GE Nuclear Energy

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February 23, 1996

MFN 026-96
Docket 52-004

Document Control Desk
U. S. Nuclear Regulatory Commission
Washington DC 20555

Attention: Theodore E. Quay, Director
Standardization Project Directorate

Subject: **SBWR - Highlights and Transmittal of Non Proprietary GE Slides from the GE/NRC Meeting February 15, 1996.**

This letter is written to document highlights from the Subject meeting, and to transmit the Non Proprietary GE Slides as an Attachment to this letter.

PANTHERS: The results of the PANTHERS Testing will be used for global qualification of the TRACG Code; the basic data from the University of California, Berkeley, (UCB) were used for correlation development. TRACG predicts performance of the PCC over a wide range of conditions. The TRACG post-test analysis results show good agreement with the test data. The NRC consultants' analyses are also showing good predictions of the PANTHERS test data. GE believes no further data are needed to characterize PCC performance. Detailed discussions provided clarifications on what was measured and which instruments should be used for specific data. The discussion was deemed quite useful by the participants in understanding how the data was taken and how it is being used to validate TRACG.

Scaling: The schedule for the review of the Scaling report was discussed. The testing is virtually complete. GE would like to receive agreement from the NRC to the effect that the facilities were scaled properly to capture the phenomenological behavior in the various phases of the LOCA transient, and that the data are appropriate for validation of the TRACG code for SBWR design and analysis The NRC Staff stated a need for final validation of the scaling by the test data. GE believes the NRC should review the report and comment on the acceptability of the methodology, subject to final validation by the test results. The NRC Consultants presented their findings to date. Review of the Scaling Report is nearing completion and written feedback from the NRC to GE is expected March, 1996.

TRACG Model LTR The TRACG Model Licensing Topical Report (LTR) was submitted to NRC February 23, 1996. NRC agreed that they could respond as to the acceptability of the report for review and conformance to NUREG-1230 and that it addressed previously identified issues by NRC/ACRS within 60 days, April, 1996.

Should you have any questions concerning the attachments please contact Bharat Shiralkar of our staff on 408-925- 6889.

Sincerely,

John Leatherman for

James E. Quinn 270008

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Attachment: **Non Proprietary GE Slides from the GE/NRC Meeting February 15, 1996**

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	S. Q. Ninh	(NRC)	(1 paper copy plus E-Mail w/o att.)
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ATTACHMENT TO MFN 026-96

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GE / NRC Meeting on PANTHERS Data

GE Perspective on PANTHERS PCC Tests

B. S. Shiralkar

February 15, 1996

GE Perspective on PANTHERS PCC Tests

- How is PANTHERS PCC data being used for SBWR Certification (TRACG Qualification) ?
- How accurately does the PCC performance need to be predicted ?

How is PANTHERS Data being Used ?

- *PANTHERS data is not being used to develop basic correlations*
- *Used for validating performance of prototype heat exchanger with existing correlations*
- *Correlations based on basic single tube data taken at UCB and MIT*
  - *Nusselt type correlations*
  - *Multipliers for shear enhancement and noncondensible degradation*
- *PANTHERS data only used to choose better of available correlations*
  - *Changed to Kuhn-Schrock-Peterson correlation from Vierow-Schrock*
  - *Recommended by UCB*
  - *Changed to pool boiling correlation from Chen correlation on pool side*
  - *Supported by technical opinion*
  - *Better agreement with data*
- *Use of data does not require more detailed instrumentation*
  - *Instrumentation and measurements were reviewed in detail with NRC/ACRS prior to testing*

How accurately does PCC performance need to be predicted ?

- *Overall SBWR system performance needs to be considered*
- *Early blowdown : majority of flow is through main vents; about 15% through PCCs*
- *After about an hour, PCCS has excess capacity for decay heat removal*
  - *Noncondensible concentration drops exponentially because of dilution effects*
  - *Steam pass through is minimal*
- *With excess capacity, PCCs become self-regulating*
  - *Feedbacks from PCC pressure and noncondensible content*
  - *Noncondensibles accumulate in PCC such that heat removal matches decay heat*
- *System response behavior demonstrated by PANDA and GIRAFFE tests*
- *Pressure drop is set by steam flow rate*
  - *Reactor vessel and drywell operate at wetwell pressure + delta-p*
- *Only criterion is that main vents do not open in the long term*
  - *Pressure drop margin is ~ 9 kPa vs. PCC pressure drop of 6-7 kPa at 1 hour*
- *An accuracy of 15% in htc and 1 kPa in pressure drop is adequate for predicting system response*

PCC "System Response" Characteristics

- PCCS tends to maintain a balance between heat removal and decay heat
  - PCCs have excess heat removal capability under pure steam conditions
  - Feedbacks on noncondensible holdup and drywell pressure stabilize response
    - Reduction in heat removal increases PCC pressure
      - Noncondensibles are pushed out through PCC vent
      - ΔT for heat transfer increases
      - Heat removal increases
    - Blanketing by noncondensibles reduces heat removal
      - Drywell pressure increases
      - Helps to purge noncondensibles to wetwell
  - Normally enough noncondensibles remain in drywell to reduce PCC heat removal to match decay heat
    - PCC volume is 0.16% of drywell volume
  - Noncondensible accumulation may occur preferentially in one of the PCC units, but overall heat removal matches decay heat

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PANTHERS-PCC Post-Test Analysis

By Jim Fitch

NRC/GE Meeting
Bethesda, Md
February 15, 1996

Outline

- Objectives of post-test evaluation
- Tests selected for post-test evaluation
- TRACG model of PANTHERS-PCC test facility
- Changes in TRACG heat transfer correlations
- Update on results of post-test evaluation
    - SS pure steam tests
    - SS steam/air tests
- Processing of tube wall temperature instrumentation
- Containment analysis with light gas
- Summary

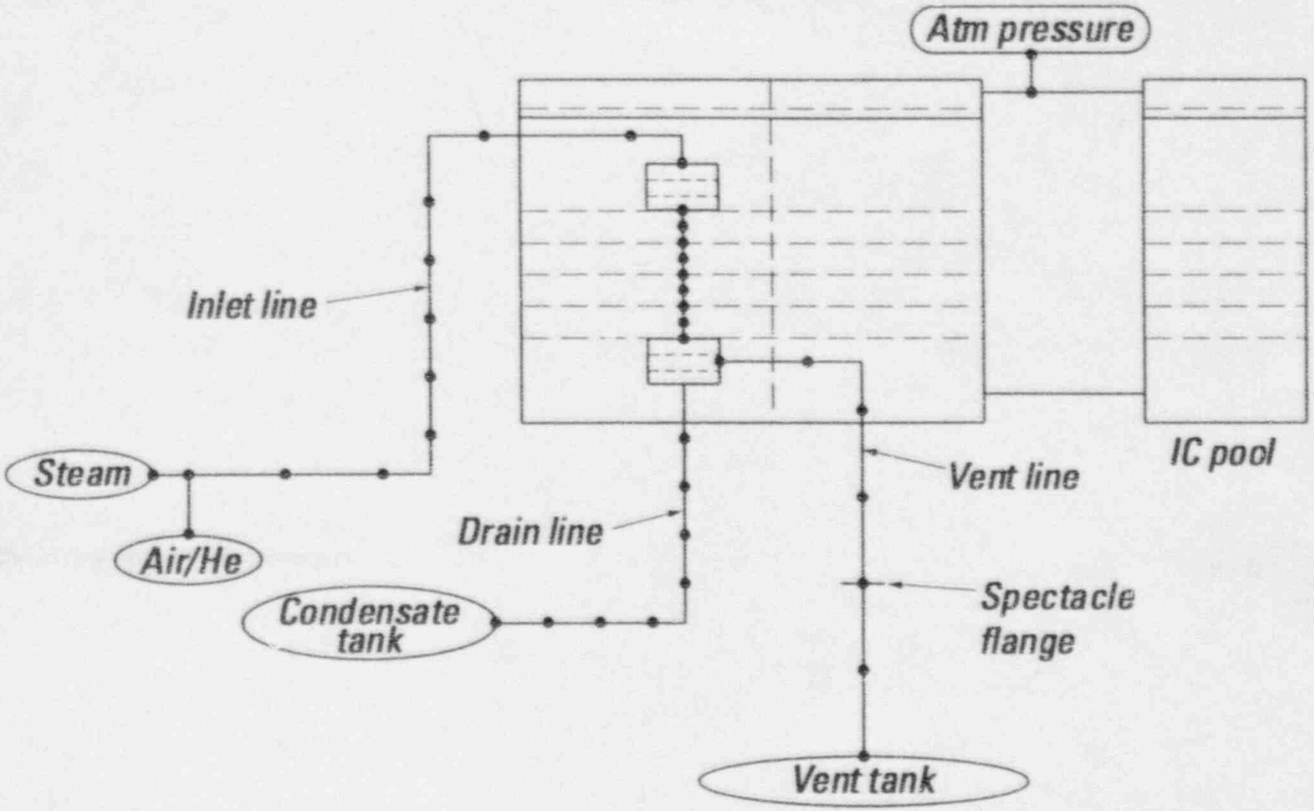
Objectives of post-test evaluation

- *Evaluate applicability of TRACG correlations for calculation of PCC performance*
  - *tube side*
  - *pool side*
- *Evaluate applicability of "lumped-tube" input model of PCC for use in containment system analysis.*
  - *parallel module effects*
  - *parallel tube effects*
  - *Condensation with heavy/light non-condensables*

Tests for post-test evaluation

Test	Test Type	Data Comparison
41	SS - pure steam	inlet pressure
43	SS - pure steam	inlet pressure
49	SS - pure steam	inlet pressure
9	SS - steam/air	heat rejection rate, Δp
15	SS - steam/air	heat rejection rate, Δp
18	SS - steam/air	heat rejection rate, Δp
23	SS - steam/air	heat rejection rate, Δp
2	SS - steam/air	heat rejection rate, Δp
17	SS - steam/air	heat rejection rate, Δp
19	SS - steam/air	heat rejection rate, Δp
22	SS - steam/air	heat rejection rate, Δp
35	SS - steam/air	heat rejection rate, Δp
51	TR - nc buildup	inlet pressure vs. air inventory
76	TR - nc buildup	inlet pressure vs. helium inventory
78	TR - nc buildup	inlet pressure vs. air/helium inventory
55	TR - water level	inlet pressure vs water level

TRACG model of PANTHERS PCC



Changes in TRACG heat transfer correlations

- *Tubeside*
  - *Incorporate results of final UCB single-tube tests and correlation (Kuhn-Schrock-Peterson)*
- *Poolside*
  - *Use pool-boiling correlation in place of Chen*

	Tubeside	Poolside
TRACG02	Vierow-Schrock ("Tsukuba")	Chen
TRACG04	Kuhn-Schrock-Peterson (KSP)	Pool boiling (Forster-Zuber)

Steady-state steam/air tests

TEST CONDITIONS

Test No.	Steam Flow (kg/sec)	Air Flow (kg/sec)	Air Mass Fraction	Inlet Pressure (kPa)	Inlet Temperature (°C)
15	5.00 - 5.10	0.165-0.167	0.032	300 - 790	140 - 176
23	4.97 - 5.03	0.85 - 0.87	0.146-0.148	298 - 584	135 - 160

Processing of tube-wall temperature data

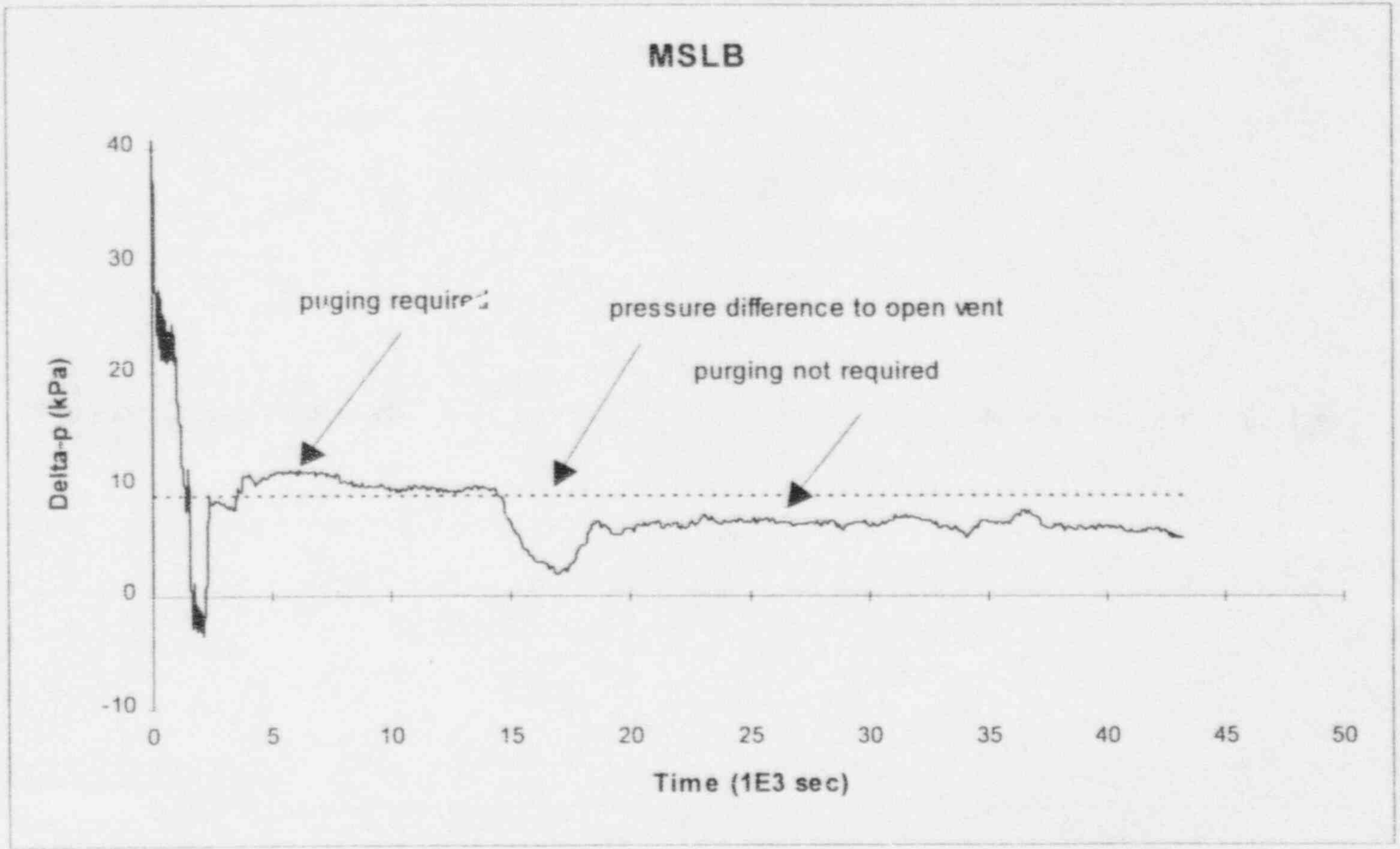
- *Instrumentation*
  - *Four tubes*
  - *Nine axial locations on each tube*
  - *Two embedded wall thermocouples at each location*
- *Pure-steam tests used for evaluation*
  - *Axially uniform tube and pool-side fluid temperatures*
  - *Significant heat transfer at all axial locations*
- *Measurements "normalized" by scaling 4-tube average heat removal to overall condenser heat removal*
- *Measurements used to infer tube wall surface temperatures*
- *Inferred film drops indicate that TRACG htc is too low on pool side and too high on tube side*

Containment analysis with light gas

- *PANTHERS/TRACG comparison indicates model revision is required to predict condenser behavior with light-gas in a "dead-end" configuration.*
- *Conditions tested at PANTHERS are only applicable to performance with vent closed.*
- *In SBWR application, any degradation in performance will force the vent to open.*
- *Gas purging via open vent will dominate over distributional effects within condenser.*
- *Calculation of condenser performance during light-gas purging with a system-type (e.g.., single-tube) model is an achievable objective.*

Containment behavior for light gas

- ***PCC vent opens whenever performance is degraded***



Containment analysis with light gas

- *Data available*
  - *Heat transfer characteristics for light gas under purging conditions well defined by UCB/MIT data*
  - *GIRAFFE tests show light gas will be purged from PCC by DW/WW pressure difference*
  - *GIRAFFE tests show pressure history is similar for nitrogen and helium purges*
- *Analysis approach*
  - *Use conservative degradation factor based on single-tube data*
  - *Modify model, as necessary, to account for distributional effects*
  - *Perform calculations to determine most limiting purging transient, e.g..*
    - *Long purge with dilute hydrogen mixture*
    - *Short purge with rich hydrogen mixture*

Summary

- *Post-test analyses of PANTHERS PCC steady-state data completed*
- *Calculations are conservative for pure steam and steam/air tests*
  - *Heat rejection rate underpredicted by 10-15%*
  - *Data trends captured*
- *TRACG correlations modified*
  - *Kuhn-Schrock-Peterson (KSP) on tube side*
  - *Pool boiling (Forster-Zuber) on pool side*
- *Processing of tube-wall temperature instrumentation has provided support for changes in TRACG correlations*
- *Procedures for light-gas analysis being developed*
  - *GIRAFFE and PANTHERS data will support modeling approach*