., NW, Washington, D.C., 20005, (202) 234-4433 (Voice), 387-7330 (Fax), E-Mail: "nrgross@nealrgross.com".

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING:
GE NUCLEAR ENERGY TRACG CODE APPLICATION TO AOO's,
EPRI REPORT- RESOLUTION OF GL 96-06 WATERHAMMER ISSUES
AUGUST 22-23, 2001
ROCKVILLE, MARYLAND

PRESENTATION SCHEDULE

Contact: P. Boehnert (301/415-8065)
("pab2@nrc.gov")

August 22, 2001

TOPIC	PRESENTER	TIME
IV. Reconvene/Opening Remarks	T. Kress, Acting Chairman	8:30 a.m.
V. GE Nuclear Energy TRACG Code for Anticipated Operational Occurrences		
A. NRC Staff Presentation (**Open**)	R. Landry, NRR	8:45 a.m.
1. Introduction and Background		
2. Safety Evaluation Report - Review Scope - Methodology - Lessons Learned from Exercise Of GE TRACG Code - Review of Uncertainty Evaluation - Results and Conditions (if any) - Conclusions		
3. Concluding Remarks		
B. GE Nuclear Energy Presentation (**Open/Closed?**)		12:30 p.m.
1. Introduction	J. Andersen, GNF, et al.	
2. Response to Subcommittee Comments (11/13-14/00 Mtg.) Regarding the TRACG Code		

Correlations & Models (see list - below)

3. Comment on NRC TRACG SBWR Review

4. Concluding Remarks

VI. Subcommittee Caucus (**Open**) 4:00 p.m.

1. Comments on Meeting Presentations

2. Follow-on Actions

3. Decision to Bring Review to ACRS

VII. Recess 4:30 p.m.

Comments on TRACG Code Models/Correlations -
November 13-14, 2000 ACRS T/H Phenomena Subcommittee Meeting

- The momentum equations do not appear to properly account for Reynolds stress.
- The origin of the equations are not clearly specified pursuant to the regulatory position in the draft regulatory guide on code submittals.
- Partition of wall shear stress in not treated consistently in the documentation
- The modeling of Tee components is not clearly explained and its adequacy is not apparent.
- There is no definitive modeling of flow regime transition, and the logic of this modeling is not clear.
- Regarding the interfacial shear model, key terms in the equations are not explained, in particular the relationship between the "c_i" and "c_0" terms needs to be clarified.
- GE has an inconsistent treatment for modeling of interfacial area and the heat transfer coefficients.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
THERMAL-HYDRAULIC PHENOMENA SUBCOMMITTEE MEETING:
DUANE ARNOLD ENERGY CENTER POWER UPRATE REQUEST,
GE NUCLEAR ENERGY TRACG CODE APPLICATION TO AOO's,
EPRI REPORT- RESOLUTION OF GL96-06 WATERHAMMER ISSUES
AUGUST 22-23, 2001
ROCKVILLE, MARYLAND

PRESENTATION SCHEDULE

Contact: P. Boehnert (301/415-8065/"pab2@nrc.gov")

August 23, 2001

TOPIC	PRESENTER	TIME
VIII. Reconvene/Opening Remarks	T. Kress, Acting Chairman	8:30 a.m.
IX. Resolution of GL 96-06 Waterhammer Issues (**Open/Closed**)		
A. NRC/Industry Resolution Approach (EPRI Study) - Summary	J. Tatum NRR/DSSA/SPLB	8:45 a.m.
B. Revised EPRI Report - Evaluation of GL 96-06 Waterhammer Issues and Resolution of Comments From 1/16-17/01Subcommittee Meeting	V. Wagoner (CP&L) A. Singh (EPRI) T. Esselman (Altran)	9:00 a.m.
C. NRC Review of EPRI Report- Results, Open Issues, Resolution Approach and Conclusions	J. Tatum	11:30 a.m.
D. Concluding Remarks	EPRI/NRC	12:30 p.m.
X. Subcommittee Caucus (**Open**)		12:45 p.m.
1. Comments on Meeting Presentations 2. Follow-on Actions 3. Decision to Bring Review to ACRS		
VII. Adjourn		1:00 p.m.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON THERMAL-HYDRAULIC PHENOMENA

AUGUST 22, 2001
Today's Date

PLEASE PRINT

NAME	AFFILIATION
JIM KLAPPROTH	GE
BRIAN R. MOORE	GNF/GE
FRAN BOLGER	GE
Tom Andersen	GE/GNF
Antonio Possolo	GE-CRD
Bharat Shrivastava	GE
Charles Heck	GE/GNF

NUCLEAR REGULATORY COMMISSION

Documents Containing Reporting or Recordkeeping Requirements: Office of Management and Budget (OMB) Review

AGENCY: Nuclear Regulatory Commission (NRC).

ACTION: Notice of the OMB review of information collection and solicitation of public comment.

SUMMARY: The NRC has recently submitted to OMB for review the following proposal for the collection of information under the provisions of the Paperwork Reduction Act of 1995 (44 U.S.C. Chapter 35).

1. *Type of submission, new, revision, or extension:* Revision.

2. *The title of the information collection:* 10 CFR 50.55a, "Codes and Standards; Amended Requirements".

3. *The form number if applicable:* Not applicable.

4. *How often the collection is required:* The American Society of Mechanical Engineers (ASME) has set a frequency for conducting these activities with its attendant recordkeeping based on operating history and the need for component functionality. The frequency is dependent on the safety function of the component. The information is generally not submitted to the NRC, but is retained by the licensees to be made available to the NRC in the event of an NRC inspection. Reporting requirements consist of one-time relief requests.

5. *Who will be required or asked to report:* Nuclear power plant licensees.

6. *An estimate of the number of responses:* A decrease of 488 responses for relief requests.

7. *The estimated number of annual respondents:* 103.

8. *An estimate of the total number of hours needed annually to complete the requirement or request:* A decrease of 1194 hours (a decrease in recordkeeping burden of 412 hours [4 hours/plant] and a decrease in reporting burden of 782 hours [8 hours/plant]).

9. *An indication of whether Section 3507(d), Public Law 104–13 applies:* Applicable.

10. *Abstract:* The proposed rule implements the later edition and addenda of Section XI, Division 1, of the ASME Boiler and Pressure Vessel Code (BPV Code), and the ASME Code for Operation and Maintenance of Nuclear Power Plants (OM Code). NRC regulations require that nuclear power plant owners (1) construct Class 1, Class 2, and Class 3 components in accordance with the rules provided in Section III, Division 1, "Requirements for Construction of Nuclear Power Plant Components," of the ASME BPV Code; (2) inspect Class 1, Class 2, Class 3, Class MC (metal containment) and Class CC (concrete containment) components in accordance with the rules provided in Section XI, Division 1, "Requirements for Inservice Inspection of Nuclear Power Plant Components," of the ASME BPV Code; and (3) test Class 1, Class 2, and Class 3 pumps and valves in accordance with the rules provided in ASME OM Code.

Every 120 months licensees are required to update their inservice inspection and inservice testing programs to meet the version of Section XI of the ASME BPV Code and ASME OM Code incorporated by reference into the regulations that are in effect 12 months prior to the start of a new 120-month interval.

Submit, by August 29, 2001, comments that address the following questions:

1. Is the proposed collection of information necessary for the NRC to properly perform its functions? Does the information have practical utility?

2. Is the burden estimate accurate?

3. Is there a way to enhance the quality, utility, and clarity of the information to be collected?

4. How can the burden of the information collection be minimized, including the use of automated collection techniques or other forms of information technology?

A copy of the submittal may be viewed free of charge at the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Room O–1 F23, Rockville, MD 20852. The proposed rule indicated in "The title of the information collection" is or has been published in the **Federal Register** within several days of the publication date of this **Federal Register** Notice. The OMB clearance package and rule are available at the NRC worldwide web site: *http://www.nrc.gov/NRC/PUBLIC/OMB/index.html* for 60 days after the signature date of this notice and are also available at the rule forum site, *http://ruleforum.llnl.gov.*

Comments and questions should be directed to the OMB reviewer Bryon Allen, Office of Information and Regulatory Affairs (3150–0011), NEOB–10202, Office of Management and Budget, Washington DC 20503, by August 29, 2001.

Comments can also be submitted by telephone at (202) 395–3087.

The NRC Clearance Officer is Brenda Jo. Shelton, 301–415–7233.

Dated at Rockville, Maryland, this 23rd day of July 2001.

For the Nuclear Regulatory Commission.

Brenda Jo. Shelton,

NRC Clearance Officer, Office of the Chief Information Officer.

[FR Doc. 01–18856 Filed 7–27–01; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards; Subcommittee Meeting on Thermal-Hydraulic Phenomena; Notice of Meeting

The ACRS Subcommittee on Thermal-Hydraulic Phenomena will hold a meeting on August 21–23, 2001, Room T–2B3, 11545 Rockville Pike, Rockville, Maryland.

Portions of the meeting may be closed to public attendance to discuss General Electric (GE) Nuclear Energy proprietary information per 5 U.S.C. 552b(c)(4).

The agenda for the subject meeting shall be as follows:

Tuesday, August 21, 2001—8:30 a.m. until the conclusion of business

Wednesday, August 22, 2001—8:30 a.m. until the conclusion of business

Thursday, August 23, 2001—8:30 a.m. until the conclusion of business

The Subcommittee will review the: (1) License amendment request of Alliant Energy for a core power uprate for the Duane Arnold Energy Center, (2) GE Nuclear Energy TRACG realistic thermal-hydraulic code version and its application to evaluation of anticipated operational occurrences, and (3) Electric Power Research Institute (EPRI) report TR–113594, "Resolution of Generic Letter 96–06 Waterhammer Issues." The purpose of this meeting is to gather information, analyze relevant issues and facts, and to formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Oral statements may be presented by members of the public with the concurrence of the Subcommittee Chairman. Written statements will be accepted and made available to the Committee. Electronic recordings will be permitted only during those portions of the meeting that are open to the public, and questions may be asked only by members of the Subcommittee, its consultants, and staff. Persons desiring to make oral statements should notify the cognizant ACRS staff engineer named below five days prior to the meeting, if possible, so that appropriate arrangements can be made.

During the initial portion of the meeting, the Subcommittee, along with any of its consultants who may be present, may exchange preliminary

views regarding matters to be considered during the balance of the meeting.

The Subcommittee will then hear presentations by and hold discussions with representatives of the NRC staff, GE Nuclear Energy, and other interested persons regarding this review.

Further information regarding topics to be discussed, whether the meeting has been canceled or rescheduled, and the Chairman's ruling on requests for the opportunity to present oral statements and the time allotted therefor, can be obtained by contacting the cognizant ACRS staff engineer, Mr. Paul A. Boehnert (telephone 301–415–8065) between 7:30 a.m. and 4:30 p.m. (EDT). Persons planning to attend this meeting are urged to contact the above named individual one or two working days prior to the meeting to be advised of any potential changes to the agenda, etc., that may have occurred.

Dated: July 24, 2001.

Sher Bahadur,

Associate Director for Technical Support.

[FR Doc. 01–18855 Filed 7–27–01; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Sunshine Act Notice

AGENCY HOLDING THE MEETING: Nuclear Regulatory Commission.

DATE: Weeks of July 30, August 6, 13, 20, 27, September 3, 2001.

PLACE: Commissioners' Conference Room, 11555 Rockville Pike, Rockville, Maryland.

STATUS: Public and Closed.

Matters To Be Considered

Week of July 30, 2001

Tuesday, July 31, 2001

1:25 p.m.: Affirmation Session (Public Meeting) (If needed)

Week of August 6, 2001—Tentative

There are no meetings scheduled for the Week of August 6, 2001.

Week of August 13, 2001—Tentative

Tuesday, August 14, 2001

9:30 a.m.: Briefing on NRC International Activities (Public Meeting) (Contact: Elizabeth Doroshuk, 301–415–2775)

Wednesday, August 15, 2001

9:30 a.m.: Briefing on EEO Program (Public Meeting) (Contact: Irene Little, 301–415–7380)

1:25 p.m.: Affirmation Session (Public Meeting) (If needed)

1:30 p.m.: Meeting with Organization of Agreement States (OAS) and Conference of Radiation Control Program Directors (CRCPD) (Public Meeting) (Contact: John Zabko, 301–415–1277)

Week of August 20, 2001–Tentative

There are no meetings scheduled for the Week of August 20, 2001.

Week of August 27, 2001–Tentative

There are no meetings scheduled for the Week of August 27, 2001.

Week of September 3, 2001–Tentative

There are no meetings scheduled for the Week of September 3, 2001.

The schedule for Commission meetings is subject to change on short notice. To verify the status of meetings call (recording)—(301) 415–1292. Contact person for more information: David Louis Gamberoni (301) 415–1651.

Additional Information

By a vote of 4–0 on July 17 and 18, the Commission determined pursuant to U.S.C. 552b(e) and § 9.107(a) of the Commission's rules that "Affirmation of Power Authority of the State of New York Entergy Companies; Applications to Transfer Licenses for Indian Point 3 and Fitzpatrick Nuclear Plants; Procedural Order Announcing Release of Redacted Version of CLI–01–14 and Addressing Parties' Treatment of Confidential Information in CLI–01–14" be held on July 19, and on less than one week's notice to the public.

By a vote of 4–0 on July 18 and 19, the Commission determined pursuant to U.S.C. 552b(e) and § 9.107(a) of the Commission's rules that "Affirmation of Florida Power & Light Company (Commission Review of LBP–01–06)" be held on July 19, and on less than one week's notice to the public.

The NRC Commission Meeting Schedule can be found on the Internet at: http://www.nrc.gov/SECY/smj/schedule.htm

This notice is distributed by mail to several hundred subscribers; if you no longer wish to receive it, or would like to be added to the distribution, please contact the Office of the Secretary, Washington, D.C. 20555 (301–415–1969). In addition, distribution of this meeting notice over the Internet system is available. If you are interested in receiving this Commission meeting schedule electronically, please send an electronic message to dkw@nrc.gov.

Dated: July 26, 2001.

David Louis Gamberoni,

Technical Coordinator, Office of the Secretary.

[FR Doc. 01–19022 Filed 7–26–01; 2:12 pm]

BILLING CODE 7590–01–M

OFFICE OF MANAGEMENT AND BUDGET

Cumulative Report on Rescissions and Deferrals

July 1, 2001.

Section 1014(e) of the Congressional Budget and Impoundment Control Act of 1974 (Public Law 93–344) requires a monthly report listing all budget authority for the current fiscal year for which, as of the first day of the month, a special message had been transmitted to Congress.

This report gives the status, as of July 1, 2001, of two deferrals contained in one special message for FY 2001. The message was transmitted to Congress on January 18, 2001.

Deferrals (Attachments A and B)

As of July 1, 2001, $1.4 billion in budget authority was being deferred from obligation. Attachment B shows the status of each deferral reported during FY 2001.

Information From Special Message

The special message containing information on the deferrals that are covered by this cumulative report is printed in the edition of the **Federal Register** cited below:

66 FR 8985, Monday, February 5, 2001

Mitchell E. Daniels, Jr.,

Director.

Attachments

ATTACHMENT A—STATUS OF FY 2001 DEFERRALS

[In millions of dollars]

	Budgetary resources
Deferrals proposed by the President	1,946.7
Routine Executive releases through July 1, 2001	−552.0
Overturned by the Congress	
Currently before the Congress	1,394.7

BILLING CODE 3110–01–P

develop and enforce relevant environmental standards.

c. Affected State and local government agencies, including those authorized to develop and enforce relevant environmental standards.

d. Any affected Indian tribe.

e. Any person who requests or has requested an opportunity to participate in the scoping process.

f. Any person who intends to petition for leave to intervene.

In accordance with 10 CFR 51.26, the scoping process for an EIS may include a public scoping meeting to help identify significant issues related to a proposed activity and to determine the scope of issues to be addressed in an EIS. The NRC has decided to hold a public meeting for the SPS license renewal supplement to the GEIS. The scoping meeting will be held in the Combined District Court Room in the Surry County Government Center, 45 School Street, Surry, Virginia, on Wednesday September 19, 2001. There will be two sessions to accommodate interested parties. The first session will convene at 1:30 p.m. and will continue until 4:30 p.m. The second session will convene at 7:00 p.m. with a repeat of the overview portions of the meeting and will continue until 10:00 p.m. Both meetings will be transcribed and will include (1) An overview by the NRC staff of the National Environmental Policy Act (NEPA) environmental review process, the proposed scope of the supplement to the GEIS, and the proposed review schedule; (2) an overview by Virginia Power of the proposed action, SPS license renewal, and the environmental impacts as outlined in the ER; and (3) the opportunity for interested Government agencies, organizations, and individuals to submit comments or suggestions on the environmental issues or the proposed scope of the supplement to the GEIS. Additionally, the NRC staff will host informal discussions one hour prior to the start of each session at the Surry County Government Center. No comments on the proposed scope of the supplement to the GEIS will be accepted during the informal discussions. To be considered, comments must be provided either at the transcribed public meetings or in writing, as discussed below. Persons may register to attend or present oral comments at the meeting on the NEPA scoping process by contacting Mr. Andrew J. Kugler by telephone at 1 (800) 368–5642, extension 2828, or by Internet to the NRC at *ajk1@nrc.gov* no later than September 11, 2001. Members of the public may also register to speak at the meeting within 15 minutes of the start of each session. Individual oral comments may be limited by the time available, depending on the number of persons who register. Members of the public who have not registered may also have an opportunity to speak, if time permits. Public comments will be considered in the scoping process for the supplement to the GEIS. If special equipment or accommodations are needed to attend or present information at the public meeting, the need should be brought to Mr. Kugler's attention no later than September 11, 2001, so that the NRC staff can determine whether the request can be accommodated.

Members of the public may send written comments on the environmental scoping process for the supplement to the GEIS to:

Chief, Rules and Directives Branch, Division of Administrative Services, Office of Administration, Mailstop T–6 D 59, U.S. Nuclear Regulatory Commission, Washington, DC 20555–0001.

Comments may be hand-delivered to the NRC at 11545 Rockville Pike, Rockville, Maryland, between 7:45 a.m. and 4:15 p.m. on Federal workdays. To be considered in the scoping process, written comments should be postmarked by October 15, 2001. Electronic comments may be sent by the Internet to the NRC at *SurryEIS@nrc.gov*. Electronic submissions should be sent no later than October 15, 2001, to be considered in the scoping process. Comments will be available electronically and accessible through the NRC's Public Electronic Reading Room (PERR) link *http://www.nrc.gov/NRC/ADAMS/index.html* at the NRC Homepage.

Participation in the scoping process for the supplement to the GEIS does not entitle participants to become parties to the proceeding to which the supplement to the GEIS relates. Notice of opportunity for a hearing regarding the renewal application was the subject of the aforementioned **Federal Register** notice of acceptance for docketing. Matters related to participation in any hearing are outside the scope of matters to be discussed at the public meeting.

At the conclusion of the scoping process, the NRC will prepare a concise summary of the determination and conclusions reached, including the significant issues identified, and will send a copy of the summary to each participant in the scoping process. The summary will also be available for inspection through the PERR link. The staff will then prepare and issue for comment the draft supplement to the GEIS, which will be the subject of separate notices and a separate public meeting. Copies will be available for public inspection at the above-mentioned addresses, and one copy per request will be provided free of charge. After receipt and consideration of the comments, the NRC will prepare a final supplement to the GEIS, which will also be available for public inspection.

Information about the proposed action, the supplement to the GEIS, and the scoping process may be obtained from Mr. Kugler at the aforementioned telephone number or e-mail address.

Dated at Rockville, Maryland, this 9th day of August 2001.

For the Nuclear Regulatory Commission.

Cynthia A. Carpenter,

Chief, Generic Issues, Environmental, Financial and Rulemaking Branch, Division of Regulatory Improvement Programs, Office of Nuclear Reactor Regulation.

[FR Doc. 01–20536 Filed 8–14–01; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards, Subcommittee Meeting on Thermal-Hydraulic Phenomena, Revisions

The schedule for the August 21–23, 2001 ACRS Subcommittee meeting on Thermal-Hydraulic Phenomena to be held in Room T–2B3, at 11545 Rockville Pike, Rockville, Maryland, has been revised. Specifically, the session scheduled for Tuesday, August 21, to review the license amendment request of the Nuclear Management Company, LLC, for a core power uprate for the Duane Arnold Energy Center has been postponed due to the unavailability of necessary documentation. The meeting will now begin on August 22. The meeting schedule is also revised to include a closed session to public attendance on August 23, 2001, to discuss Electric Power Research Institute (EPRI) proprietary information per 5 U.S.C. 552b(c)(4). Notice of this meeting was published in the **Federal Register** on Monday, July 30, 2001 (66 FR 39373). All other items pertaining to this meeting remain the same as previously published.

FOR FURTHER INFORMATION CONTACT: Mr. Paul A. Boehnert, cognizant ACRS staff engineer, (telephone 301–415–8065) between 7:30 a.m. and 4:30 p.m. (EDT).

Dated: August 9, 2001.

Sher Bahadur,

Associate Director for Technical Support.

[FR Doc. 01–20531 Filed 8–14–01; 8:45 am]

BILLING CODE 7590–01–P

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON THERMAL-HYDRAULIC PHENOMENA

AUGUST 22, 2001
Today's Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

NAME	NRC ORGANIZATION
RALPH LANDRY	NRR/DSSA/SRXB
RALPH CARUSO	NRR/SRXB
TONY ULSES	NRC/RES
Yuri Orechwa	NRC/NRR/DSSA/SRXB
UNDINE SHOOP	NRR/DSSA/SRXB

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON THERMAL-HYDRAULIC PHENOMENA

AUGUST 23, 2001
Today's Date

NRC STAFF SIGN IN FOR ACRS MEETING

PLEASE PRINT

NAME	NRC ORGANIZATION
James Tatum	NRR/DSSA/SPLTB
Beth Wetzel	NRR/DLPM/PDIII-1
Gary Hammer	NRR/DE/EMEB
UJAGAR S. BHACHU	NRC/NRR/DRIPM
George Hubbard	NRR/NRR/SPLB
Walton Jensen	NRC/NRR/SRXB

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON THERMAL-HYDRAULIC PHENOMENA

AUGUST 23, 2001
Today's Date

PLEASE PRINT

NAME	AFFILIATION
FRED MOODY	CONSULTANT
MAHMOOD HUSAINI	Southern Calif. Edison
TIMOTHY D. BROWN	DUKE ENERGY
VAUGHN WAGONER	CP&L
GREG ZYSK	ALTRAN
TOM ESSELMAN	ACTRAN
~~HAGAR S. BOHACH~~	~~NRC/NRR/DLPM.~~
John BUTLER	NEI

TRACG CODE FOR ANTICIPATED OPERATIONAL OCCURRENCES

DRAFT SAFETY EVALUATION REPORT

ACRS THERMAL/HYDRAULIC SUBCOMMITTEE

RALPH R. LANDRY
REACTOR SYSTEMS BRANCH
AUGUST 22, 2001

TRACG DSER

TOPICS

- REVIEW TIMELINE
- APPROACH TO REVIEW
- CODE APPLICABILITY
- CODE ASSESSMENT
- STAFF EVALUATION
  - THERMAL-HYDRAULICS
  - NEUTRON KINETICS
  - STATISTICAL METHODOLOGY
  - CODE USER EXPERIENCE
- CONDITIONS AND LIMITATIONS
- CONCLUSIONS

TRACG DSER

REVIEW TIMELINE

- MAY 25, 1999 - PRELIMINARY INFO MEETING
- JULY 15, 1999 - PRELIMINARY INFO MEETING
- JANUARY 2000 - TRACG SUBMITTAL
- NOVEMBER 13, 2000 - ACRS T/H SUBCOMMITTEE
- JULY 2001 - FORMAL RAIs ISSUED
- JULY 2001 - DRAFT SER

TRACG DSER

STAFF APPROACH TO REVIEW

- EXTENSIVE T/H REVIEW DURING SBWR REVIEW EFFORT FOR LOCA APPLICATION
- STAFF BUILT ON THAT REVIEW FOR AOO REVIEW
- EMPHASIS ON NEUTRON KINETICS AND STATISTICAL METHODOLOGY

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TRACG AOO APPLICABILITY

- **INCREASE IN HEAT REMOVAL BY SECONDARY SYSTEM**
  - **DECREASE IN FEEDWATER FLOW**
  - **INCREASE IN FEEDWATER FLOW**
  - **INCREASE IN STEAM FLOW**
  - **INADVERTENT OPENING OF SAFETY RELIEF VALVE**
- **DECREASE IN HEAT REMOVAL BY SECONDARY SYSTEM**
  - **LOSS OF EXTERNAL LOAD**
  - **TURBINE TRIP**
  - **LOSS OF CONDENSER VACUUM**
  - **CLOSURE OF MAIN STEAM ISOLATION VALVE**
  - **STEAM PRESSURE REGULATOR FAILURE**
  - **LOSS OF NON-EMERGENCY AC POWER**
  - **LOSS OF NORMAL FEEDWATER**
- **DECREASE IN REACTOR COOLANT FLOW RATE**
  - **LOSS OF FORCED REACTOR COOLANT FLOW**
  - **FLOW CONTROLLER MALFUNCTION**

- **REACTIVITY AND POWER DISTRIBUTION ANOMALIES**
  - **STARTUP OF INACTIVE OR RECIRCULATION LOOP**
  - **FLOW CONTROLLER MALFUNCTION CAUSING INCREASE IN BWR CORE FLOW RATE**
- **INCREASE IN REACTOR COOLANT INVENTORY**
  - **INADVERTENT OPERATION OF ECCS**
  - **CVCS MALFUNCTION**
- **DECREASE IN REACTOR COOLANT INVENTORY**
  - **INADVERTENT OPENING OF PRESS RELIEF VALVE**

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CODE ASSESSMENT

- ASSESSMENT PERFORMED BY COMPARISON WITH DATA FROM:
  - PHENOMENOLOGICAL TESTS
  - SEPARATE EFFECTS TESTS
  - INTEGRAL SYSTEMS TESTS
  - PLANT OPERATIONAL DATA
- PLANT NODALIZATION IS TO BE CONSISTENT WITH ASSESSMENT MODELING
- PIRT PREPARED CORRELATING PHENOMENA WITH TESTS AND QUANTITATIVE ASSESSMENT PERFORMED
- ALL MEDIUM AND HIGH RANKED PHENOMENA ASSESSED
- ASSESSMENT SHOWS CAPABILITY OF CODE TO REPRESENT EXPERIMENTAL AND OPERATING DATA

TRACG DSER

STAFF EVALUATION
THERMAL-HYDRAULICS

- Two-fluid model, six conservation equations, boron transport equation, noncondensible gas mass equation.

- Two-regime unified flow map - covers normal operating and anticipated regimes for BWR.

- Two-phase level tracking model uses approximations for void fraction above and below mixture level with cutpoint, α_{cut}, for level detection. Acceptable for AOO, but will be reevaluated for LOCA application.

- Kinetic energy term retained in energy equations. Avoids energy balance errors due to nonconservation of energy.

- GEXL heat transfer correlation:

  - NRC staff review related to power-uprate found data generated by COBRAG code used for GEXL14 correlation instead of experimental data.

TRACG DSER

STAFF EVALUATION
THERMAL-HYDRAULICS

- Use of artificial data instead of empirical data called into question validity of statistical results used to establish MCPR Safety Limit.

- Resolution pending - when NRC staff approves critical boiling length correlation uncertainty, it will be applied in use of TRACG.

- Basic component models are used as building blocks to construct physical models.

- Applicability to isolation condenser needs to be demonstrated should the code be applied to transients for which the condenser is important.

- Steam separator validated against full-scale performance data for two-stage and three-stage steam separators.

- Default - fully implicit integration for hydraulic equations and heat conduction equations by predictor-corrector iterative technique. Implicit coupling between heat conduction and coolant hydraulics. Less prone to error on phase shift in a thermally induced oscillation.

TRACG DSER

STAFF EVALUATION
NEUTRON KINETICS

TONY ULSES

TRACG DSER

STAFF EVALUATION
STATISTICAL METHODOLOGY

YURI ORECHWA

TRACG DSER

STAFF EVALUATION
USER EXPERIENCE

- TRACG uses input deck closely related to input deck specification of original TRAC-B code.
- Knowledgeable TRAC user can readily understand structure and design of TRACG input.
- Major changes from TRAC-B to TRACG well described in Model Description report appendix.
- Execution structure of control blocks retained.
- Additional guidance to the user on time step size would be useful.
- TRACG determines correct flow regimes for components during steady-state initialization.
- Standard input has been developed for classes of BWRs and transients. Reduce user introduced errors in code results.

TRACG DSER

STAFF EVALUATION
CONDITIONS AND LIMITATIONS

- USE OF GEXL14 CORRELATION IS ACCEPTABLE PROVIDED THAT WHEN NRC APPROVES THE CRITICAL BOILING LENGTH CORRELATION UNCERTAINTY IT IS APPLIED IN USE OF TRACG.

- SHOULD TRACG BE APPLIED TO STABILITY ANALYSIS, THE METHODOLOGY IS TO BE SUBMITTED FOR STAFF REVIEW.

- TRACG HAS NOT BEEN REVIEWED FOR ATWS.

- PIRT18 MODEL NEEDS FURTHER JUSTIFICATION BEFORE APPLICATION TO RIA ANALYSES. HOW CAN A MONTE CARLO MODEL RELIABLY PREDICT POINT KINETIC ANSWERS?

- SEPARATE ISOLATION CONDENSER MODEL OR ABILITY TO ADEQUATELY MODEL THE CONDENSER NEEDS TO BE DEMONSTRATED SHOULD APPLICATION BE MADE TO ISOLATION CONDENSER IMPORTANT TRANSIENTS.

TRACG DSER

CONCLUSIONS

- USE OF GEXL14 CORRELATION ACCEPTABLE PROVIDED NRC APPROVED UNCERTAINTY APPLIED.
- KINETICS SOLVER IS ADEQUATE TO SUPPORT CONCLUSION MODELS ARE CORRECTLY DERIVED AND ACCOUNT FOR PHENOMENA INVOLVED IN AOO TRANSIENTS.
- KINETICS SOLVER BENCHMARKING DEMONSTRATE TRACG ADEQUATELY PREDICTS RESULTS FOR AOO TRANSIENTS.
- STAFF ANALYSES PROVIDE CONFIDENCE TRACG ACCEPTABLE FOR AOO ANALYES.
- PIRT18 RESULTS DO NOT SIGNIFICANTLY AFFECT AOO ANALYSES.
- THE UNCERTAINTY ANALYSIS FOLLOWS ACCEPTED CSAU ANALYSIS METHODOLOGY.
- UNCERTAINTIES AND BIASES HAVE BEEN IDENTIFIED AND HIGHLY RANKED PHENOMENA BASED ON EXPERIMENTAL DATA VALIDATED.
- THE PROCESS IS ACCEPTABLE AND THE QUANTITIES ARE REASONABLE.

TRACG DSER

CONCLUSIONS CONT'D

- STANDARD INPUT HAS BEEN DEVELOPED FOR THE CLASSES OF BWR SYSTEMS TO WHICH TRACG IS TO BE APPLIED.

- THE STAFF FINDS THE TRACG02A CODE ACCEPTABLE FOR APPLICATION TO THE AOO TRANSIENTS PRESENTED IN THE SUBMITTAL, NEDE-32906P, "TRACG APPLICATION FOR ANTICIPATED OPERATIONAL OCCURRENCES (AOO) TRANSIENT ANALYSES," DATED JANUARY 2000.

R

TRACG Kinetics Review

Tony P. Ulses
USNRC
August 22, 2001

Outline

- Topics Covered
- Method of Review
- Review Conclusions
- Lessons Learned / Detailed Description of Specific Review Areas

Areas of Review

- Documentation
- Theoretical Development
- Auxiliary Models
- Validation

Method of Review

- As in the past, performance based
- Documentation and theory were reviewed
- Emphasis on execution of code and comparison to relevant benchmarking
- Executing the code led the staff into review subjects that would have been missed had we not run the code

Review Summary

- Modeling captures relevant physics
- Auxiliary models (i.e. direct moderator heating, structural heating, etc.) well theoretically developed
- Decay heat model adequate for proposed application
- Documentation acceptable for internal GNF use. Some models undocumented or documentation is weak.

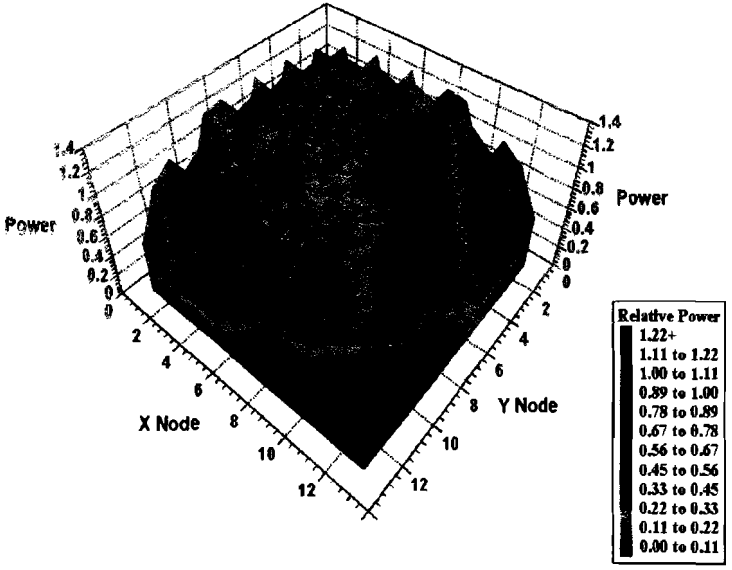
GNF Validation Studies

- Peach Bottom Turbine Trips
- Hatch 2 pump trip and MSIV closure tests
- NMP2 Pump Upshift
- Leibstadt Loss of Feedwater Event
- Numerous stability events

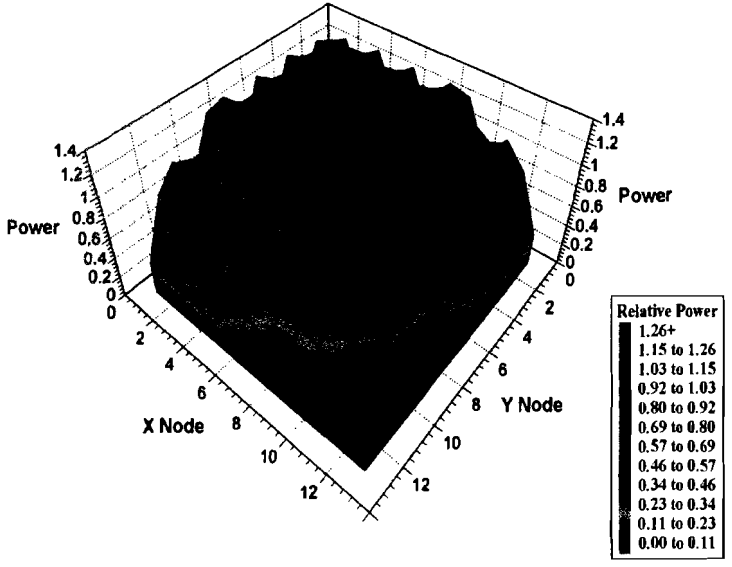
Test Problem

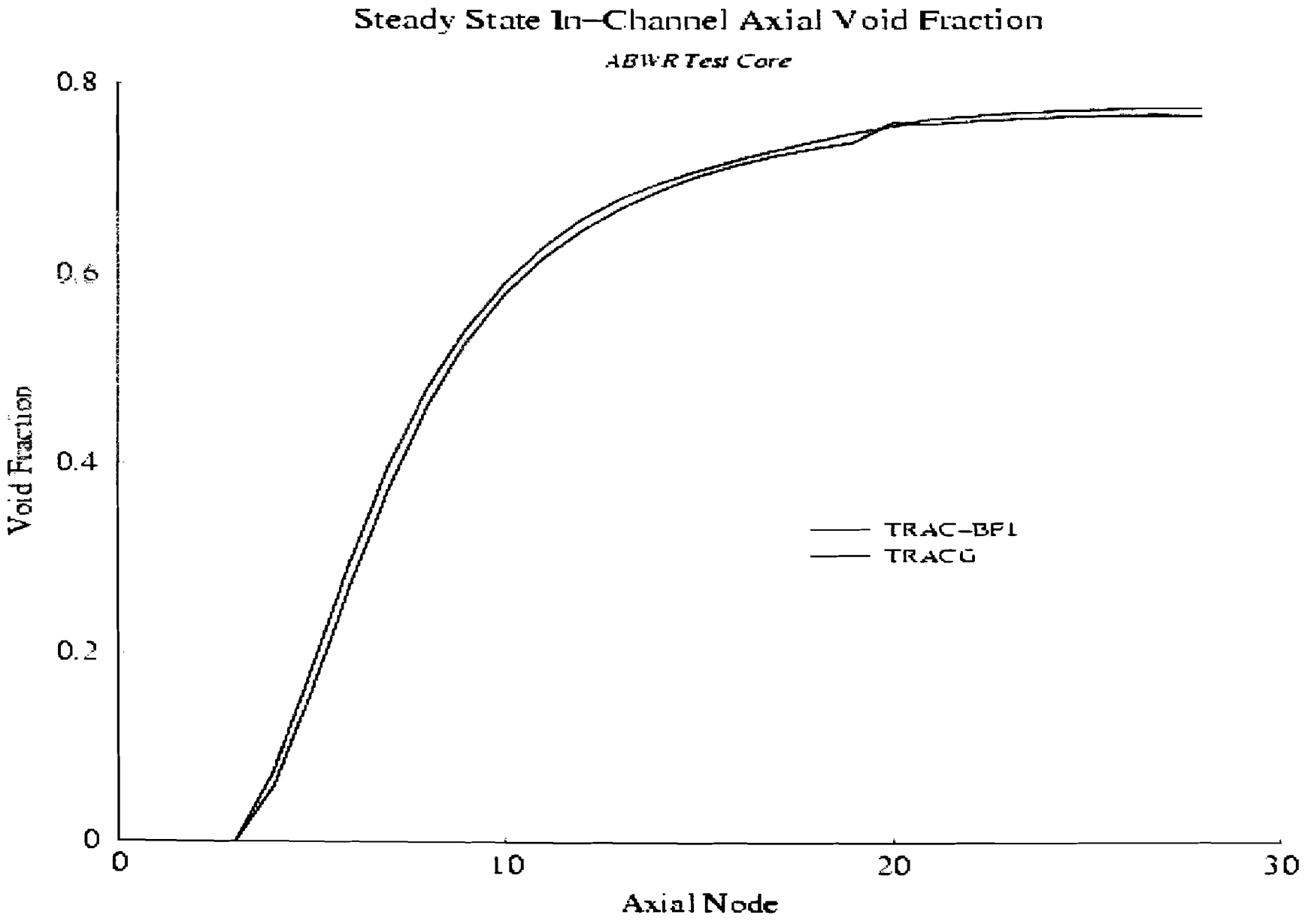
- Intended to improve staff's understanding of TRACGs ability to model a core with modern fuel design
- Based on ABWR core design
- Only models reactor - no balance of plant
- Steady-state results compare well
- Small pertubation transient results compare well

TRAC/NESTLE



TRACG




Steady State In-Channel Axial Void Fraction
ABWR Test Core
Void Fraction
0.8
0.6
0.4
0.2
0
0
10
20
30
Axial Node
TRAC-BF1
TRACG

Simulated Pressurization Transient

- Simulated MSIV closure without SCRAM using complete deck to generate boundary conditions
- Modeled transient with different modeling options

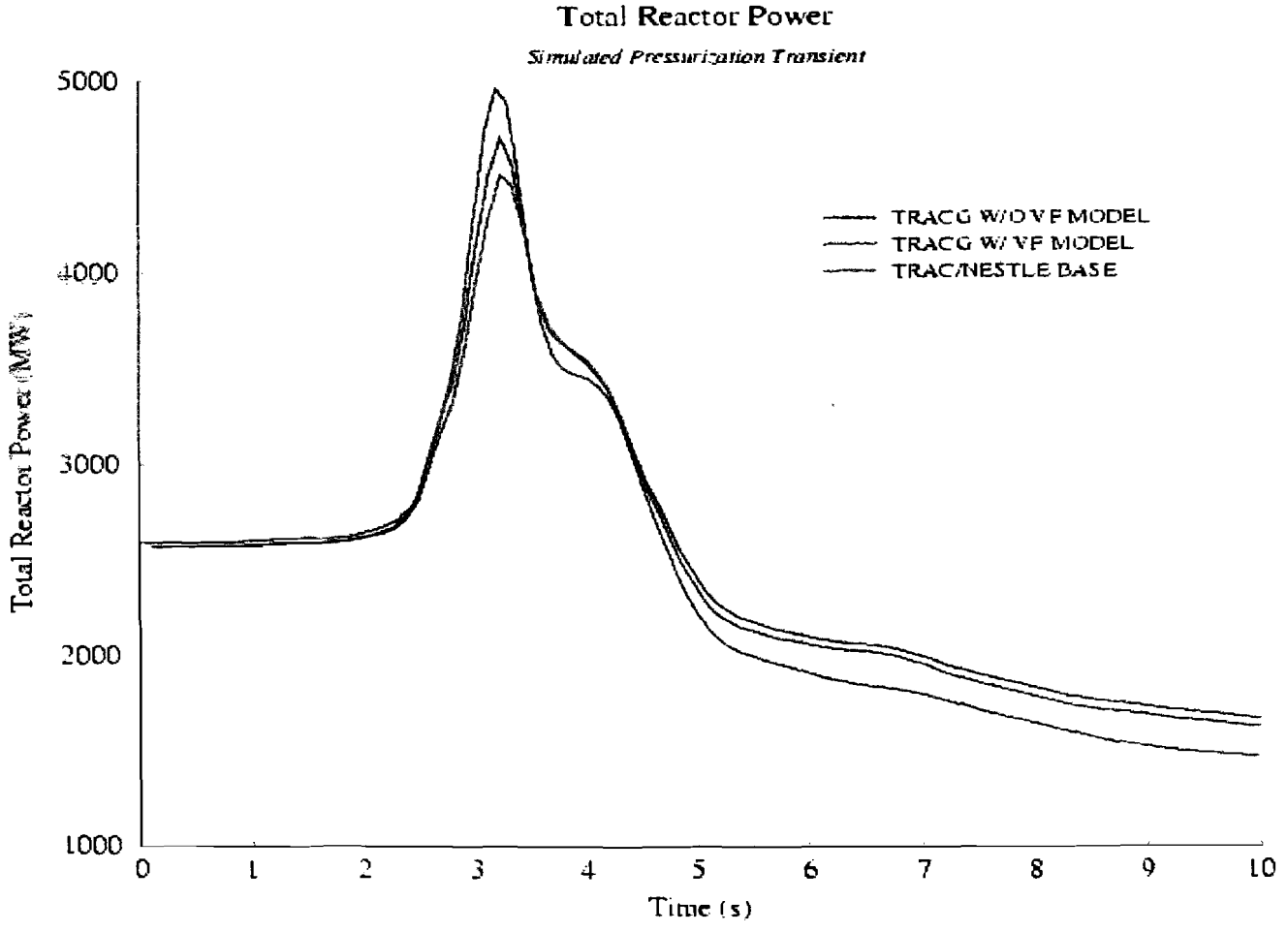


Figure 5 Total Reactor Power for Simulated Pressurization Transient

Review Conclusions

- Reasonable assurance that TRACG can be used as an AOO analysis tool
- Based on staff analyses and evaluation of GNF benchmarking
- Not reviewed for licensing application to any non-AOO transient (i.e. stability, RIA, etc.)

Challenges!

- First time that the staff was unsuccessful defining a problem to eliminate cross section effects
- Difficulties identifying reasons for differences
- Improper conclusion regarding the source of differences
- Problems led staff to review items that would have not been fully reviewed

Use of MCNP

- GNF relies heavily on MCNP
- MCNP used to validate TGBLA code results
- MCNP results used to tune TGBLA results in TRACG
  - PIRT18 model
- Everyone uses MCNP to validate; staff knows of no other organization using MCNP results to modify licensing code predictions

PIRT18 Model

- MCNP, like all Monte Carlo codes, does not provide user with single valued results
- Predicted eigenvalues are statistically derived and have uncertainty
- Uncertainty represented by the 95th percentile confidence interval needs to be accounted for
- Staff predicted uncertainty bands would lead to small differences in TRACG predictions if applied to results
- Effect of model is minimal - not well justified

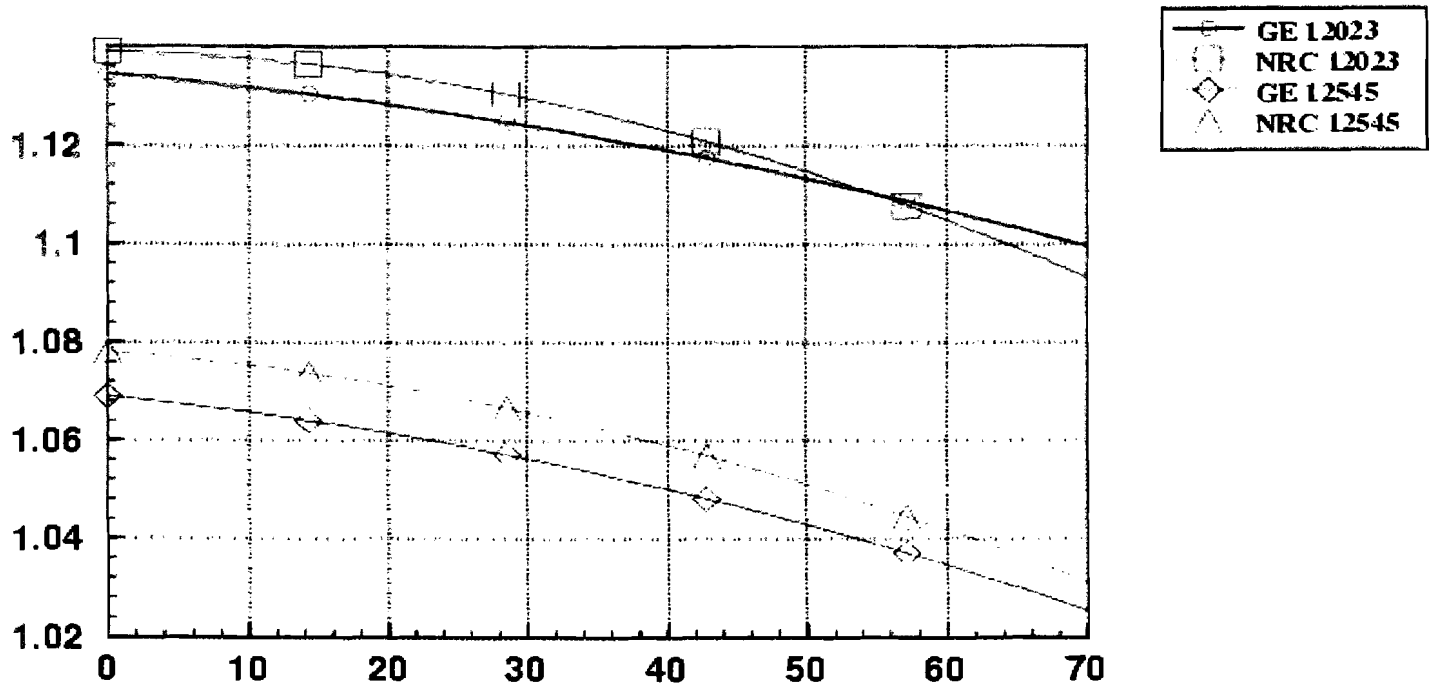


Figure 2 Comparison of Void Reactivity between NRC and GE Methods for Sample Core

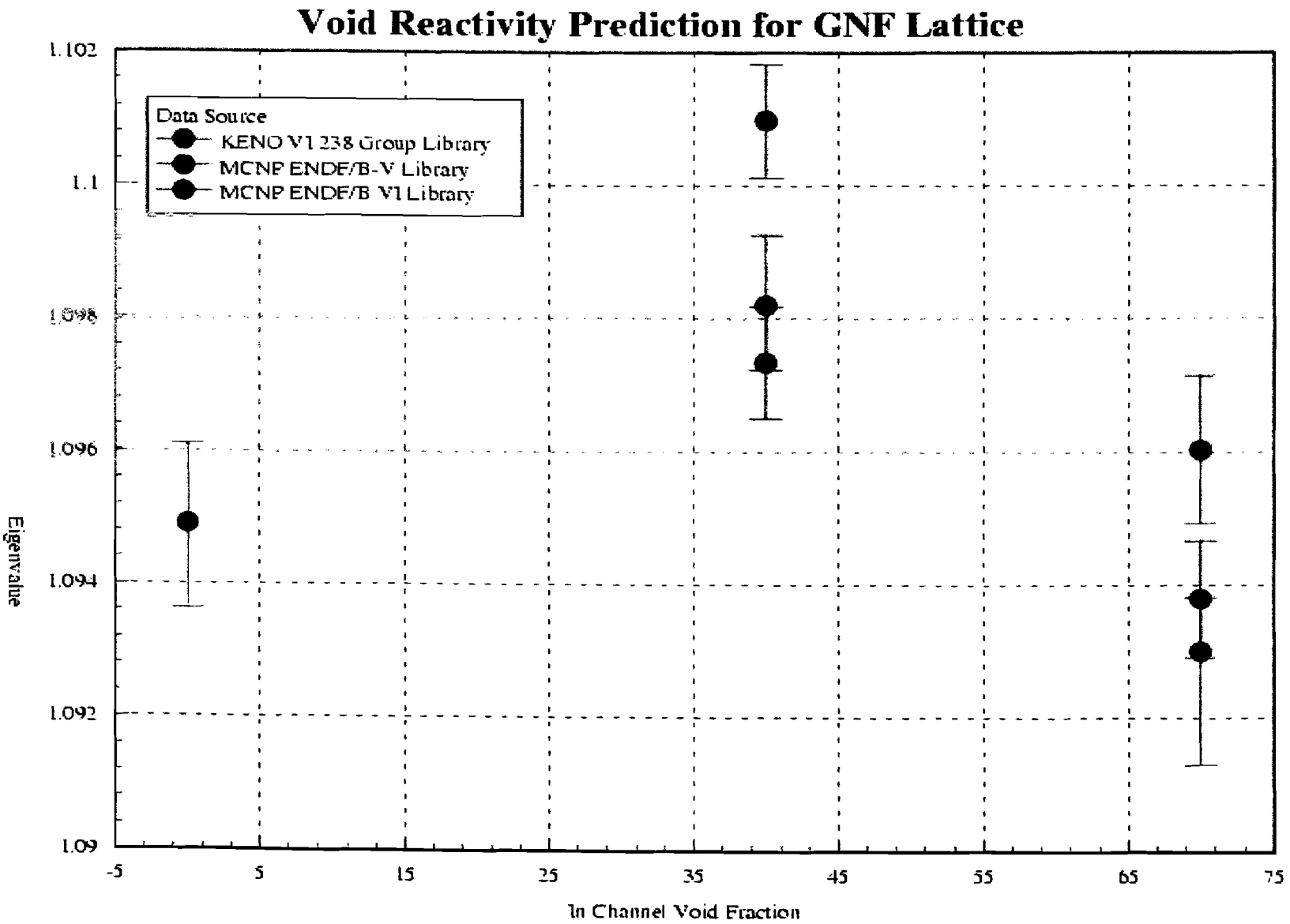


Figure 6 Comparison of Different Monte Carlo Evaluations of the Same GNF Lattice

Validation

- Non-valve closure transients were considered, but did not form a large part of our review conclusion
- Staff conclusions regarding SPERT predictions differ from GNF
- Staff's own methods validate very well against SPERT demonstrating that three-dimensional diffusion theory codes can predict test
- GNF results do not compare well with experiment - not considered in our review because of proposed application

Lessons Learned

- Even difficulties can be successes
- Work harder at defining problems that eliminate cross section effects
- Require that upstream codes needed to properly perturb input stream information be supplied
- Don't jump to conclusions - THINK!

TRACG Analysis of Anticipated Operational Occurrences

Review of Uncertainty Evaluation

Y. Orechwa

NRR/DSSA/SRXB

Review Topics

- Model Uncertainties and Biases

- Combination of Uncertainties to Estimate Design and Operating Limits

TRACG

Neutronic Model:

$$\underline{\underline{A}}(\underset{\sim}{\theta}, \underset{\sim}{\psi})\,\underset{\sim}{P}(\underset{\sim}{r}, t) = \underset{\sim}{S}(\underset{\sim}{r}, t)$$

Thermal-Hydraulic Model:

$$\underline{\underline{B}}(\underset{\sim}{\phi}, \underset{\sim}{P})\,\underset{\sim}{\psi}(\underset{\sim}{r}, t) = Q(\underset{\sim}{r}, t)$$

Initial and Boundary Conditions

$$\underset{\sim}{\theta} \sim f_N(\mu_\theta, \sigma_\theta^2) \qquad \underset{\sim}{\phi} \sim f_{TH}(\mu_\phi, \sigma_\phi^2)$$

$\therefore$ Determination of Model Uncertainties and Biases

$\Rightarrow$ estimate $f(\mu, \sigma^2)$

TRACG Solution:

$$\underset{\sim}{\Psi}^{TRACG}(\underset{\sim}{r}, t \mid \underset{\sim}{\Theta}, \underset{\sim}{\alpha}) \equiv \text{thermal-hydraulic conditions at } (\underset{\sim}{r}, t)$$

$$\Psi_k^{TRACG} \sim \text{distribution function}$$

$\Rightarrow$ **Design Limits**

$$CPR = \frac{q_{crit}^{GEXL}(\underset{\sim}{\Psi}^{TRACG})}{q^{TRACG}(\underset{\sim}{\Psi}^{TRACG})}$$

$\Rightarrow$ **Operating Limits**

Model Uncertainties and Biases of $\underset{\sim}{\theta}$, $\mathcal{L}$

- **Identify Phenomena that have an impact**

- **Establish nominal values, biases, and uncertainties for the model parameters in TRACG associated with the phenomena identified above.**

  - Separate effects test facility data
  - Integral test facility data
  - Component qualification test data
  - BWR plant data
  - Code comparisons
  - Engineering judgement

- **Evaluate normality and estimate distribution parameters for $\underset{\sim}{\theta}$ and $\underset{\sim}{\phi}$.**

- **Sensitivity of $\Delta CPR/ICPR$ to variation in each model parameter for a turbine trip without bypass.**

Combination of Uncertainties

A. Estimation of Design Limits

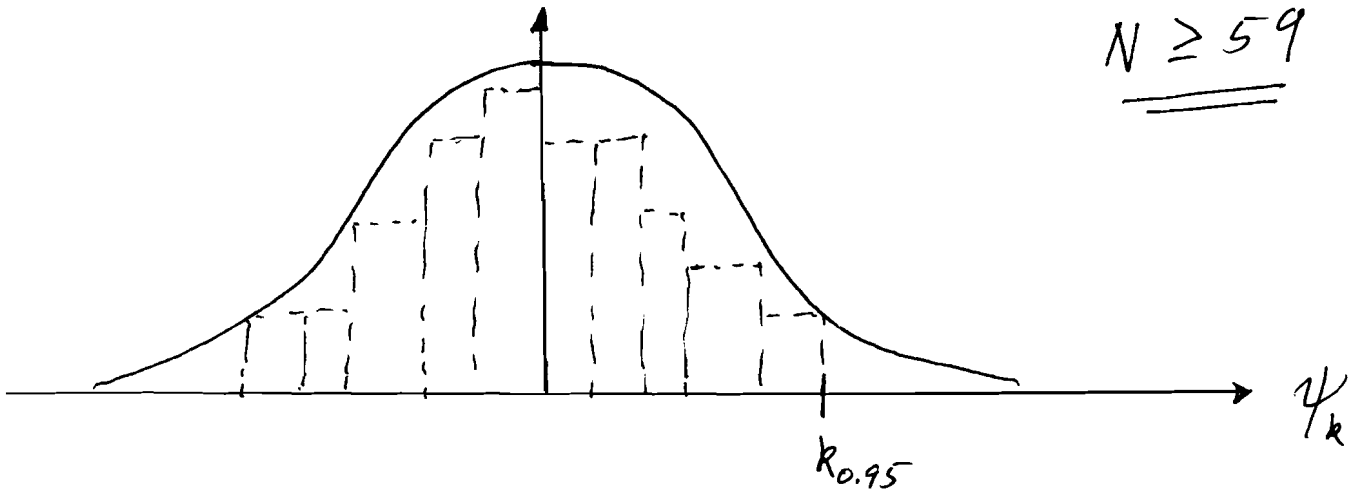
Design Parameters

$$\psi_k = \psi_k(\underline{r}, t \mid \underset{\sim}{\theta}, \underset{\sim}{\phi})$$

where

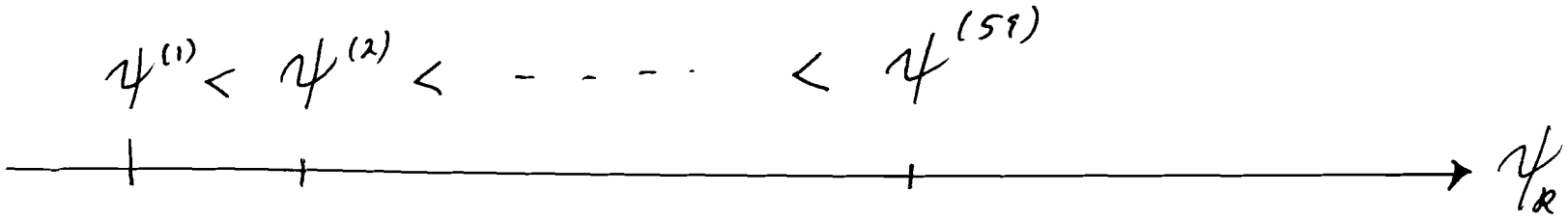
$$\underset{\sim}{\theta} \sim f_\theta(\mu_\theta, \sigma_\theta^2) \qquad \underset{\sim}{\phi} \sim f_\phi(\mu_\phi, \sigma_\phi^2)$$

I. Normal Theory



$$\psi_k \leq \overline{\psi}_k + z_{0.95} \times \sigma_\psi$$

II. Order Statistics



$$\psi_k \leq \psi^{(59)} \quad \text{at } 95\%$$

Note: Normal Theory intervals are likely to be much smaller than the Order Statistic estimates.

B. Determination of Operating Minimum Critical Power Ratio

- **Safety Limit Minimum Critical Power (SLMCPR)**

  "Value of CPR at which less than 0.1 % of the rods in the core are expected to experience boiling transition"

- **ΔCPR**

  "Change in CPR due to transient event"

- **OLMCPR = SLMCPR + ΔCPR**

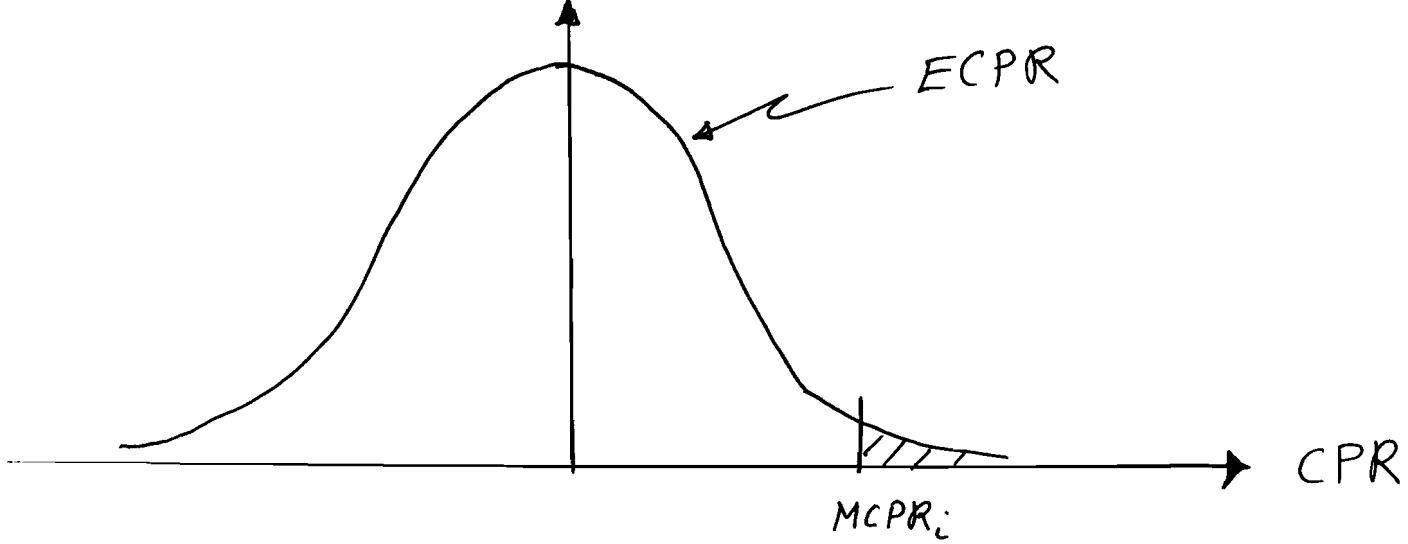
Computation of the Probability of a Rod Experiencing Transition Boiling

- **Experimental Data (Atlas facility):**

$$ECPR \equiv \frac{q^{GEXL}(\underset{\sim}{\psi}^{Exp})}{q^{Crit}_{Exp}}$$

- **Computed by TRACG (Reactor):**

$$MCPR \equiv \frac{q^{GEXL}(\underset{\sim}{\psi}^{TRACG})}{q_{TRACG}}$$



$$P_i = \int_{MCPR_i}^{+\infty} f_{ECPR}(CPR \mid \mu, \sigma)\, d\,CPR$$

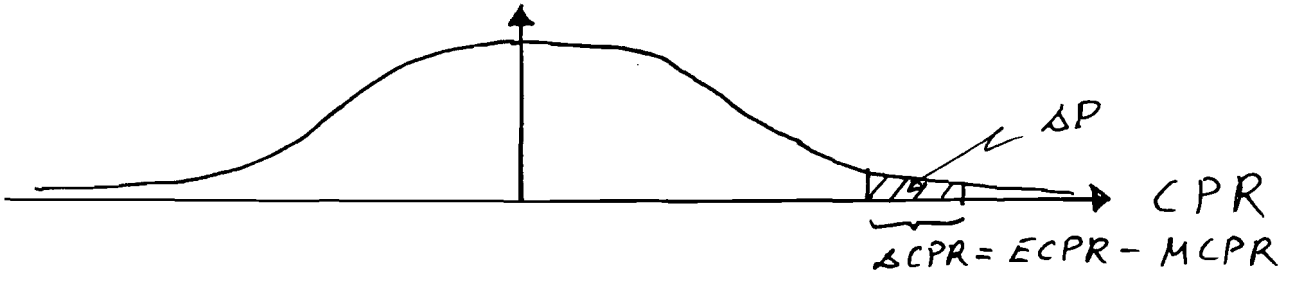
only if $f_{ECPR} = f_{MCPR}$

Engineering Judgement

I.

$$ECPR \cong MCPR + \underbrace{\frac{\partial MCPR}{\partial \underset{\sim}{\psi}^{TRACG}}}_{<< 1.0} \left(\underbrace{\underset{\sim}{\psi}^{TRACG} - \underset{\sim}{\psi}^{exp}}_{\lesssim 1.0} \right)$$

II.



$$\Delta P = \int_{\Delta CPR} \left(\int_{ECPR} f(CPR/\mu,\sigma)\, d\,CPR \right) \approx 0$$

Determination of OLMCPR

- Generic (by class and type) distribution of ΔCPR/ICPR via TRACG trials
- Nominal (reactor specific) TRACG trasient calculation of ΔCPR/ICPR
- Random trials of ICPR

$$MCPR_i = ICPR_i \left[1 - \left(\frac{\Delta CPR}{ICPR} \right)_i \right]$$

Compute the Number of Rods Subject to Boiling Transition (NRSBT)

if $\overline{NRSBT} = 0.1\%$

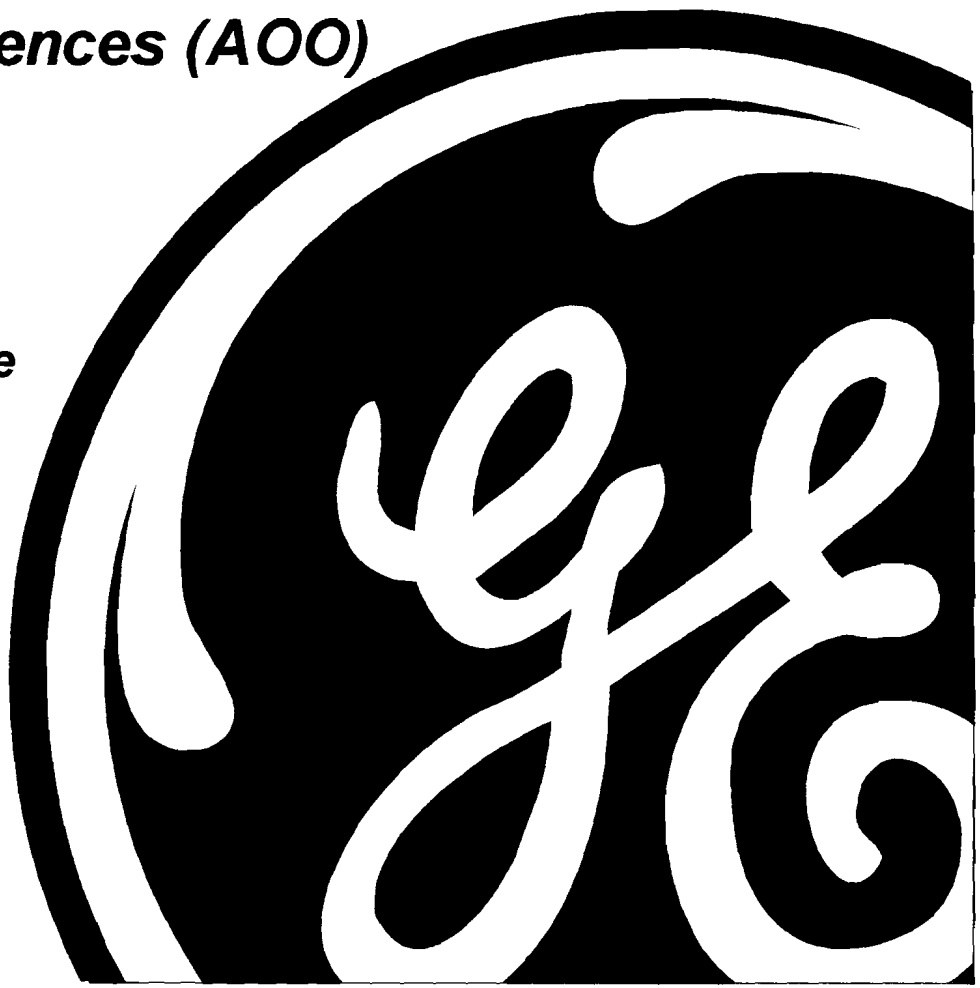
Initial minCPR = OLMCPR

R

GE Nuclear Energy

TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses

ACRS Thermal / Hydraulics Subcommittee
August 22, 2001



Introductions

James F. Klapproth (GENE)
Manager
Engineering and Technology

Jens G. M. Andersen (GNF-A)
Project Manager
TRACG Development

Francis T. Bolger (GENE)
Team Leader
Transient Analyses

Charles L. Heck (GNF-A)
TRACG02A Responsible Engineer
Technology Development

Brian R. Moore (GNF-A)
Team Leader
Technology Development

Antonio Possolo (CRD)
Applied Statistics
GE CR&D

Bharat Shiralkar (GENE)
Project Manager
TRACG LOCA Application

Overview

- **TRACG Application for AOO Transients**
  - Extensive documentation on TRACG submitted to NRC
  - NRC Review
    - Meetings and communication with NRC
    - Request for additional information and GE responses
  - ACRS T/H Subcommittee review
    - Response to Subcommittee Comments (11/13-14/00 Meeting)
    - Comment on NRC TRACG SBWR Review
- **Concluding Remarks**

Scope: Application of TRACG for BWR Transients

- **Plants:** **BWR/2/3/4/5/6**
- **Events:** **Anticipated Operational Occurrences (Transients)**
  - *Increase / Decrease in Reactor Pressure*
  - *Increase / Decrease in Core Flow*
  - *Increase / Decrease in Reactor Coolant Inventory*
  - *Decrease in Core Coolant Temperature*
- **Documentation**
  - *TRACG Licensing Application Framework for AOO Transient Analyses, NEDC-32900P*
  - *TRACG Model Description LTR, NEDE-32176P, Revision 2*
  - *TRACG Qualification LTR , NEDE-32177P, Revision 2*
  - *TRACG Application LTR for AOO Transient Analyses, NEDE-32906P*
  - *TRACG02A Users Manual, NEDC-32956P*
  - *TRACG02A Source Code and Sample Problems*
- **Review Scope**
  - *SER for Application of TRACG to BWR AOO Transients*
    - *Applicability of TRACG for AOO Transients*
    - *Qualification*
    - *Application Methodology for AOO Transients*

Time Line

• ***Plan and Road Map for TRACG AOO Application***	***May 1999***
• ***All TRACG documents submitted***	***February 2000***
• ***Review Kick-off***	***March 2000***
– *NRC and ACRS*	
• ***NRC Acceptance of TRACG for Review***	***April 2000***
• ***NRC Review Concerns***	***September 2000***
• ***ACRS T/H Subcommittee Review***	***November 2000***
• ***NRC Requests for Additional Information (RAI)***	
– *23 Requests for Additional Information (RAI)*	
– *Responses provided to all RAIs*	
– *All issues resolved*	
• ***Draft Safety Evaluation Report (SER)***	***July 2001***
• ***ACRS T/H Subcommittee Review***	***August 2001***
• ***SER on TRACG Application to AOO Transients***	***September 2001***

Review of TRACG Application to BWR AOO Transients

- **Extensive Documentation Submitted to NRC**
  - *Model Description, Qualification, Application Methodology*
  - *TRACG Code Installed on NRC Computers*
    Users Manual, Source Code and Test Problems
- **Extensive Prior NRC Reviews and Acceptance of TRACG Applications**
  - *Benchmark code for current LOCA, Transient, ATWS and Stability Applications*
  - *SBWR Project*
- **Extensive Communication with NRC during Review**
  - *Regular communication with NRC (meetings, teleconferencing, e-mail)*
  - *Support for TRACG installation and benchmarking against NRC codes*
  - *ACRS T/H Subcommittee Review*
  - *23 RAI received (Including RAI generated from ACRS comments)*
  - *Primarily Additional information and Clarification*
  - *Responses provided and all issues resolved*
  - *Very good and professional interaction with NRC reviewers*

23 RAIs

- Test case for benchmarking of TRACG against NRC codes
- SPERT test case provided to NRC
- Impact of burnup on transient MCPR documented in NEDE-32906P, Section 6.2
- Impact of power distribution on transient MCPR documented in NEDE-32906P, Section 6.2
- Gamma smearing included in lattice calculations
- Time step and convergence sensitivity studies for kinetics solution provided.
- Implicit integration solver used for all AOO transients
- Central differencing not used
- Impact of channel grouping documented in NEDE-32177P, Section 8.2
- PANAC10/TGBLA04 is the basis for TRACG kinetics
- Impact of fuel rod grouping
- Basis for uncertainty in void coefficient
  Basis for uncertainty in void coefficient
  Clarification of normality test
- Reference for pellet heat transfer parameters
- Clarification of statistical method NEDE-32906P, Section 7.3.3-7.5.1 revised
- Clarification of statistical limits
- Clarification of statistical method
- Clarification of statistical method
- Formulation of field equations for steam air mixtures
- Plant test cases for AOO transients provided to NRC
- Resolution of differences between TRACG and NRC benchmark calculations
- Adequacy of TRACG pressure drop calculation
- Clarification of TRACG time step control

All Issues Resolved and Draft SER Issued

Response to Subcommittee Comments (11/13-14/00 Meeting)

Comments on TRACG Code Models/Correlations -
November 13-14, 2000 ACRS T/H Phenomena Subcommittee Meeting

One comment received January 26, 2001

- Response to RAI 19

Additional comments received August 7, 2001

- The momentum equations do not appear to properly account for Reynolds stress.
- The origin of the equations are not clearly specified pursuant to the regulatory position in the draft regulatory guide on code submittals.
- Partition of wall shear stress is not treated consistently in the documentation
- The modeling of Tee components is not clearly explained and its adequacy is not apparent.
- There is no definitive modeling of flow regime transition, and the logic of this modeling is not clear.
- Regarding the interfacial shear model, key terms in the equations are not explained, in particular the relationship between the "c_i" and "c_0" terms needs to be clarified.
- GE has an inconsistent treatment for modeling of interfacial area and the heat transfer coefficients.

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***The momentum equations do not appear to properly account for Reynolds stress.***

- **Reynolds stress not included in TRACG**
- **Stresses due to interfacial shear and wall shear are included through empirical correlations**
- **Wall shear is the dominant source of stress in BWR applications**
- **TRACG models for interfacial shear and wall shear**
  - Interfacial shear model is described in NEDE-32176P, Rev. 2, Section 6.1
  - Wall shear model is described in NEDE-32176P, Rev. 2, Section 6.2
- **Extensive assessment**
  - Assessment for the applicability of these models over the range of interest for BWR applications is provide in the referenced sections of NEDE-32176P, Rev. 2
  - Extensive qualification documented in NEDE-32177P, Rev. 2

Pressure Drop and Void Fraction

- ***Wall shear and Pressure drop***
  - *Models apply for BWR operating range*
  - *Pressure drop well predicted.*
    Bundle pressure drop predicted within 5% bias and uncertainty
    Other pressure drops typically within 10%

- ***Interfacial shear and void fraction***
  - *Models apply for BWR operating range*
  - *Void fraction well predicted.*
    Bundle void fraction predicted with 2-3% uncertainty
    Other void fractions typically within 5%

- ***Pressure drop and void fraction uncertainties accounted for in the application methodology***

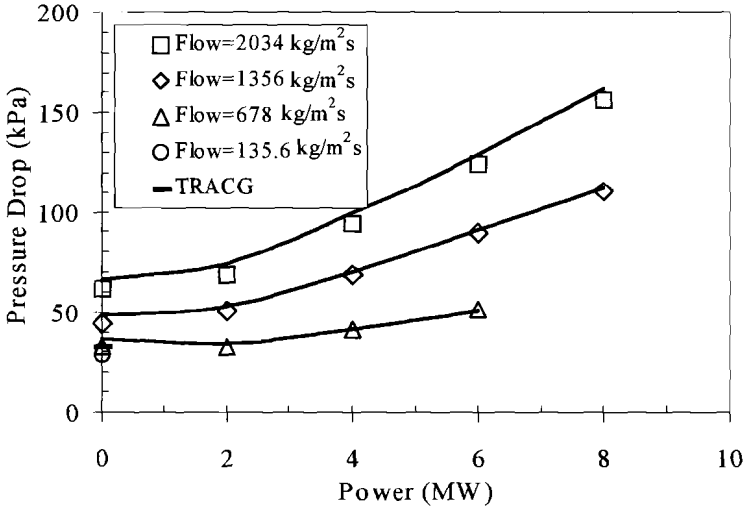


Figure 3.5-3. ATLAS Bundle Pressure Drop Comparison

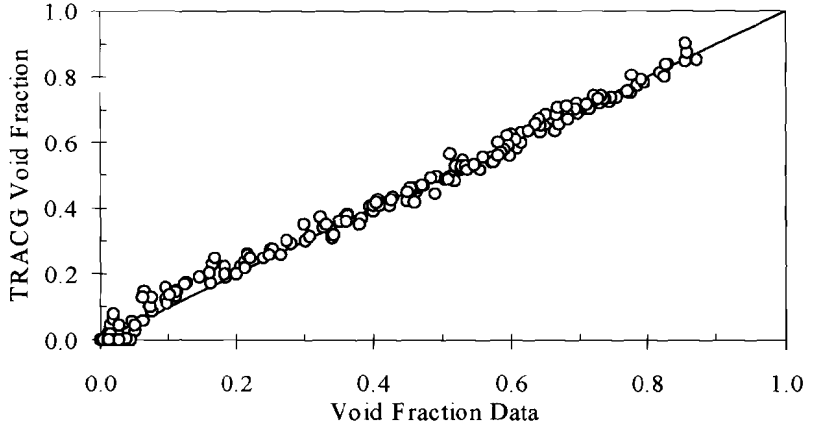


Figure 3.1-5. FRIGG Void Fraction Distribution, Pressure 6.8 MPa

BWR Flow and Phase Distribution Adequately Calculated by TRACG

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***The origin of the equations are not clearly specified pursuant to the regulatory position in the draft regulatory guide on code submittals.***

- **The equations originate with the work by Stuhmiller as indicated by Reference [3-9] on page 3.1-3 of NEDE-32176P, Rev. 2.**
  - J.H. Stuhmiller, *A Review of the Rational Approach to Two-Phase Flow Modeling*, Jaycor, Del Mar, California, PB-255 548, July 1976.
- **Based on Ishii's formulation of two-phase equations**
  - M. Ishii, Thermo-Fluid Dynamic Theory for Two-Phase Flow, Collection de la Direction des Etudes et Recherces D'Electricity de France, Eyroles, Paris 1975.
- **Basic formulation of TRACG equation is the same as in TRAC-M**

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***Partition of wall shear stress is not treated consistently in the documentation.***

- **Partitioning of the wall shear stress is described in detail in the TRACG Model Description, NEDE-32176P, Rev. 2, Section 6.1**
  - Basis for partitioning described in Section 6.1.2

    Based on integration of shear stress for each phase
  - Application to various flow regimes described in Section 6.1.3
  - Wall shear stress calculated from empirical friction factor
  - Partitioning of wall shear stress most appropriate for dispersed flow
  - Partitioning of wall shear stress:

    Does not affect total frictional pressure drop since this is calculated from the mixture equation

    Pressure drop is well calculated by TRACG NEDE-32176, Section 6.2
    NEDE-32177, Section 3.5
    NEDE-32906P, Section 5.0

    Does affect relative velocity between phases and void fraction

    Void fraction is well calculated by TRACG NEDE-32176P, Section 6.1
    NEDE-32177P, Section 3.1
    NEDE-32906P, Section 5.0

Pressure Drop and Void Fraction

- ***Wall shear and Pressure drop***
  - *Model apply for BWR operating range*
  - *Pressure drop well predicted.*
    Bundle pressure drop predicted within 5% bias and uncertainty
    Other pressure drops typically within 10%

- ***Interfacial shear and void fraction***
  - *Void fraction well predicted.*
    Bundle void fraction predicted with 2-3% uncertainty
    Other void fractions typically within 5%

- ***Pressure drop and void fraction uncertainties accounted for in the application methodology***

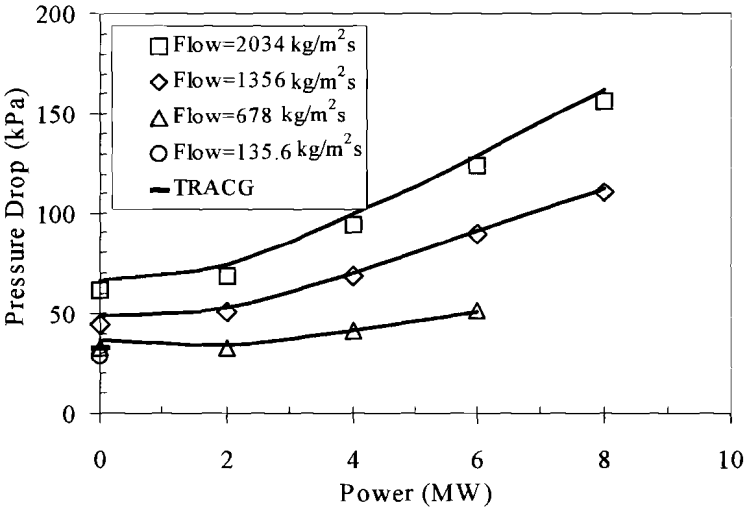


Figure 3.5-3. ATLAS Bundle Pressure Drop Comparison

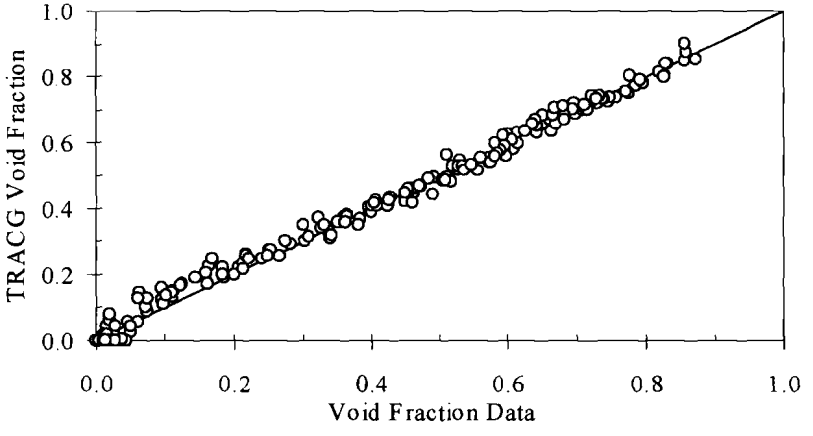


Figure 3.1-5. FRIGG Void Fraction Distribution, Pressure 6.8 MPa

Pressure Drop and Phase Distribution Adequately Calculated for BWR Applications

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***The modeling of Tee components is not clearly explained and its adequacy is not apparent.***

- **The modeling of the generic TEE component is described in NEDE-32176, Section 7.4**
  - Source terms for mass, momentum and energy included
  - Models for phase separation at junction not included
- **Additional models for pressure drop and phase separation incorporated in TEE based component where significant.**
  - Jet Pump

    Mechanistic model for mixing of drive and suction flow, Momentum transfer, M-N characteristics

Model description	NEDE-32176, Section 7.6
Qualification	NEDE-32177, Section 4.1 and 7
Application	NEDE-32906, Section 5

  - Steam Separator

    Mechanistic model for flow separation, Carry under and carry over, Pressure drop

Model description	NEDE-32176, Section 7.7
Qualification	NEDE-32177, Section 4.2 and 7
Application	NEDE-32906, Section 5

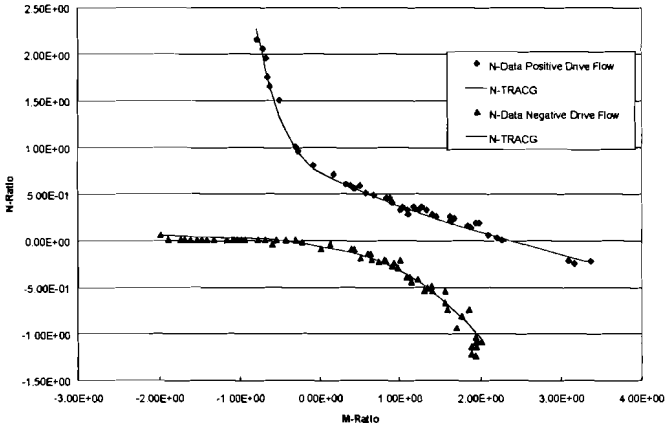
  - Fuel channel

    Channel leakage flow

Model description	NEDE-32176, Section 7.5
Qualification	NEDE-32177, Section 5 and 7
Application	NEDE-32906, Section 5
- **Models described in detail**
- **Model accuracy quantified and found to be adequate**

TEE components

- **Jet Pump**
  - *Mixing of drive and suction flow,*
  - *Momentum transfer*
  - *M-N characteristics*
- **Steam Separator**
  - *Flow separation*
  - *Carry under and carry over*
  - *Pressure drop*
- **Models apply for BWR operating range**
- **Flow split and phase separation well predicted**
- **Model uncertainties accounted for in the application methodology**



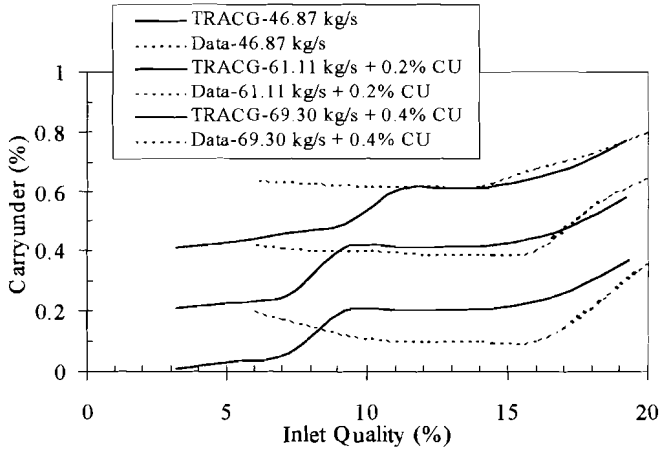


Figure 4.2-4. Comparison of Carryunder vs. Inlet Flow for BWR/4&5 2-Stage Separator, Submergence – 0.635m (25 inches)

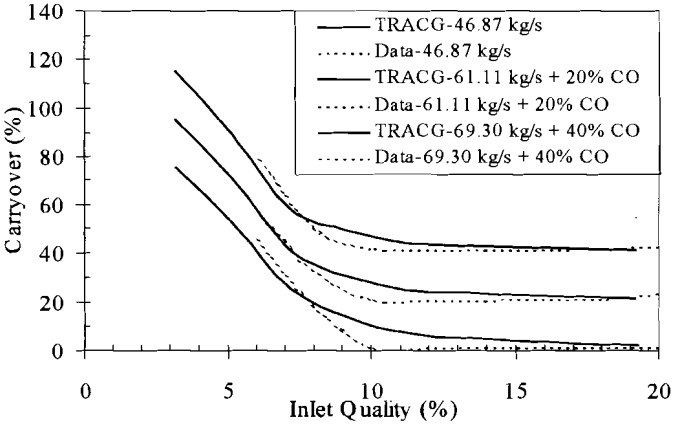


Figure 4.2-5. Comparison of Carryover vs. Inlet Flow for BWR/4&5 2-Stage Separator, Submergence – 0.635m (25 inches)

Models for Flow and Phase Distribution in Junctions Adequate for BWR Applications

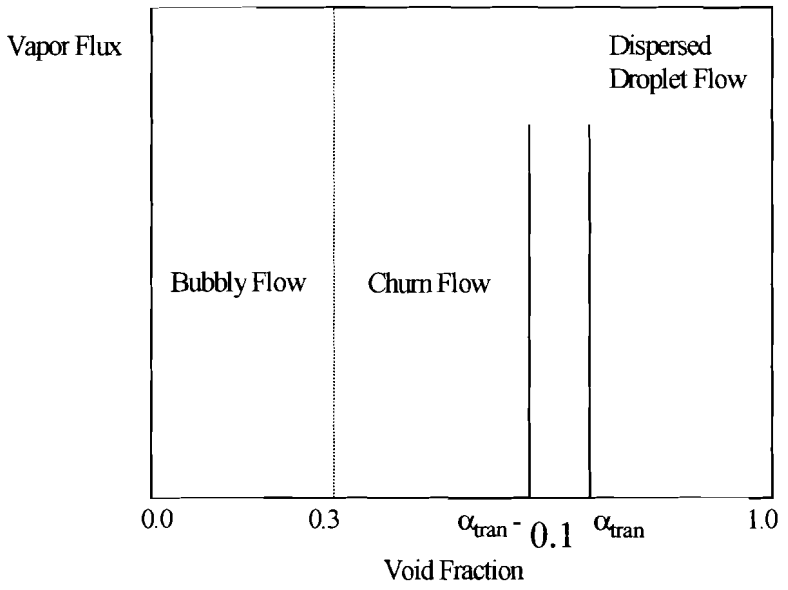
Response to Subcommittee Comments (11/13-14/00 Meeting)

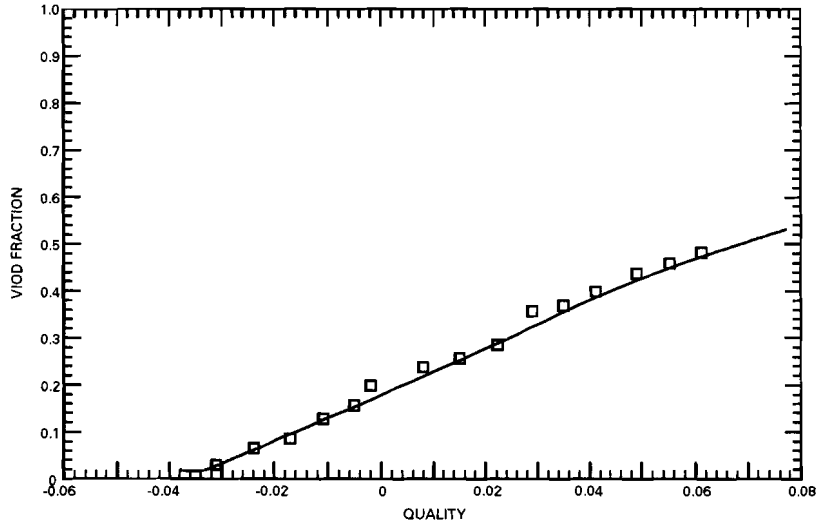
❑ ***There is no definitive modeling of flow regime transition, and the logic of this modeling is not clear.***

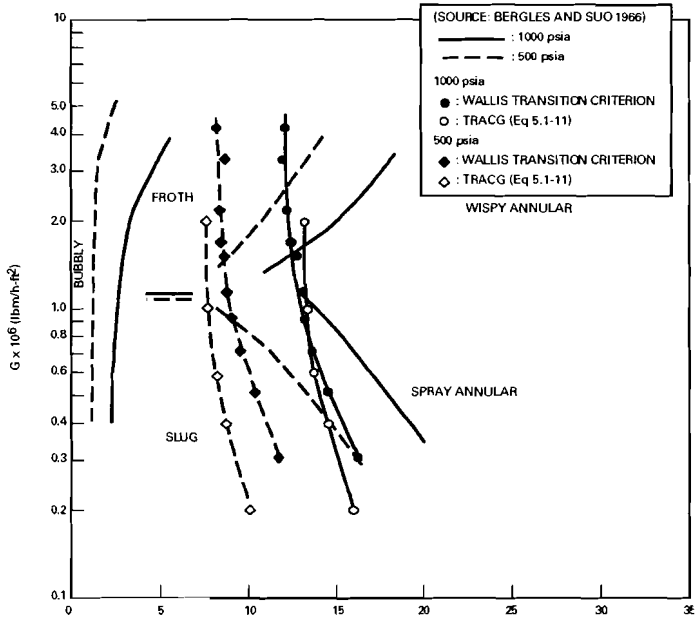
- **TRACG uses a simple flow regime map where the flow regime is determined as function of thermal hydraulic conditions (flow rate, void fraction...) and wall condition**
- **Flow regime map described in NEDE-32176, Section 5**
  - Flow regime map is used consistently by all TRACG component
  - Flow regime map used consistently for calculation of wall heat transfer, interfacial heat transfer and shear.
  - Reasonable agreement with more complex flow regime maps
  - Qualification shows that TRACG accurately calculates:
    - Void fraction
    - Pressure drop
    - Heat transfer

Flow Regime Map

- **TRACG flow regime map**
- **Qualification shows that TRACG accurately calculates:**
  - *Void fraction*
  - *Pressure drop*
  - *Heat transfer*
- **Models apply for BWR operating range**
- **Model uncertainties accounted for in the application methodology**







Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***Regarding the interfacial shear model, key terms in the equations are not explained, in particular the relationship between the "c_i" and "c_0" terms needs to be clarified.***

- **The interfacial shear model is described in NEDE-32176, Section 6.1**
- **The relation ship between c_i and C_0 is defined in NEDE-32176 Equations 6.1-24 and 6.1-25**

$$\bar{v}_r = \frac{1 - \langle\alpha\rangle C_o}{\langle 1 - \alpha\rangle}\bar{v}_v - C_o\bar{v}_\ell \qquad C_0 = \frac{\langle\alpha j\rangle}{\langle\alpha\rangle\langle j\rangle}$$

$$\langle f_{\ell v}\rangle = \bar{c}_i\left|\bar{v}_r\right|\bar{v}_r$$

$$\langle f_{\ell v}\rangle = \bar{c}_i\left|\frac{1 - \langle\alpha\rangle C_o}{\langle 1 - \alpha\rangle}\bar{v}_v - C_o\bar{v}_\ell\right|\left(\frac{1 - \langle\alpha\rangle C_o}{\langle 1 - \alpha\rangle}\bar{v}_v - C_o\bar{v}_\ell\right)$$

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***GE has an inconsistent treatment for modeling of interfacial area and the heat transfer coefficients.***

- **TRACG uses a simple flow regime map where the flow regime is determined as function of thermal hydraulic conditions (flow rate, void fraction...) and wall condition**
  - Flow regime map described in NEDE-32176, Section 5
  - Flow regime map is used consistently by all TRACG components
  - Flow regime map used consistently for calculation of wall heat transfer, interfacial heat transfer and shear.
  - Interfacial area and heat transfer coefficients chosen consistent with flow regime
  - Flow regime map: NEDE-32176, Section 6
  - Interfacial heat transfer NEDE-32176, Section 6.5
  - Wall heat transfer NEDE-32176, Section 6.6

Interfacial Area and Heat Transfer

- **Interfacial heat transfer calculated by:**

$$q_{\ell i} = A_i h_{i\ell}\left(T_\ell - T_{sat}\right) \;;\quad q_{vi} = A_i h_{iv}\left(T_v - T_{sat}\right) \qquad \Gamma_g = \frac{q_{\ell i} + q_{vi}}{h_{fg}}$$

- **Correlated interfacial area and heat transfer coefficients (HTC)**
- **Bubbly/churn flow**
  - *Area given by critical Weber number for bubbles*
  - *Vapor HTC from conduction in spherical particle with empirical factor to account for internal circulation*
  - *Liquid HTC from flow over spherical particle*
- **Annular flow**
  - *Area calculated from wall surface area and film thickness.*
  - *Vapor HTC correlated to Stanton number*
  - *Liquid HTC based on conduction across liquid film*
- **Droplet flow**
  - *Area given by critical Weber number for droplets*
  - *Vapor HTC from flow over spherical particle*
  - *Liquid HTC from conduction in spherical particle with empirical factor to account for internal circulation*
- **Two-phase level**
  - *Area given by surface area of free level*
  - *Based on free convection heat transfer*

Consistent Models for Interfacial Area and Heat Transfer

Comments on NRC TRACG SBWR Review

- **TRACG Model Description, LTR, NEDE-32176P, Rev. 0 and TRACG Qualification, LTR, NEDE-32177P, Rev. 1 Submitted to NRC for review for the SBWR project.**
  - *Application for AOO transients, LOCA, Stability and ATWS*
  - *Several Rounds of RAIs and GE responses*
  - *Revision 1 to Model Description Incorporated Responses to RAIs*
- **TRACG models and qualification were also reviewed by ACRS T/H Subcommittee**
- **SBWR project was cancelled in 1996 and the review of TRACG stopped.**
- **NRC issued letter on the status of the TRACG Review in 1996**
  - *NRC/GE Letter, T. R. Quay to J. E. Quin, dated July 6, 1996, "Staff Review of General Electric's (GE's) Licensing Topical Report (LTR), NEDE-32176P, TRACG Model Description", Revision 1*
  - *NRC/GE Letter, T. R. Quay to J. E. Quin, dated June 27, 1996, "Status Staff Review of of the TRACG Qualification (NEDE-32177, Rev. 1) and Application (NEDE-32178, Rev. 0) Licensing Topical Reports (LTRs)*

Issues Relevant for TRACG Application to BWR/2-6 AOO Transients Addressed in Current Submittal

Comments on NRC TRACG SBWR Review of TRACG Model Description, NEDE-32176P, Rev. 1

- **Resolution of Issues**
  - *Assessment of identified models when relevant for application to BWR/2-6 AOO transients included in TRACG Qualification LTR, NEDE-32177P, Rev. 2*
  - *Models important for BWR AOO transients included*
  - *Description of nuclear models included or referenced*

All Issues Relevant for TRACG Application to BWR/2-6 AOO Transients Addressed

Comments on NRC TRACG SBWR Review of TRACG Qualification, NEDE-32177P, Rev. 1

- ***Resolution of Issues***
  - *Definitions and Clarifications included*
  - *All Qualification has been repeated with TRACG02A*
  - *References to PIRT Tables included in TRACG Application Methodology LTR, NEDE-32906P, Rev. 0*
  - *Qualification specific to SBWR not included. Application is for BWR/2-6*
  - *Nodalization and time step sensitivity studies included*
  - *Model and correlation application ranges defined and compared to BWR operational parameters*
  - *Test parameter ranges additional information on test facilities included*
  - *Accuracy of qualification and model uncertainties quantified.*
  - *Some qualification not relevant for AOO transients not includes, e.g., low pressure film boiling and void fraction*

Comments on NRC TRACG SBWR Review of TRACG Qualification, NEDE-32177P, Rev. 1

- **Resolution of Issues - continued**
  - *Additional detail on CCFL model included in TRACG Model Description and TRACG Application Methodology LTRs*
  - *Additional qualification included in Model Description, e.g., interfacial heat transfer*
  - *Boiling transition evaluated from the GEXL correlation.*
  - *Additional plots and figures included*
  - *Typographical errors corrected*

All Issues Relevant for TRACG Application to BWR/2-6 AOO Transients Addressed

Concluding Remarks

- *Scope: BWR/2-6 AOO Transients*
- *Meets All Regulatory Requirements*
- *Demonstration of Model Capability and Applicability*
- *Extensive Review and Acceptance of TRACG*
- *Rigorous and Sound Statistical Methodology*
- *Application Methodology Demonstrated for All Event Types*

TRACG is Applicable to BWR/2-6 AOO Transients for Licensing Analysis

GL 96-06/EPRI INITIATIVE

INTRODUCTION -- BACKGROUND INFORMATION

- GL 96-06 WATERHAMMER & NUREG/CR-5220
- EPRI INITIATIVE PROPOSED 8/98
- ABOUT 24 PLANTS/12 UTILITIES PARTICIPATING
- TBR PRESENTED TO ACRS T/H SUBCOMMITTEE (11/99; 1/01)
- NRR REVIEWERS
  - JIM TATUM, NRR/DSSA/SPLB
  - WALTON JENSEN, NRR/DSSA/SRXB
  - GARY HAMMER, NRR/DE/EMEB

GL 96-06/EPRI INITIATIVE

REMAINING ISSUES FROM LAST MEETING

- ACRS T/H SUBCOMMITTEE:
  - + LIMITATIONS OF AIR RELEASE FRACTION TEST APPARATUS
  - + DETERMINATION OF "h" FOR CONDENSING HEAT TRANSFER
  - + SENSITIVITY OF "SCALING-UP" TEST DATA TO PLANT DESIGN

- NRR STAFF:
  - + PRESSURE RISE TIME PLOT WITH & W/OUT AIR IN VOID
  - + PLANT DESIGN VS. TEST APPARATUS FOR AIR RELEASE
  - + PULSE RISE TIME USED IN RBM
  - + SINGLE VS. MULTIPLE WATERHAMMER PULSES
  - + FLUID STRUCTURE INTERACTION -- ATTENUATION
  - + STRUCTURAL DAMPING VALUE USED FOR ANALYZED LOADS VS. MEASURED LOADS

GL 96-06/EPRI INITIATIVE

LATEST SUBMITTALS:

- JULY 10, 2001; REVISED TBR SECTIONS (ACRS ISSUES)
- AUGUST 9, 2001; LETTER RESPONSE (NRR STAFF ISSUES)

NRR REVIEW COMMENTS

- GOOD EFFORT BY THE INDUSTRY TO ESTABLISH ANALYTICAL METHODOLOGY; NOTABLE STRENGTHS INCLUDE:
  + PIRT
  + TESTING & DATA COLLECTION
  + ENDORSEMENT BY EXPERT PANEL MEMBERS

GL 96-06/EPRI INITIATIVE

NRR REVIEW COMMENTS (cont.)

- AREAS OF CONTINUING REVIEW -- THERMAL HYDRAULICS
  - + DETERMINATION OF AIR RELEASE FRACTION
  - + SCALING OF HEAT TRANSFER SURFACE AREA
  - + PRESSURE LIMITATIONS ASSOCIATED WITH CIWH DATA

- AREAS OF CONTINUING REVIEW -- MECHANICAL/STRUCTURAL
  - + PULSE RISE TIME PREDICTION
  - + SINGLE VS. MULTIPLE PULSE LOADING
  - + USE OF DAMPING VALUES; 2-3% (TYPICAL) VS. 0.1%

R

EPRI/Industry Collaborative Project to Support Resolution of GL 96-06 Waterhammer Issues

Vaughn Wagoner, CP&L, Chairman, Utility Advisory Group
Dr. Peter Griffith, MIT, Chairman, Expert Panel
Dr. Fred Moody, Consultant, Expert Panel
Dr. Ben Wylie, University of Michigan, Expert Panel
Dr. Avtar Singh, Project Manager, EPRI
Dr. Tom Esselman, President, Altran Corporation
Greg Zysk, Altran Corporation

NRC/ACRS Meeting
August 23, 2001

1

Program Objectives

- Understand the behavior of the system during the transient.
- Provide methodology to assure pressure boundary integrity – focus is on piping support loads.
- Minimize modifications to plant systems.
  - Adding supports or strengthening existing supports, if not necessary, will not increase overall plant safety.

2

Objective of Meeting

Address Issues raised by the ACRS T/H Subcommittee at our last meeting:

1. Test apparatus for determination of air release fraction.
2. Determination of the "h" in the "hA" term
3. Scale-up of the test data.

7

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2. Determination of the "h" in the "hA" term
3. Scale-up of the CCWH test data.

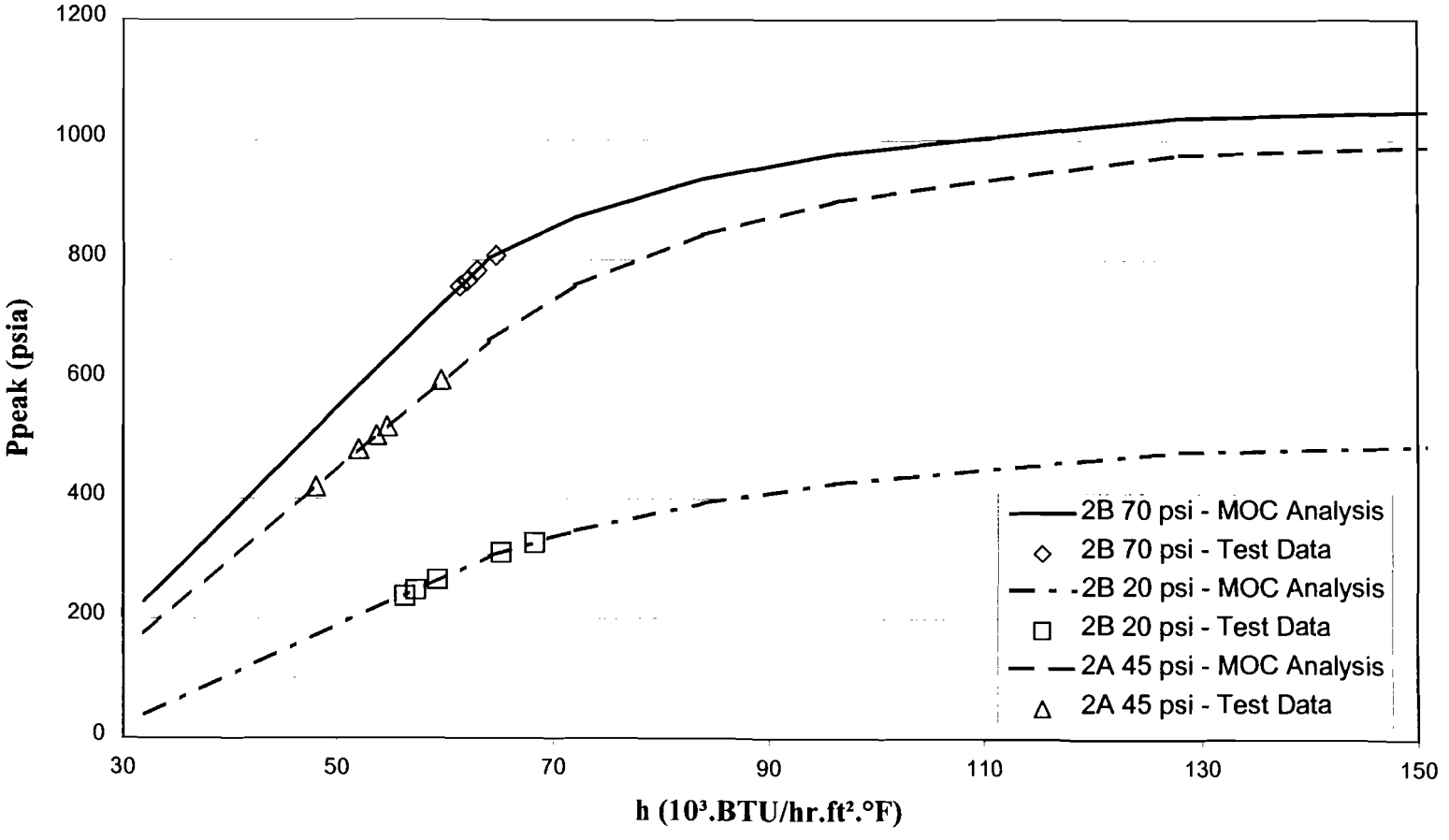
Steam Compression and Condensation

- During the final closure of the void, steam in the void will compress and pressurize.
- The mass of steam is reduced by condensation on water surfaces.
- Heat transfer from the pipe walls is not significant and is neglected.
- Condensing surfaces of the water is irregular but is taken to be the projected flow area of the water (A).
- Using the constant area (A), heat transfer coefficients (h) were determined from the test data to be up to 64,000 BTU/hr ft^2 F (hA = 2,652 BTU/hr F for 2" pipe area) to match the test data.
- The h coefficient was increased to 72,000 BTU/hr ft^2 F for Rigid Body Model (RBM) predictions.

Heat Transfer Coefficient from Test Data

- *h* was varied from 32,000 to 150,000 BTU/hr ft^2 °F in the MOC analysis and the waterhammer pressure calculated.
- The test data is compared to that MOC calculation.
- As *h* is increased, the column closure event becomes less dependent on the heat transfer at the steam/water interface, and the event becomes inertially dominated.

Heat Transfer Coefficient Sensitivity

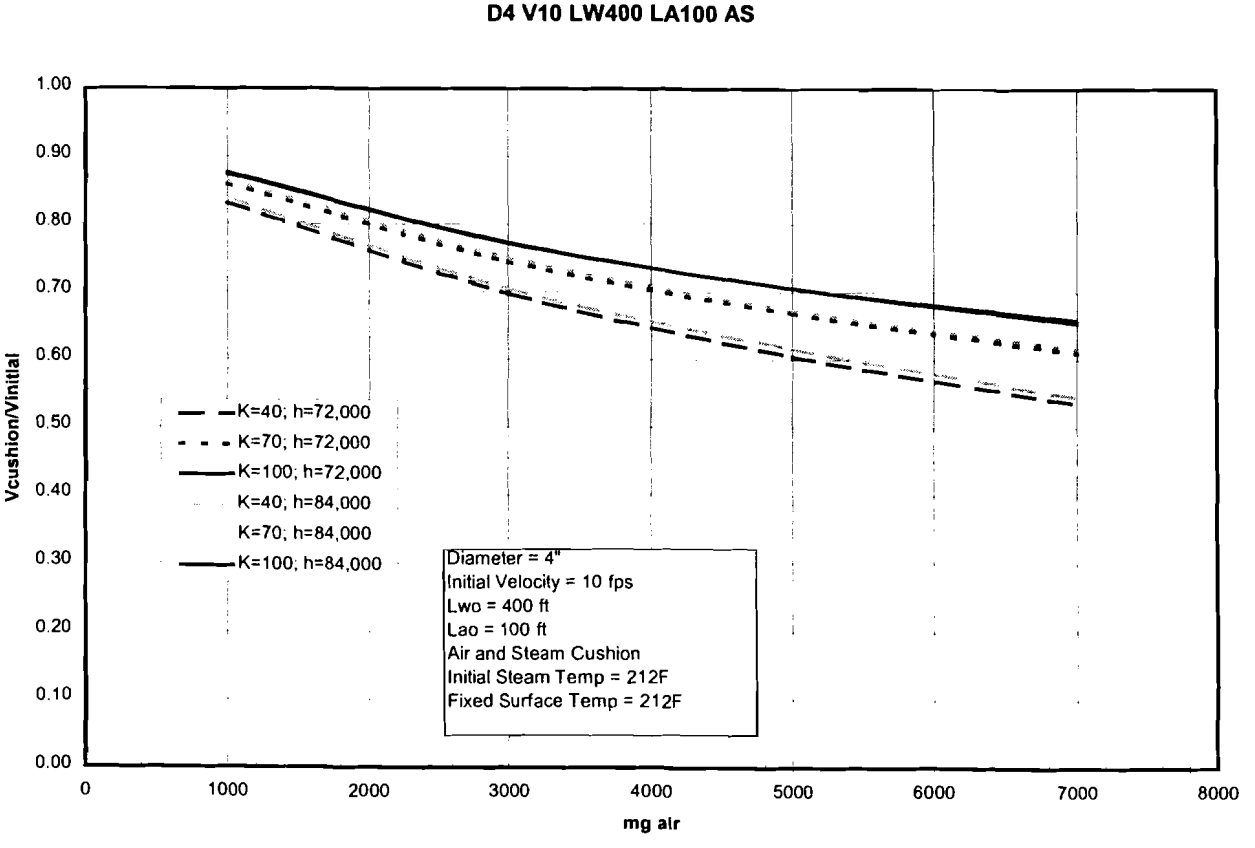


hA Sensitivity for RBM

- For plant application, the Rigid Body Model (RBM) was used to develop a series of curves showing the effects of void compression for various conditions.
- To assess the effect of variation in the hA on the RBM predictions waterhammer parameters, h was varied from 72,000 BTU/hr.ft^2.°F (h_{rec}) to 84,000 BTU/hr.ft^2.°F (25% above the largest h_{test}) in the Rigid Body Model equations.
- RBM curves were prepared for air and steam cushioning.

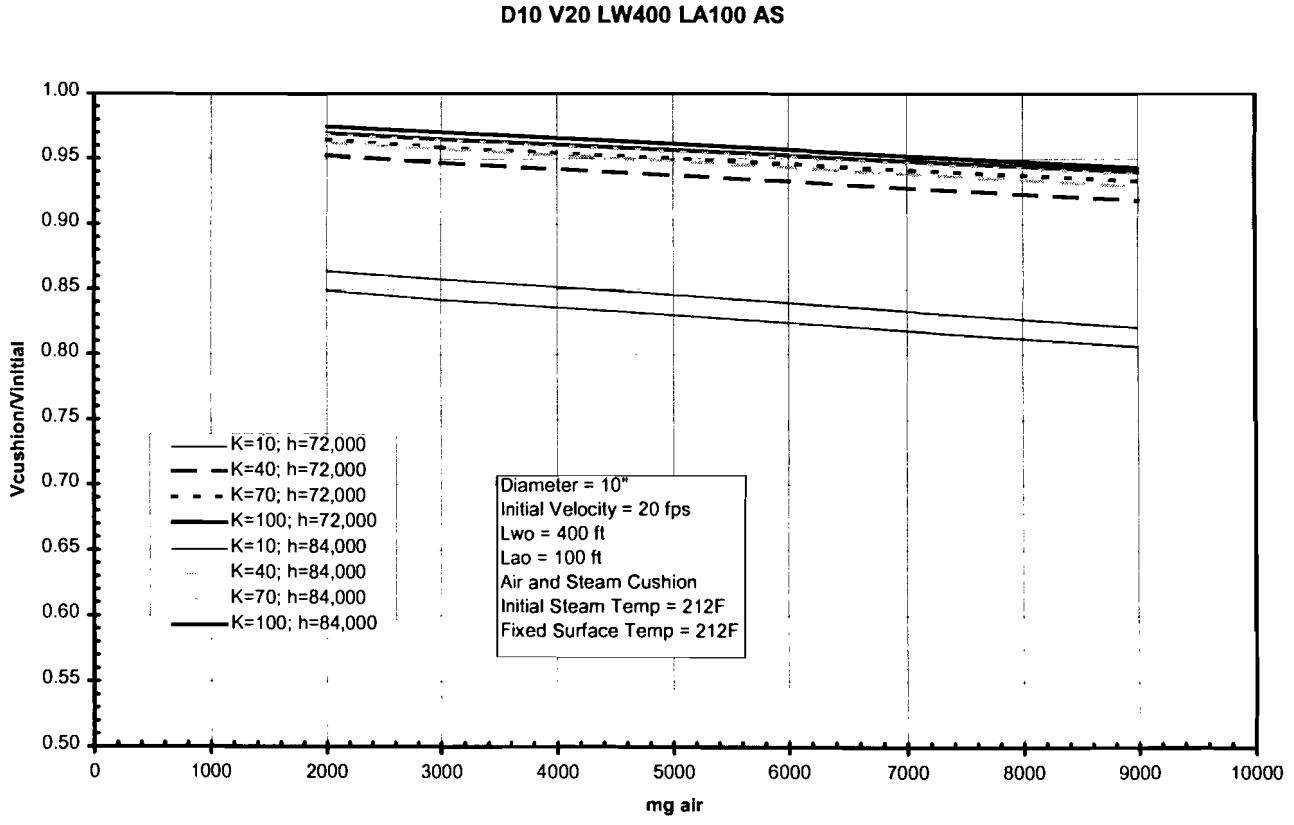
hA Sensitivity for RBM

For a 4" diameter pipe, the cushioned velocity calculated using h = 84,000 BTU/hr.ft^2.°F increases by approximately 1% of the initial velocity for the low K case (low pipe resistance model). The change is less for the other cases.



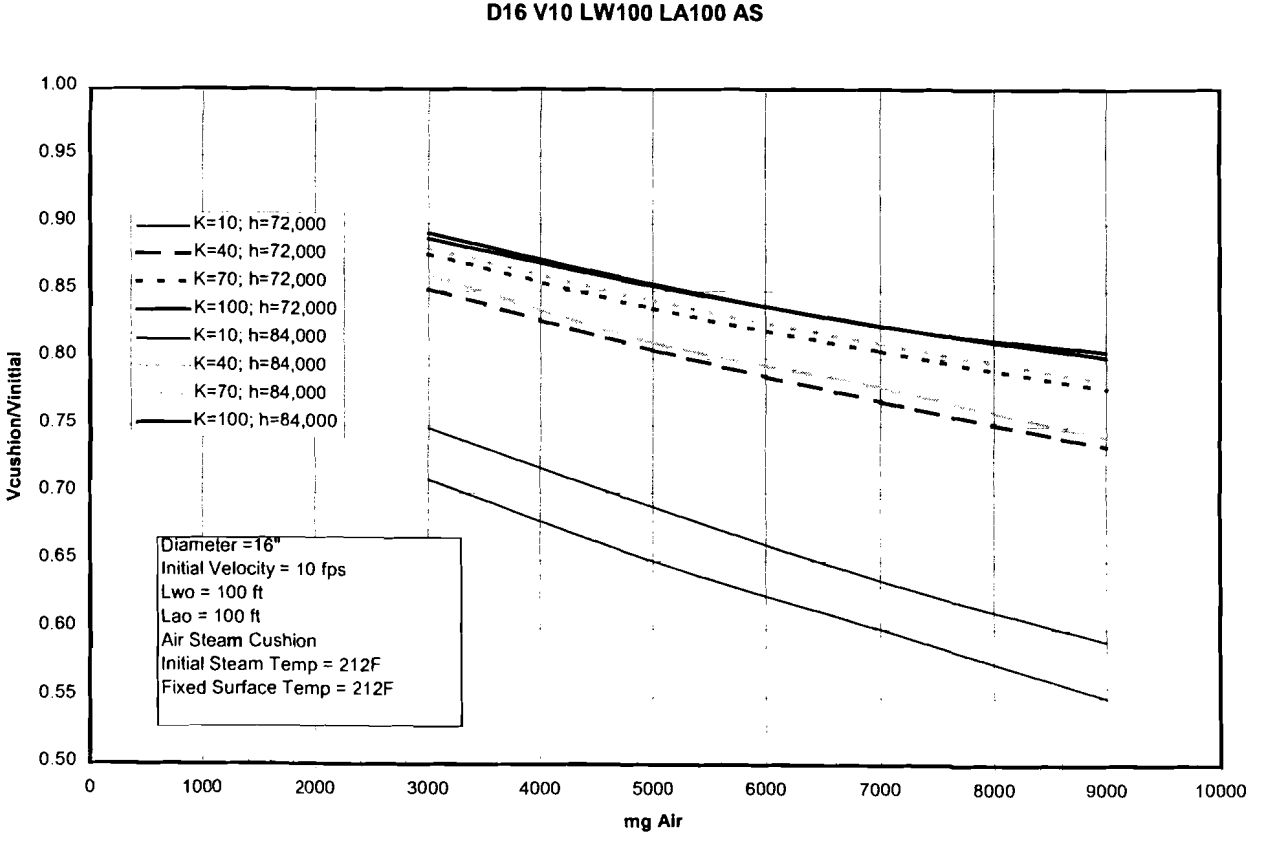
hA Sensitivity for RBM

For a 10" pipe, the cushioned velocity calculated using *h* equal to 84,000 BTU/hr.ft^2.°F increases by approximately 2% of the initial velocity for the low K case (low pipe resistance model). The change is less for the other cases.



hA Sensitivity for RBM

For a 16" pipe, the cushioned velocity calculated using *h* equal to 84,000 BTU/hr.ft^2.°F increases by approximately 3 to 4% of the initial velocity for the low K case (low pipe resistance model). The change is less for the other cases.



Pipe Diameter Effects

- Basic flow equations are employed to show that the pipe friction effect on water flow is negligible and independent of the flow area (or pipe diameter).
- Noncondensable gas compression is also independent of the pipe area.
- However, removal of the steam by condensation is determined predominantly by heat transfer to the water interfaces.
  - Heat transfer on turbulent water surfaces is velocity dependent and not diameter dependent.
- Therefore, the heat transfer to the water tends to occur as a uniform heat flux, which also is independent of pipe flow area.

Pipe Diameter Effects (cont.)

- Water motion, gas and steam state properties, and condensation heat transfer only depend on the length scale in the flow direction, but not on the cross-sectional area or pipe diameter.
- It follows that the tendency of the hA product to remain constant is supported by:
  - the fact that the area A cancels from all the equations
  - the simplified condensation modeling shows that the condensing coefficient h is influenced by the turbulent velocity and thermodynamic state properties, but not the pipe diameter.

R

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NRC/ACRS Meeting
August 23, 2001

Objective of Meeting

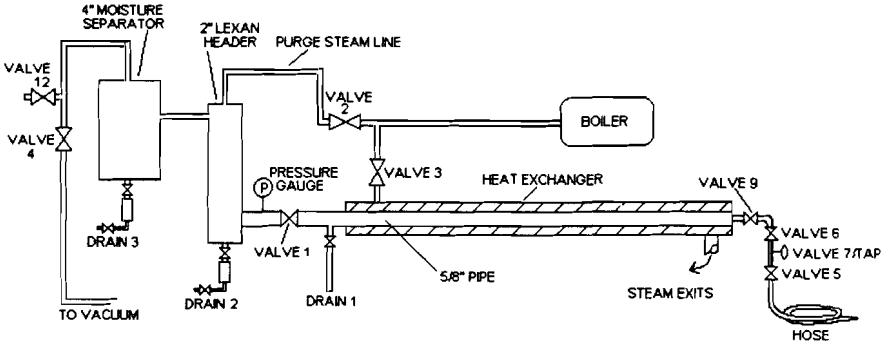
Address Issues raised by the ACRS T/H Subcommittee at our last meeting:

1. Test apparatus for determination of air release fraction.
2. Determination of the "h" in the "hA" term
3. Scale-up of the CCWH test data.

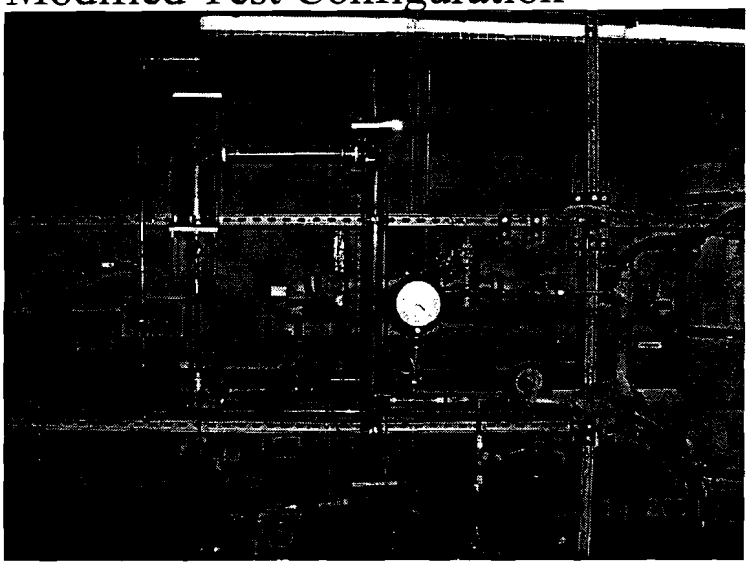
Air Release

- Dissolved non-condensable gases will be released from the water in a voiding system and will enter the steam voids.
- This gas will pressurize during a column closure event and cushion the impact.
- Air release will occur due to depressurization and boiling.

Modified Test Configuration



Modified Test Configuration



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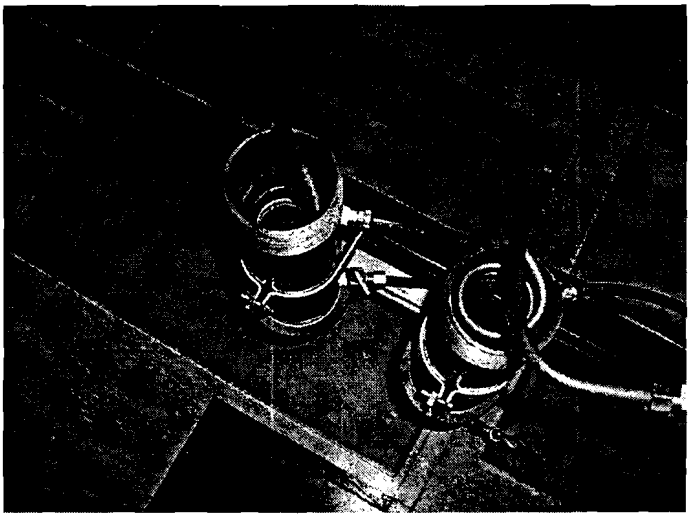
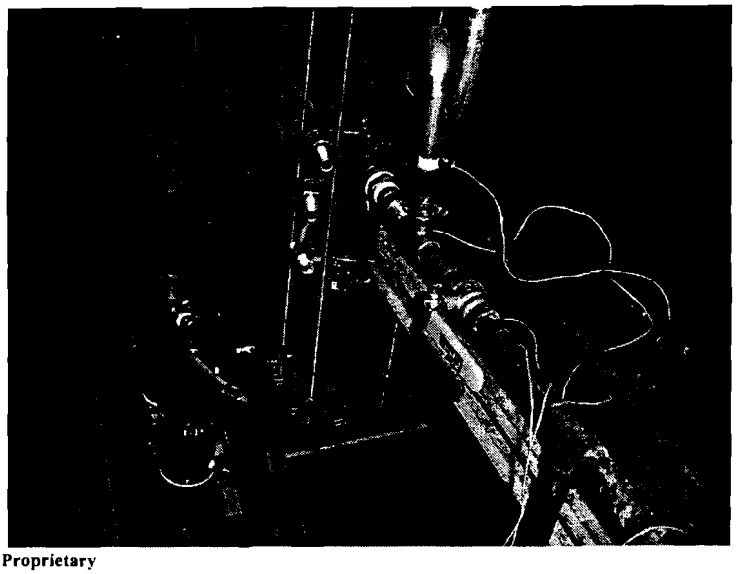


Modified Test Configuration



Test Parameters

- Tube Diameter and Length
- Tube Orientation
- Header Orientation
- Steam Temperature
- Steam Pressure
- Water Properties
- Time

Tube Diameter and Length

- Test Conditions : A 10 foot long 5/8" unfinned copper tube was tested.
- Plant Conditions : Typical fan cooler tubes range in size from ½" to 7/8" and are often finned. Fins would transfer more heat, increase the boiling, and evolve more gas. Fan cooler tubes are typically 40 feet long. A longer tube will transfer more heat during a longer transit time and evolve more gas.

Tube Orientation

- Test Conditions: A horizontal tube was tested.
- Plant Conditions: Fan cooler tubes are oriented horizontally.

Header Orientation

- **Test Conditions:** A vertical header was tested with a single tube entering the header and with various amounts of water in the header.
- **Plant Conditions:** Fan cooler tubes either drain or discharge to a header that contains trapped water. Multiple tubes will enhance the air release from the water in the header.

Steam Temperature

Test Conditions: High temperature and low temperature heating steam was tested. The low temperature steam was supplied at approximately atmospheric pressure to the jacket of the heat exchanger. The high temperature steam was supplied at approximately 40 psig.

Plant Conditions: These temperatures are prototypical for many LOCA events. The minimum steam pressure of interest is atmospheric and typical LOCA peak pressures are approximately 40 psig. Higher temperatures and pressures would increase the boiling and evolve more gas.

Initial Water Pressure

- **Test Conditions :** The pressure of the water in the test section was lowered to 15" Hg (7.5 psia) as steam was added to the jacket.
- **Plant Conditions :** This is somewhat higher than typical in an open loop plant (1-2 psia) and somewhat lower than typical in a closed loop plant (approximately 20 psia). The initial pressure is secondary as a method of gas release in comparison to boiling.

Water

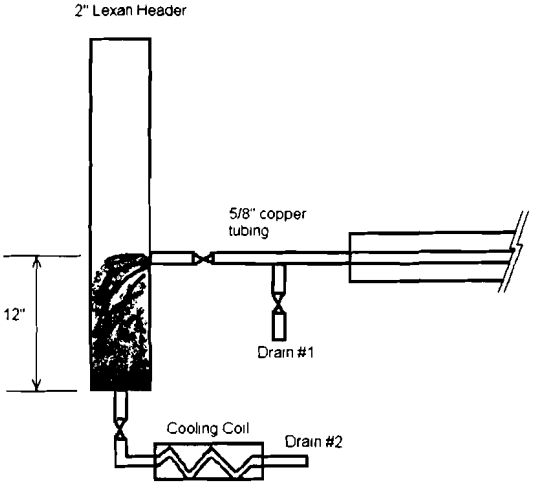
- **Test Conditions :** The tests were performed using "normal" tap water (approximately 10 ppm oxygen). The oxygen content was measured for each test.
- **Plant Conditions :** The gas content of this water is typical of that in service water systems.

Time

- Test Conditions : The test section was heated for 30 seconds.
- Plant Conditions: The time of the tests is prototypical for the LOOP/LOCA transient. Pump restart typically occurs between 28 and 35 seconds following the occurrence of the LOOP.

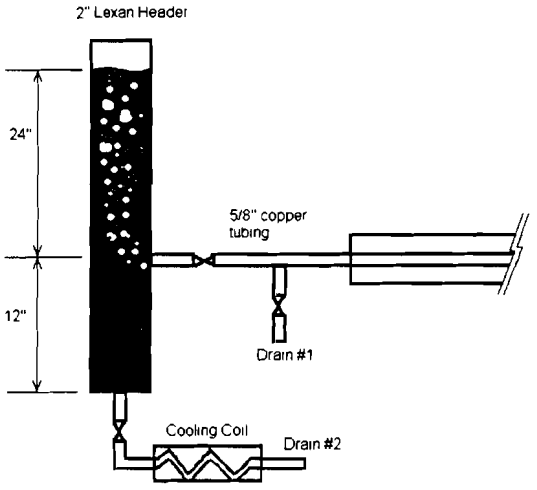
Description of Air Release Testing

- Test Sequence 1 – Draining FCU



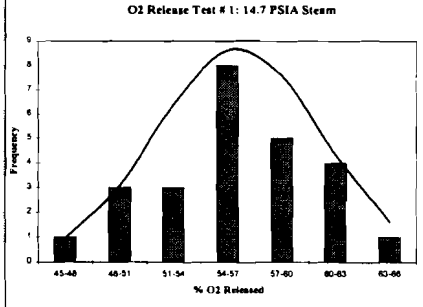
Description of Air Release Testing

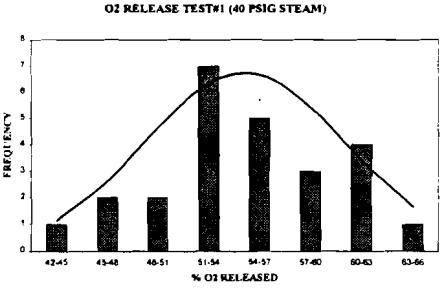
- Test Sequence 2 – FCU with a Vertical Header



Air Released: Sequence #1

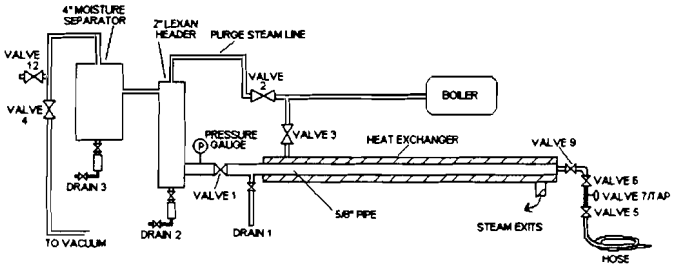
In test sequence 1, the case that represented a draining FCU, the dissolved oxygen content of the water initially in the tube was reduced by approximately 50%.



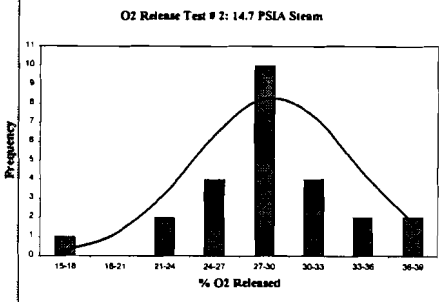


Air Released: Sequence #2

- In test sequence 2, a similar amount of gas is released for the water that was initially in the tube.
- The gas released from the water in the header is conservatively represented by the water that spilled into the moisture separator and drain 3, approximately 24%.
- More gas was released by the water that remained in the header, approximately 46%.



Air Released: Sequence #2



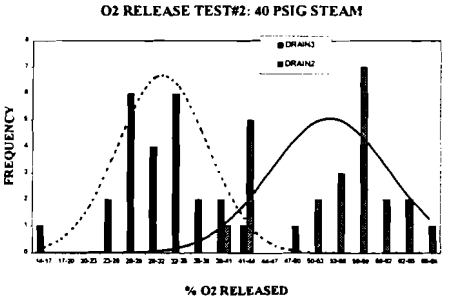
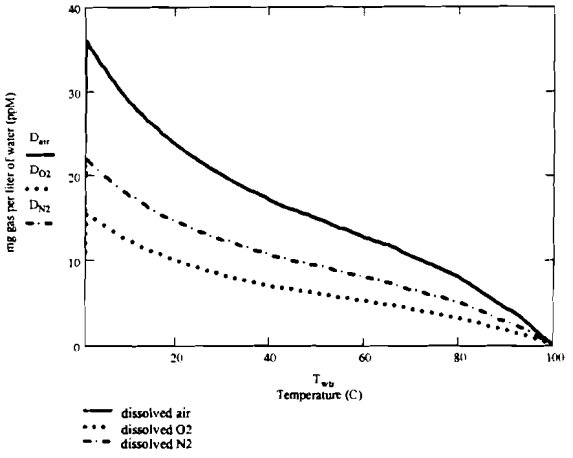


Figure 6-5 and 6-6: Distribution of Air Release Test Data for Sequence #2

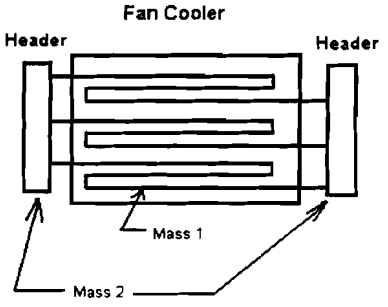
Application to Plant Model

Determine initial air concentration for the water in the heat exchanger tubes and header. This should be based on plant specific temperature, pressure, and dissolved air data as shown in the following figure (Henry's Law) for one atmosphere.



Application to Power Plant

- Determine mass of water that will boil in the heat exchanger tubes (Mass 1).
- Air evolved into the void is 50% of the air in this water mass.
- If the heat exchanger has headers that drain, then the calculation is finished.



- **If the heat exchanger has headers that remain full:**
- Determine mass of water in the heat exchanger headers and attached piping through which steam can pass (Mass 2 in).
- Air evolved from Mass 2 is 24% of the air in this mass of water.
- Total air evolved is the sum of the air released from Mass 1 and Mass 2.

Air Test Additional Points

- The equilibrium point of air concentration for depressurization alone is not reached within the time period of the transient. Boiling is the significant contributor to the gas release.
- The drains from the header and moisture separator were equipped with coolers to decrease the temperature of the exiting water to approximately room-temperature (95 to 100°F) for the purpose of measuring the dissolved oxygen. The temperature at the time of measurement is recorded.

Air Test Additional Points

- The draining velocity for a horizontal 1/2" tube is approximately 0.5 ft/second, which would drain the 10' tube in approximately 20 seconds. Boiling initiated within the first 2-3 seconds of steam addition. Substantial amounts of the tube was heated and degassed. If the tube had been longer or if the heat transfer occurred more rapidly, more heating and degassing would occur. The 50% air release value based on the sample of water at drain 2 was chosen as a conservative value.
- The header extended 12" below the tube. This was sized so that in the draining FCU case, all the water in the tube could collect in the header.

Air Test Additional Points

- In Test 2, it is likely that some water drained back into the tube from the header as the voids condensed there when the steam was shut off. However, the release from this mixed water in the header water was conservatively not used.
- The water blown out of the header into the moisture separator had little mixing with the water in the tube. To be conservative, the smaller amount of released dissolved gas for test sequence #2 in the moisture separator was used.

Air Test Additional Points

- Dissolved oxygen was used as an indicator of overall air evolution under low pressure boiling conditions. Air and nitrogen will behave similarly. Consideration must be made for the initial concentration of each gas based on temperature and pressure.
- The air released from the lowest temperature steam (212°F) provided the lowest amount of air release (24% at the header drain). The higher temperature steam (255°F) provided 53.4% and 31.3% release from the header and moisture separator, respectively. The 24% release value was chosen as a conservative lower bound from the test results.

Air Test Additional Points

- The thermal-hydraulic conditions tested are typical of the actual plants. Test parameters were prototypical or were selected to make the results conservative.
  - Tube Diameter and Length
  - Tube Orientation
  - Header Orientation
  - Steam Temperature
  - Steam Pressure
  - Water Properties
  - Time

GE Nuclear Energy

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August 21, 2001

MFN 01-042

Mr. Paul A. Boehnert
Senior Staff Engineer
US Nuclear Regulatory Commission
TWFN Building –Mail Stop P2-E26
11545 Rockville Pike
Rockville, MD 20852-2738

Subject: **GE Presentation Material for August 22-23, 2001 ACRS-Thermal-Hydraulic Phenomena Subcommittee Meeting: "GE Nuclear Energy TRACG Code Application to AOO's"**

References:

1.) GE Letter, 6/18/1999, MFN 99-016, transmitting and submitting: GE Licensing Topical Report, NEDC-32900P, **TRACG Licensing Application Framework for AOO Transient Analysis,** June 1999.

2.) GE Letter, 12/15/1999, MFN 99-040, transmitting and submitting: GE Licensing Topical Report, NEDE 32176P, **TRACG Model Description**, Revision 2, December 1999.

3.) GE Letter, 1/25/2000, MFN 00-001, transmitting and submitting: GE Licensing Topical Report, NEDE-32906P, **TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses**, January 2000.

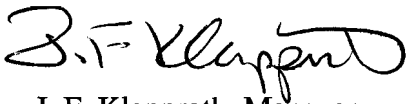
4.) GE Letter, 1/31/2000, MFN 00-002, transmitting and submitting: GE Licensing Topical Report, NEDE-32177P, **TRACG Qualification,** Revision 2, January 2000.

5.) GE Letter, 2/28/2000, MFN 00-007, transmitting and submitting: GE Report, NEDC-32956P, **TRACG02A User's Manual,** Revision 0, February 2000.

This letter provides, as an attachment, the presentation material to be covered during the ACRS Thermal Hydraulic Phenomena Subcommittee meeting, scheduled for August 22, 2001, with members of the ACRS, NRC staff and representatives of GE. The referenced letters provide the context of the TRACG methodology submittals.

Please note that the attachments contain proprietary information of the type that GE maintains in confidence and withholds from public disclosure. The information has been handled and classified as proprietary to GE as indicated in the attached affidavit. GE hereby requests that this information be withheld from public disclosure in accordance with the provisions if 10CFR2.790.

Sincerely,



J. F. Klapproth, Manager
Engineering and Technology
GE Nuclear Energy
(408) 925-5434
james.klapproth@gene.ge.com

Attachments:

Affidavit by David J. Robare, dated August 20, 2001

Presentation Slides:

> ***TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses,*** *ACRS Thermal / Hydraulics Subcommittee, August 22, 2001.*
> *(25 pages)*

cc:

R. Pulsifer	(NRC)	w/o attachments
Ralph Landry	(NRC)	w/o attachments
R. Caruso	(NRC)	w/o attachments
G. Watford	(GNF-A)	w/o attachments
J. G. M. Andersen	(GNF-A)	w/o attachments
F. T. Bolger	(GENE-Wlm)	w/o attachments
C. L. Heck	(GNF-A)	w/o attachments
G. B. Stramback	(GENE-SJ)	w/ attachments
R. S. Drury, Jr.	(GENE-SJ)	w/ attachments

General Electric Company

AFFIDAVIT

I, David J. Robare, being duly sworn, depose and state as follows:

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

(2) The information sought to be withheld is contained in the Presentation Slides Attachment to GE letter MFN 01-042, dated August 21, 2001, J. F. Klapproth to NRC, *TRACG Application for Anticipated Operational Occurences (AOO) Transient Analysis – ACRS Thermal-Hydraulics Subcommittee, August 22, 2001.* The proprietary information is delineated by bars marked in the margin adjacent to the specific material.

(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), 2.790(a)(4), and 2.790(d)(1) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions 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 cost or price information, production capacities, budget levels, or commercial strategies of General Electric, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, of potential commercial value to General Electric;

e. 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 both paragraphs (4)a. and (4)b., above.

(5) 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 the results of analytical models, methods and processes, including computer codes, which GE has developed, discussed and submitted to the NRC, and intends to apply to perform evaluations of transients for the GE Boiling Water Reactor ("BWR").

The development and approval of the TRACG computer code was achieved at a significant cost, on the order of several million dollars, 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.

STATE OF CALIFORNIA)
) ss:
COUNTY OF SANTA CLARA)

David J. Robare, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

Executed at San Jose, California, this 20TH day of AUGUST 2001.

David J. Robare
General Electric Company

Subscribed and sworn before me this 20th day of August 2001.

TERRY J. MORGAN
Commission # 1304914
Notary Public - California
Santa Clara County
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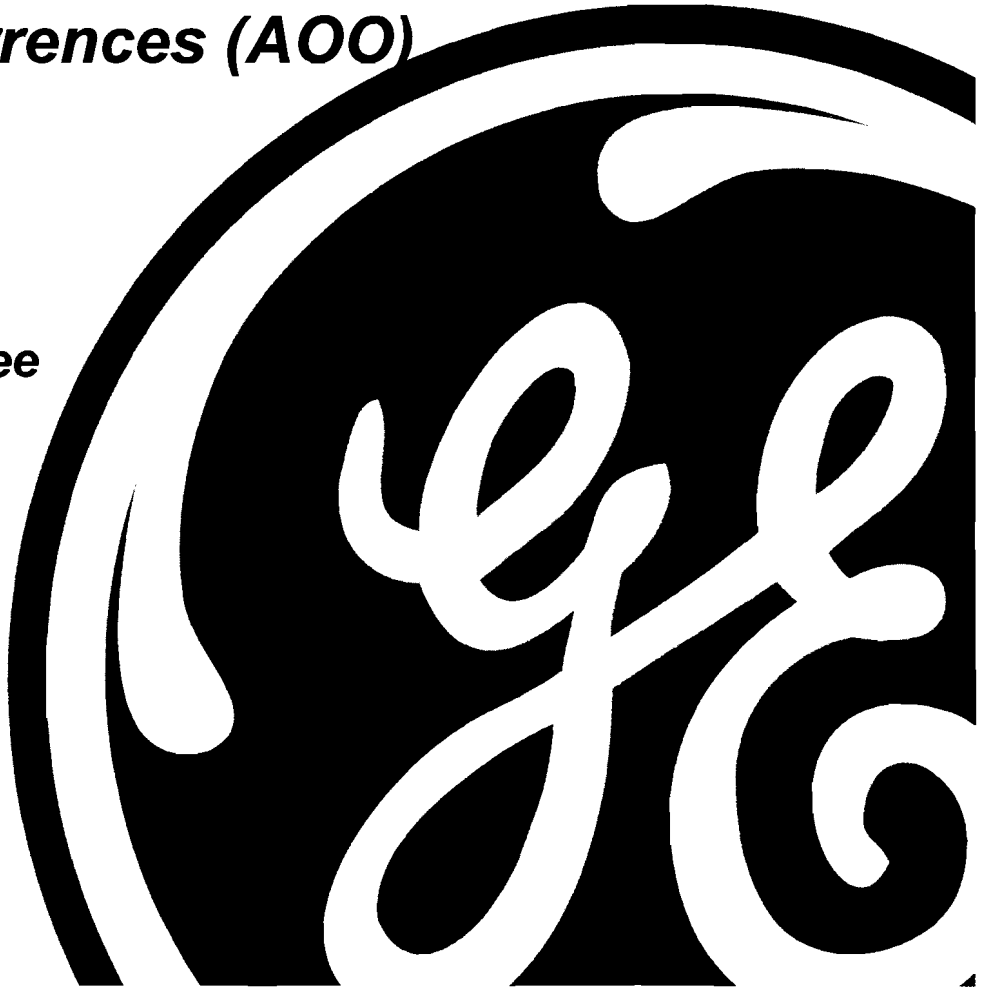
GE Nuclear Energy

TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses



ACRS Thermal / Hydraulics Subcommittee
August 22, 2001

Introductions

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Manager
Engineering and Technology

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Project Manager
TRACG Development

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GE CR&D

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Project Manager
TRACG LOCA Application

Overview

- ***TRACG Application for AOO Transients***
  - *Extensive documentation on TRACG submitted to NRC*
  - *NRC Review*
    - *Meetings and communication with NRC*
    - *Request for additional information and GE responses*
  - *ACRS T/H Subcommittee review*
    - *Response to Subcommittee Comments (11/13-14/00 Meeting)*
    - *Comment on NRC TRACG SBWR Review*
- ***Concluding Remarks***

Scope: Application of TRACG for BWR Transients

- ***Plants:*** ***BWR/2/3/4/5/6***
- ***Events:*** ***Anticipated Operational Occurrences (Transients)***
  - *Increase / Decrease in Reactor Pressure*
  - *Increase / Decrease in Core Flow*
  - *Increase / Decrease in Reactor Coolant Inventory*
  - *Decrease in Core Coolant Temperature*
- ***Documentation***
  - *TRACG Licensing Application Framework for AOO Transient Analyses, NEDC-32900P*
  - *TRACG Model Description LTR, NEDE-32176P, Revision 2*
  - *TRACG Qualification LTR , NEDE-32177P, Revision 2*
  - *TRACG Application LTR for AOO Transient Analyses, NEDE-32906P*
  - *TRACG02A Users Manual, NEDC-32956P*
  - *TRACG02A Source Code and Sample Problems*
- ***Review Scope***
  - *SER for Application of TRACG to BWR AOO Transients*
    - *Applicability of TRACG for AOO Transients*
    - *Qualification*
    - *Application Methodology for AOO Transients*

Time Line

- ***Plan and Road Map for TRACG AOO Application*** — ***May 1999***
- ***All TRACG documents submitted*** — ***February 2000***
- ***Review Kick-off*** — ***March 2000***
  - *NRC and ACRS*
- ***NRC Acceptance of TRACG for Review*** — ***April 2000***
- ***NRC Review Concerns*** — ***September 2000***
- ***ACRS T/H Subcommittee Review*** — ***November 2000***
- ***NRC Requests for Additional Information (RAI)***
  - *23 Requests for Additional Information (RAI)*
  - *Responses provided to all RAIs*
  - *All issues resolved*
- ***Draft Safety Evaluation Report (SER)*** — ***July 2001***
- ***ACRS T/H Subcommittee Review*** — ***August 2001***
- ***SER on TRACG Application to AOO Transients*** — ***September 2001***

Review of TRACG Application to BWR AOO Transients

- ***Extensive Documentation Submitted to NRC***
  - *Model Description, Qualification, Application Methodology*
  - *TRACG Code Installed on NRC Computers*
    Users Manual, Source Code and Test Problems
- ***Extensive Prior NRC Reviews and Acceptance of TRACG Applications***
  - *Benchmark code for current LOCA, Transient, ATWS and Stability Applications*
  - *SBWR Project*
- ***Extensive Communication with NRC during Review***
  - *Regular communication with NRC (meetings, teleconferencing, e-mail)*
  - *Support for TRACG installation and benchmarking against NRC codes*
  - *ACRS T/H Subcommittee Review*
  - *23 RAI received (Including RAI generated from ACRS comments)*
  - *Primarily Additional information and Clarification*
  - *Responses provided and all issues resolved*
  - *Very good and professional interaction with NRC reviewers*

23 RAIs

- *Test case for benchmarking of TRACG against NRC codes*
- *SPERT test case provided to NRC*
- *Impact of burnup on transient MCPR documented in NEDE-32906P, Section 6.2*
- *Impact of power distribution on transient MCPR documented in NEDE-32906P, Section 6.2*
- *Gamma smearing included in lattice calculations*
- *Time step and convergence sensitivity studies for kinetics solution provided.*
- *Implicit integration solver used for all AOO transients*
- *Central differencing not used*
- *Impact of channel grouping documented in NEDE-32177P, Section 8.2*
- *PANAC10/TGBLA04 is the basis for TRACG kinetics*
- *Impact of fuel rod grouping*
- *Basis for uncertainty in void coefficient Basis for uncertainty in void coefficient Clarification of normality test*
- *Reference for pellet heat transfer parameters*
- *Clarification of statistical method NEDE-32906P, Section 7.3.3-7.5.1 revised*
- *Clarification of statistical limits*
- *Clarification of statistical method*
- *Clarification of statistical method*
- *Formulation of field equations for steam air mixtures*
- *Plant test cases for AOO transients provided to NRC*
- *Resolution of differences between TRACG and NRC benchmark calculations*
- *Adequacy of TRACG pressure drop calculation*
- *Clarification of TRACG time step control*

Comments on TRACG Code Models/Correlations -
November 13-14, 2000 ACRS T/H Phenomena Subcommittee Meeting

One comment received January 26, 2001

- Response to RAI 19

Additional comments received August 7, 2001

- The momentum equations do not appear to properly account for Reynolds stress.
- The origin of the equations are not clearly specified pursuant to the regulatory position in the draft regulatory guide on code submittals.
- Partition of wall shear stress is not treated consistently in the documentation
- The modeling of Tee components is not clearly explained and its adequacy is not apparent.
- There is no definitive modeling of flow regime transition, and the logic of this modeling is not clear.
- Regarding the interfacial shear model, key terms in the equations are not explained, in particular the relationship between the "c_i" and "c_0" terms needs to be clarified.
- GE has an inconsistent treatment for modeling of interfacial area and the heat transfer coefficients.

Response to Subcommittee Comments (11/13-14/00 Meeting)

- ***The momentum equations do not appear to properly account for Reynolds stress.***

- **Reynolds stress not included in TRACG**
- **Stresses due to interfacial shear and wall shear are included through empirical correlations**
- **Wall shear is the dominant source of stress in BWR applications**
- **TRACG models for interfacial shear and wall shear**
  - Interfacial shear model is described in NEDE-32176P, Rev. 2, Section 6.1
  - Wall shear model is described in NEDE-32176P, Rev. 2, Section 6.2
- **Extensive assessment**
  - Assessment for the applicability of these models over the range of interest for BWR applications is provide in the referenced sections of NEDE-32176P, Rev. 2
  - Extensive qualification documented in NEDE-32177P, Rev. 2

Pressure Drop and Void Fraction

- ***Wall shear and Pressure drop***
  - *Models apply for BWR operating range*
  - *Pressure drop well predicted.*
    Bundle pressure drop predicted within 5% bias and uncertainty
    Other pressure drops typically within 10%
- ***Interfacial shear and void fraction***
  - *Models apply for BWR operating range*
  - *Void fraction well predicted.*
    Bundle void fraction predicted with 2-3% uncertainty
    Other void fractions typically within 5%
- ***Pressure drop and void fraction uncertainties accounted for in the application methodology***

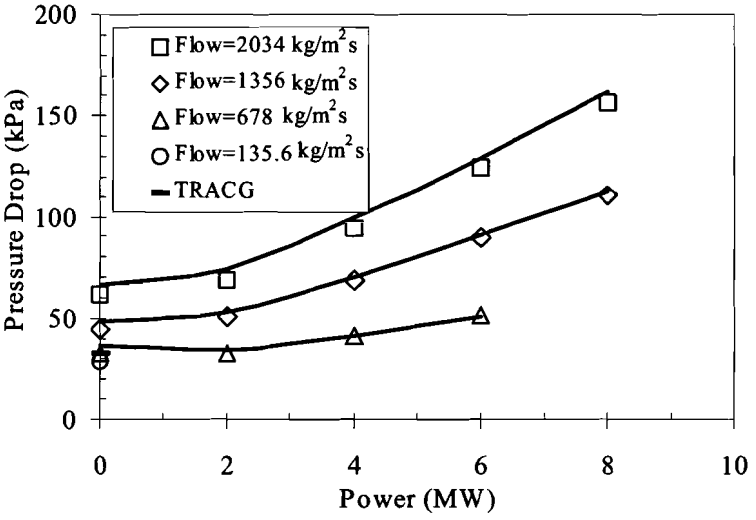


Figure 3.5-3. ATLAS Bundle Pressure Drop Comparison

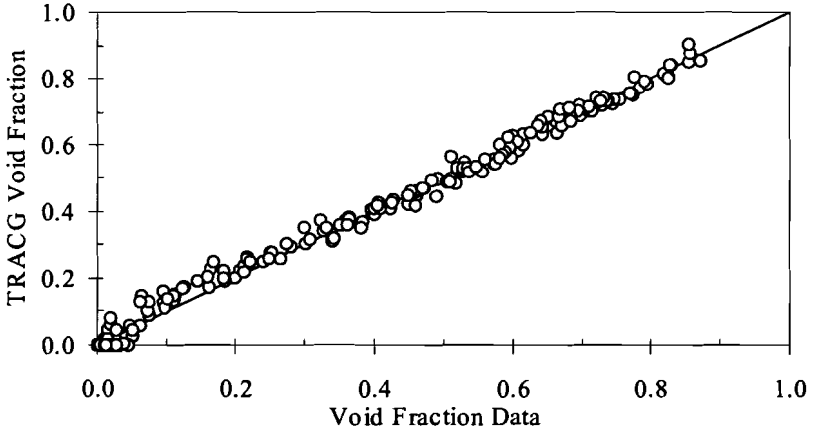


Figure 3.1-5. FRIGG Void Fraction Distribution, Pressure 6.8 MPa

Response to Subcommittee Comments (11/13-14/00 Meeting)

- ***The origin of the equations are not clearly specified pursuant to the regulatory position in the draft regulatory guide on code submittals.***

- **The equations originate with the work by Stuhmiller as indicated by Reference [3-9] on page 3.1-3 of NEDE-32176P, Rev. 2.**
  - J.H. Stuhmiller, *A Review of the Rational Approach to Two-Phase Flow Modeling*, Jaycor, Del Mar, California, PB-255 548, July 1976.
- **Based on Ishii's formulation of two-phase equations**
  - M. Ishii, Thermo-Fluid Dynamic Theory for Two-Phase Flow, Collection de la Direction des Etudes et Recherces D'Electricity de France, Eyroles, Paris 1975.
- **Basic formulation of TRACG equation is the same as in TRAC-M**

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***Partition of wall shear stress is not treated consistently in the documentation.***

- **Partitioning of the wall shear stress is described in detail in the TRACG Model Description, NEDE-32176P, Rev. 2, Section 6.1**
  - Basis for partitioning described in Section 6.1.2

    Based on integration of shear stress for each phase
  - Application to various flow regimes described in Section 6.1.3
  - Wall shear stress calculated from empirical friction factor
  - Partitioning of wall shear stress most appropriate for dispersed flow
  - Partitioning of wall shear stress:

    Does not affect total frictional pressure drop since this is calculated from the mixture equation

    Pressure drop is well calculated by TRACG NEDE-32176, Section 6.2
    NEDE-32177, Section 3.5
    NEDE-32906P, Section 5.0

    Does affect relative velocity between phases and void fraction

    Void fraction is well calculated by TRACG NEDE-32176P, Section 6.1
    NEDE-32177P, Section 3.1
    NEDE-32906P, Section 5.0

Pressure Drop and Void Fraction

- ***Wall shear and Pressure drop***
  - *Model apply for BWR operating range*
  - *Pressure drop well predicted.*
    Bundle pressure drop predicted within 5% bias and uncertainty
    Other pressure drops typically within 10%

- ***Interfacial shear and void fraction***
  - *Void fraction well predicted.*
    Bundle void fraction predicted with 2-3% uncertainty
    Other void fractions typically within 5%

- ***Pressure drop and void fraction uncertainties accounted for in the application methodology***

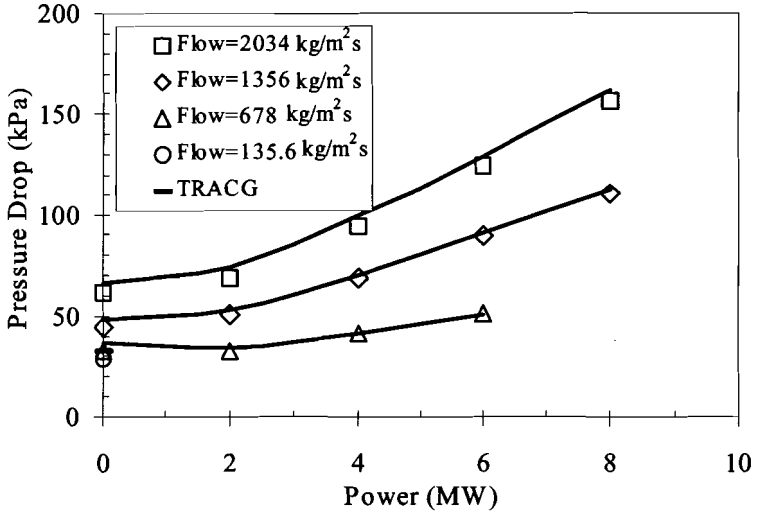


Figure 3.5-3. ATLAS Bundle Pressure Drop Comparison

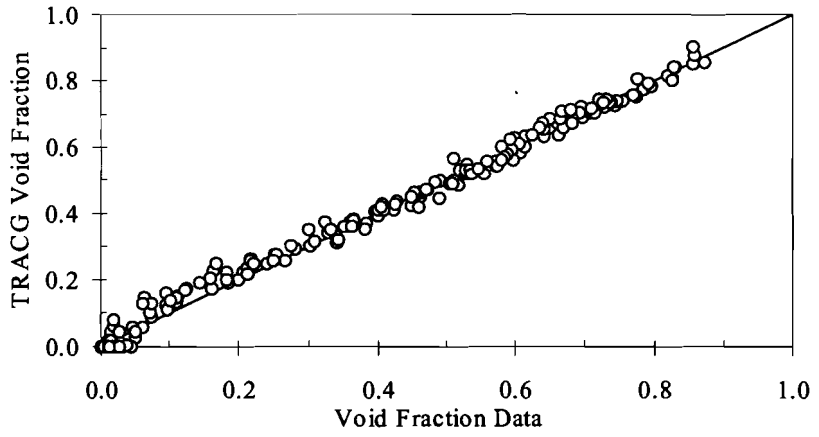


Figure 3.1-5. FRIGG Void Fraction Distribution, Pressure 6.8 MPa

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***The modeling of Tee components is not clearly explained and its adequacy is not apparent.***

- **The modeling of the generic TEE component is described in NEDE-32176, Section 7.4**
  - Source terms for mass, momentum and energy included
  - Models for phase separation at junction not included
- **Additional models for pressure drop and phase separation incorporated in TEE based component where significant.**
  - Jet Pump

    Mechanistic model for mixing of drive and suction flow, Momentum transfer, M-N characteristics

Model description	NEDE-32176, Section 7.6
Qualification	NEDE-32177, Section 4.1 and 7
Application	NEDE-32906, Section 5

  - Steam Separator

    Mechanistic model for flow separation, Carry under and carry over, Pressure drop

Model description	NEDE-32176, Section 7.7
Qualification	NEDE-32177, Section 4.2 and 7
Application	NEDE-32906, Section 5

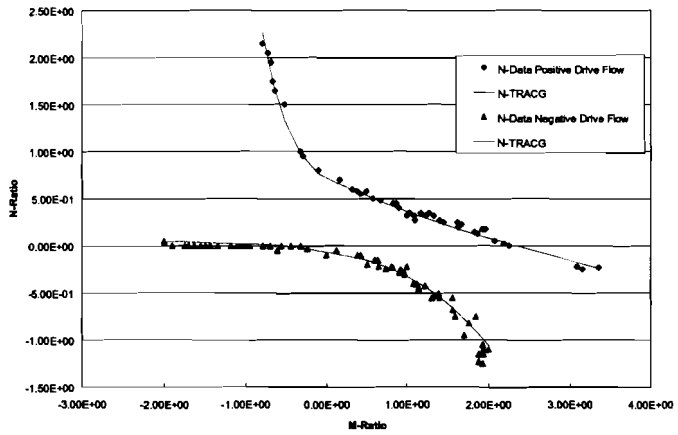
  - Fuel channel

    Channel leakage flow

Model description	NEDE-32176, Section 7.5
Qualification	NEDE-32177, Section 5 and 7
Application	NEDE-32906, Section 5
- **Models described in detail**
- **Model accuracy quantified and found to be adequate**

TEE components

- **Jet Pump**
  - *Mixing of drive and suction flow,*
  - *Momentum transfer*
  - *M-N characteristics*
- **Steam Separator**
  - *Flow separation*
  - *Carry under and carry over*
  - *Pressure drop*
- **Models apply for BWR operating range**
- **Flow split and phase separation well predicted**
- **Model uncertainties accounted for in the application methodology**



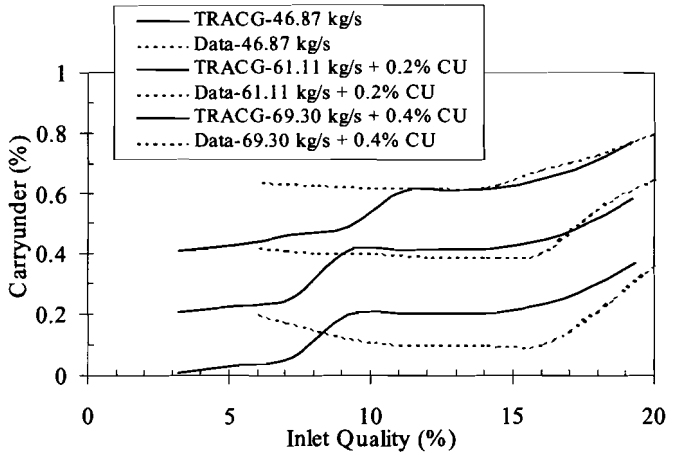


Figure 4.2-4. Comparison of Carryunder vs. Inlet Flow for BWR/4&5 2-Stage Separator, Submergence – 0.635m (25 inches)

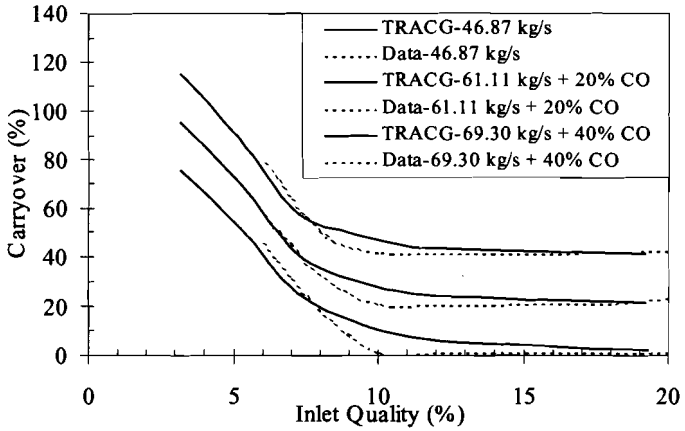


Figure 4.2-5. Comparison of Carryover vs. Inlet Flow for BWR/4&5 2-Stage Separator, Submergence – 0.635m (25 inches)

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***There is no definitive modeling of flow regime transition, and the logic of this modeling is not clear.***

- **TRACG uses a simple flow regime map where the flow regime is determined as function of thermal hydraulic conditions (flow rate, void fraction...) and wall condition**
- **Flow regime map described in NEDE-32176, Section 5**
  - Flow regime map is used consistently by all TRACG component
  - Flow regime map used consistently for calculation of wall heat transfer, interfacial heat transfer and shear.
  - Reasonable agreement with more complex flow regime maps
  - Qualification shows that TRACG accurately calculates:

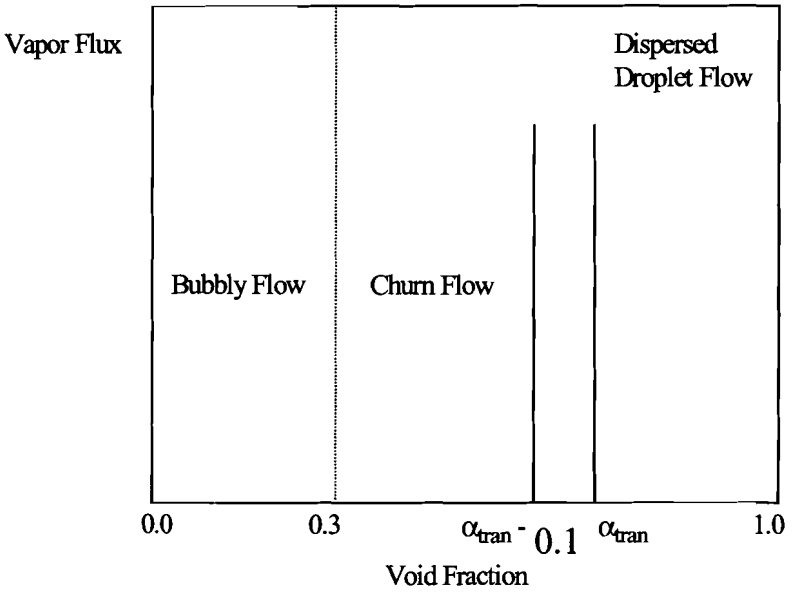
    Void fraction

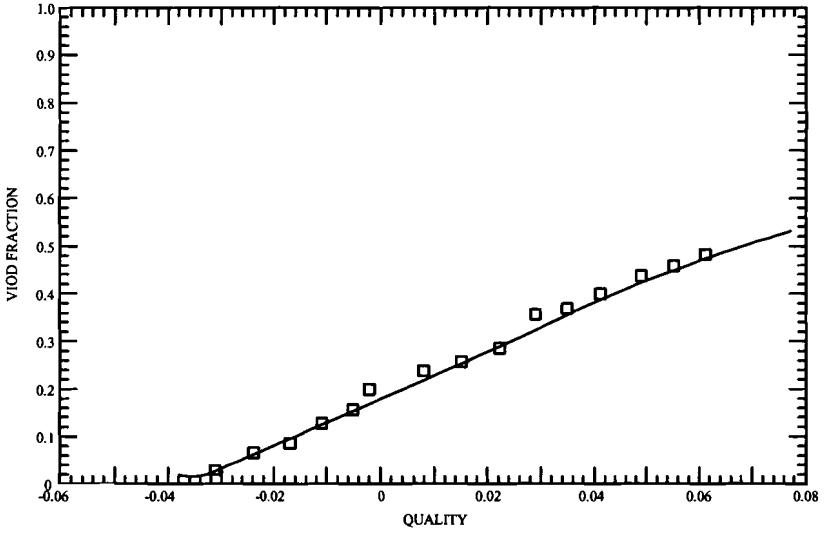
    Pressure drop

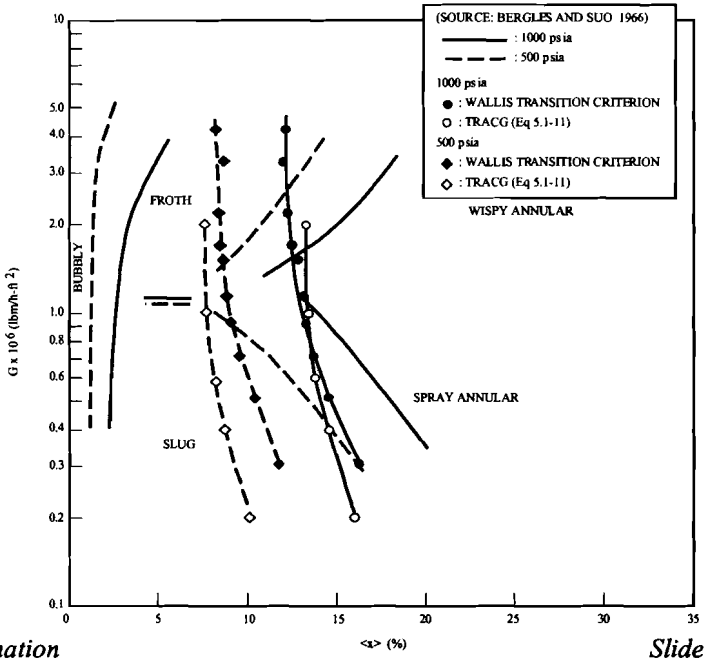
    Heat transfer

Flow Regime Map

- **TRACG flow regime map**
- **Qualification shows that TRACG accurately calculates:**
  - *Void fraction*
  - *Pressure drop*
  - *Heat transfer*
- **Models apply for BWR operating range**
- **Model uncertainties accounted for in the application methodology**







Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***Regarding the interfacial shear model, key terms in the equations are not explained, in particular the relationship between the "c_i" and "c_0" terms needs to be clarified.***

- **The interfacial shear model is described in NEDE-32176, Section 6.1**
- **The relation ship between c_i and C_0 is defined in NEDE-32176 Equations 6.1-24 and 6.1-25**

$$\bar{v}_r = \frac{1 - \langle\alpha\rangle C_o}{\langle 1 - \alpha\rangle}\bar{v}_v - C_o\bar{v}_\ell \qquad C_0 = \frac{\langle\alpha j\rangle}{\langle\alpha\rangle\langle j\rangle}$$

$$\langle f_{\ell v}\rangle = \bar{c}_i\left|\bar{v}_r\right|\bar{v}_r$$

$$\langle f_{\ell v}\rangle = \bar{c}_i\left|\frac{1 - \langle\alpha\rangle C_o}{\langle 1 - \alpha\rangle}\bar{v}_v - C_o\bar{v}_\ell\right|\left(\frac{1 - \langle\alpha\rangle C_o}{\langle 1 - \alpha\rangle}\bar{v}_v - C_o\bar{v}_\ell\right)$$

Response to Subcommittee Comments (11/13-14/00 Meeting)

❑ ***GE has an inconsistent treatment for modeling of interfacial area and the heat transfer coefficients.***

- **TRACG uses a simple flow regime map where the flow regime is determined as function of thermal hydraulic conditions (flow rate, void fraction...) and wall condition**
  - Flow regime map described in NEDE-32176, Section 5
  - Flow regime map is used consistently by all TRACG components
  - Flow regime map used consistently for calculation of wall heat transfer, interfacial heat transfer and shear.
  - Interfacial area and heat transfer coefficients chosen consistent with flow regime
  - Flow regime map: NEDE-32176, Section 6
  - Interfacial heat transfer NEDE-32176, Section 6.5
  - Wall heat transfer NEDE-32176, Section 6.6

Interfacial Area and Heat Transfer

- **Interfacial heat transfer calculated by:**

$$q_{\ell i} = A_i h_{i\ell}\left(T_\ell - T_{sat}\right) \;;\quad q_{vi} = A_i h_{iv}\left(T_v - T_{sat}\right) \qquad \Gamma_g = \frac{q_{\ell i} + q_{vi}}{h_{fg}}$$

- **Correlated interfacial area and heat transfer coefficients (HTC)**
- **Bubbly/churn flow**
  - *Area given by critical Weber number for bubbles*
  - *Vapor HTC from conduction in spherical particle with empirical factor to account for internal circulation*
  - *Liquid HTC from flow over spherical particle*
- **Annular flow**
  - *Area calculated from wall surface area and film thickness.*
  - *Vapor HTC correlated to Stanton number*
  - *Liquid HTC based on conduction across liquid film*
- **Droplet flow**
  - *Area given by critical Weber number for droplets*
  - *Vapor HTC from flow over spherical particle*
  - *Liquid HTC from conduction in spherical particle with empirical factor to account for internal circulation*
- **Two-phase level**
  - *Area given by surface area of free level*
  - *Based on free convection heat transfer*

Comments on NRC TRACG SBWR Review

- ***TRACG Model Description, LTR, NEDE-32176P, Rev. 0 and TRACG Qualification, LTR, NEDE-32177P, Rev. 1 Submitted to NRC for review for the SBWR project.***
  - *Application for AOO transients, LOCA, Stability and ATWS*
  - *Several Rounds of RAIs and GE responses*
  - *Revision 1 to Model Description Incorporated Responses to RAIs*
- ***TRACG models and qualification were also reviewed by ACRS T/H Subcommittee***
- ***SBWR project was cancelled in 1996 and the review of TRACG stopped.***
- ***NRC issued letter on the status of the TRACG Review in 1996***
  - *NRC/GE Letter, T. R. Quay to J. E. Quin, dated July 6, 1996, "Staff Review of General Electric's (GE's) Licensing Topical Report (LTR), NEDE-32176P, TRACG Model Description", Revision 1*
  - *NRC/GE Letter, T. R. Quay to J. E. Quin, dated June 27, 1996, "Status Staff Review of of the TRACG Qualification (NEDE-32177, Rev. 1) and Application (NEDE-32178, Rev. 0) Licensing Topical Reports (LTRs)*

Comments on NRC TRACG SBWR Review of TRACG Model Description, NEDE-32176P, Rev. 1

- **Resolution of Issues**
  - *Assessment of identified models when relevant for application to BWR/2-6 AOO transients included in TRACG Qualification LTR, NEDE-32177P, Rev. 2*
  - *Models important for BWR AOO transients included*
  - *Description of nuclear models included or referenced*

All Issues Relevant for TRACG Application to BWR/2-6 AOO Transients Addressed

Comments on NRC TRACG SBWR Review of TRACG Qualification, NEDE-32177P, Rev. 1

- **Resolution of Issues**
  - *Definitions and Clarifications included*
  - *All Qualification has been repeated with TRACG02A*
  - *References to PIRT Tables included in TRACG Application Methodology LTR, NEDE-32906P, Rev. 0*
  - *Qualification specific to SBWR not included. Application is for BWR/2-6*
  - *Nodalization and time step sensitivity studies included*
  - *Model and correlation application ranges defined and compared to BWR operational parameters*
  - *Test parameter ranges additional information on test facilities included*
  - *Accuracy of qualification and model uncertainties quantified.*
  - *Some qualification not relevant for AOO transients not includes, e.g., low pressure film boiling and void fraction*

Comments on NRC TRACG SBWR Review of TRACG Qualification, NEDE-32177P, Rev. 1

- **Resolution of Issues - continued**
  - *Additional detail on CCFL model included in TRACG Model Description and TRACG Application Methodology LTRs*
  - *Additional qualification included in Model Description, e.g., interfacial heat transfer*
  - *Boiling transition evaluated from the GEXL correlation.*
  - *Additional plots and figures included*
  - *Typographical errors corrected*

Concluding Remarks

- *Scope: BWR/2-6 AOO Transients*
- *Meets All Regulatory Requirements*
- *Demonstration of Model Capability and Applicability*
- *Extensive Review and Acceptance of TRACG*
- *Rigorous and Sound Statistical Methodology*
- *Application Methodology Demonstrated for All Event Types*