

Westinghouse Electric Corporation **Energy Systems**

Box 355 Pittsburgh Pennsylvania 15230-0355

AW-95-812

April 18, 1995

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

ATTENTION:

MR. T. R. QUAY

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT:

PRESENTATION MATERIALS FROM THE APRIL 10 & 11, 1995 MEETING ON AP600 HYDROGEN TOPICS AND THE APRIL 10, 1995 MEETING ON

AP600 PCS TEST AND ANALYSIS PROGRAM

Dear Mr. Quay:

The application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10CFR Section 2.790, Affidavit AW-95-812 accompanies this application for withholding setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-95-812 and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager

Nuclear Safety Regulatory And Licensing Activities

/nja

cc: Kevin Bohrer

NRC 12H5

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Brian A. McIntyre, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Brian A. McIntyre, Manager

Advanced Plant Safety and Licensing

Sworn to and subscribed

before me this 18 day

Notary Public

Notarial Seal Rose Mane Payne, Notary Public Monroeville Boro, Allegheny County My Commission Expires Nov. 4, 1996

Member, Pennsylvania Association of Notaries

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- (1) I am Manager, Advanced Plant Safety and Licensing, in the Advanced Technology Business Area, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.
- (2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.
- (3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.
- (4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.
 - (i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.
 - (ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

- (a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.
- (b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.
- (c) Its use 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 a similar product.
- (d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.
- (e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.
- (f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

- (a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.
- (b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

- (c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.
- (d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.
- (e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.
- (f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.
- (iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.
- (iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.
- (v) Enclosed is Letter NTD-NRC-95-4439, April 18, 1995 being transmitted by Westinghouse Electric Corporation (W) letter and Application for Withholding Proprietary Information from Public Disclosure, N. J. Liparulo (W), to Mr. T. R. Quay, Office of NRR. The proprietary information as submitted for use by Westinghouse Electric Corporation is in response to questions concerning the AP600 plant and the associated design certification application and is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of licensing advanced nuclear power plant designs.

This information is part of that which will enable Westinghouse to:

- (a) Demonstrate the design and safety of the AP600 Passive Safety Systems.
- (b) Establish applicable verification testing methods.
- (c) Design Advanced Nuclear Power Plants that meet NRC requirements.
- (d) Establish technical and licensing approaches for the AP600 that will ultimately result in a certified design.
- (e) Assist customers in obtaining NRC approval for future plants.

Further this information has substantial commercial value as follows:

- (a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for advanced plant licenses.
- (b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar advanced nuclear power designs and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

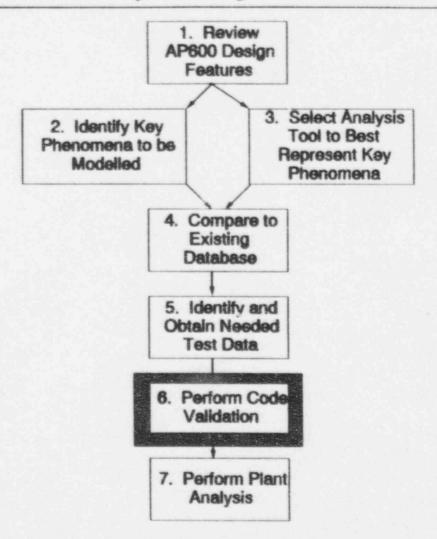
The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing analytical methods and receiving NRC approval for those methods.

Further the deponent sayeth not.

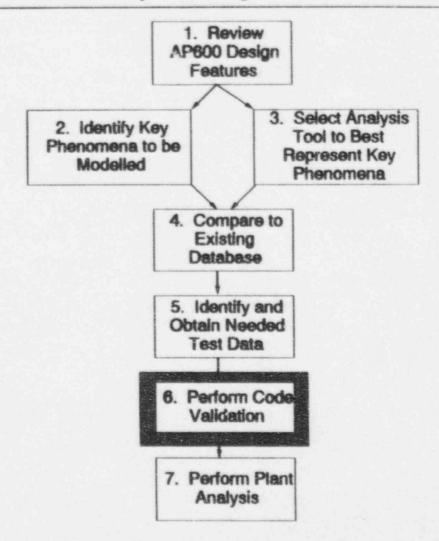
AP600 PCS Test and Analysis Program





AP600 PCS Test and Analysis Program





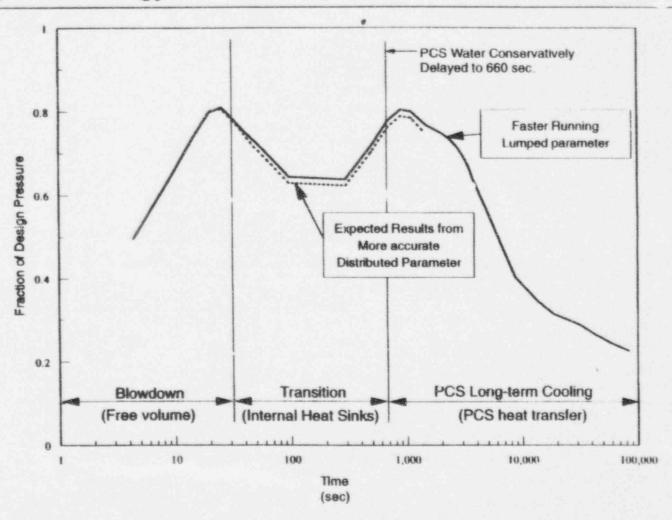
WGOTHIC LST Modeling Methods



- Modeling Methodology
- LST Data Usage for Code Validation
- Key WGOTHIC Input Parameters and Noding Basis

Modeling Methodology





Modeling Methodology



- Lumped parameter will be used for LOCA pressure response analysis.
- Distributed parameter will be used through the peak pressure calculations while the containment most nearly approaches containment design pressure.
- Noding corresponding to the LST models will be used for the plant analysis.

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Large-scale tests to be run with WGOTHIC lumped parameter and distributed parameter models have 13 different steady-state conditions:

212.1 A, B, C

214.1 A, B

216.1 A, B

219.1 A, B, C

222.1

222.4 A, B

These large-scale tests have been selected that address code validation for the parameters with the largest effect on vessel pressure, as shown in the scaling analysis and the test data.

Address important phenomena as identified in the PIRT



| Test Parameters | Test Numbers | | | |
|--|---|--|--|--|
| Containment pressure is a primary function of: | | | | |
| Steam source flow rate and orientation | 219.1C : 212.1 A,B,C 222.1 : 212.1 A,B,C 222.1 : 222.4A,B | | | |
| External water flow rate/coverage | 219.1A,B: 219.1C 216.1A:216.1B 212.1B: 216.1A,B | | | |
| Steam and noncondensable partial pressures | 219.1A: 219.1B 222.4B: 222.1 | | | |
| Containment pressure is a secondary function of: | | | | |
| External air flow rate characteristics | 214.1A: 214.1B | | | |

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| Run & Test Number | Description | | | | |
|--------------------|---|---------|-----|---|--|
| | ms (lb/s) | PCS (%) | | Characteristics | |
| RC048-212.1A, B, C | | | 79, | 3 steady-state P _v | |
| RC044-214.1A, B | | | | free/forced air | |
| RC046-216.1A, B | | | | PCS quadrant | |
| RC057-219.1A, B, C | | | | He, dry/wet PCS | |
| RC061-222.1 | | | | blowdown | |
| RC066-222.4A, B | | | | blowdown, 3-in. pipe 6 ft. above deck-up | |
| RC062-220.1 | | | | blowdown, blind test | |
| | ass flow rate (lb/s) er coverage (%) essure | | | | |



PCS PHENOMENA IDENTIFICATION AND RANKING TABLE FOR AP600 LOCA AND MSLB

| Component | Phenomena | Rank | Test |
|----------------|--|------|------------------------------------|
| Module Volume | Multi-component compressible gases | Н | |
| | Buoyancy | Н | |
| | Jet-plume mixing/entrainment | Н | |
| | Steam source superheating | M | |
| | Flow field stability/stratification | Н | |
| Module Surface | Liquid film heat transfer | М | |
| | Liquid film stability/coverage | H | All the phenomena are addressed by |
| | Liquid film subcooling | M | the following: |
| | Free convection heat transfer | M | |
| | Forced convection heat transfer | L | 212.1 A,B,C: 214.1 A,B; 216.1 A,B; |
| | Radiation heat transfer | L | 219.1 A,B,C; 222.1; 222.4 A,B |
| | Free convection mass transfer | Н | |
| | Forced convection mass transfer | Н | |
| Module Solids | One-dimensional transient conduction heat transfer | н | |
| | Two or three-dimensional conduction | L | |
| Inter-Module | Convection | М | |
| | Conduction | Н | |
| | Form and friction losses | Н | |

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Conclusions

Tests have been selected for comparison to the WGOTHIC code:

- Cover the range of parameters with the largest effect on vessel pressure as shown in the test results
- Address important phenomena as identified in the PIRT
- Will be used to validate the LST lumped parameter and distributed parameter models



Key Input Parameter and Noding Basis

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Key Input Parameters



| Input | Examples | | |
|---------------------------------------|---|--|--|
| Design Data | Geometry Flow areas Volumes Protection system configuration | | |
| Noding Selection | Type (lumped/distributed parameter) Size Number Locations Connections | | |
| Accident Boundary Conditions | Mass and energy releases Equipment assumptions | | |
| Initial Conditions | Pressure Temperature Humidity Ambient conditions | | |
| Model/Correlation Selection and Input | Uchida condensation correlation Friction factors Channel correlations for external heat and mass transfer Flat plate correlations for internal shell heat and mass transfer | | |

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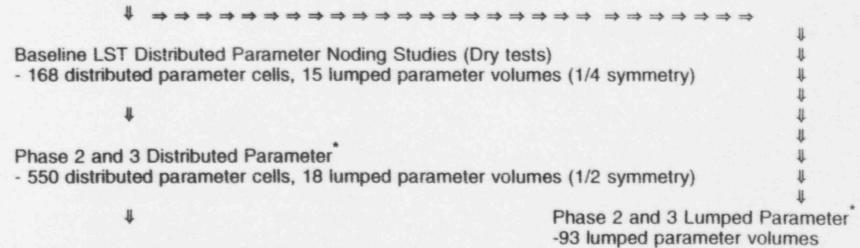
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Noding Methodology



LST Noding Development Process

Baseline LST Lumped Parameter - WCAF-13246, Rev. 0 - 41 lumped parameter volumes (1/4 symmetry)



Phase 2 and 3 Optimized Distributed Parameter

- 375 distributed parameter cells, 18 lumped parameter volumes (1/2 symmetry)

^{*}To be discussed today



- Did noding studies on Baseline LST (dry tests)
- Applied knowledge to build the 550 distributed parameter cell deck with detailed noding to capture important effects
- Simplify noding without distorting the ability to model the most important effects (375 distributed parameter deck)

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- The vessel is divided into subvolumes using the distributed parameter formulation (~550 distributed parameter cells).
- The air annulus is modeled with the lumped parameter formulation.
- The large-scale test is symmetrical about the 0° 180° line. The model takes advantage of the symmetry.

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Detailed noding around the jet

- In the vertical and radial direction to model entrainment into jet

In the radial direction to model jet expansion

 Relatively small nodes along the wall to provide a "local" bulk velocity, temperature, and pressure for the PCS heat and mass transfer correlations

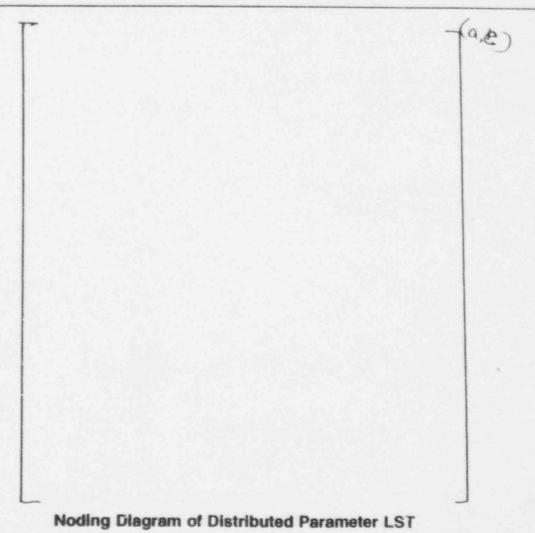
• Use facility geometry and internal equipment location to determine

noding

The specific location of several of the subvolume boundaries are determined based on location of walls, equipment, etc. For example, subvolume boundaries were determined based on the steam generator box walls, the steam generator model height, the internal gutter height, etc.

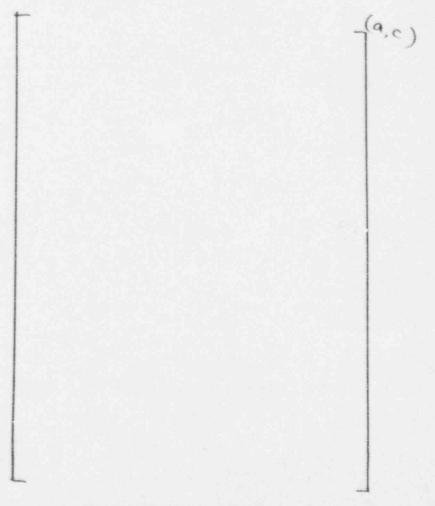
 Remaining noding was determined to provide enough detail to capture gradients and flow field





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Distributed Parameter Noding

ACRS Thermal-Hydraulics Subcommittee Meeting on AP600 PCS



H. WGOTHIC LST CODE VALIDATION RESULTS

March 30, 1995

M. Kennedy

Contact: John Butler Phone: 412-374-5268

Westinghouse Electric Corporation

Contains Westinghouse Proprietary Class 2 Information

WGOTHIC LST Code Validation Results



- Distributed Parameter Comparison to LST (550 cell model)
 - Base case
 - Sensitivity to explore mixing effects
- Optimized Distributed Parameter LST Model (375 cell model)
- Lumped Parameter Comparison to LST
- Modeling Conclusions Relative to AP600

WGOTHIC LST Code Validation Results



The distributed parameter and lumped parameter comparisons will be made to LST 212.1

Test Characteristics

- Three steam flow rate levels, reaching a steady-state pressure with each flow rate.
- Forced convection in air annulus.
- Exterior water coverage for the first and second steady-state periods was 100% wet. For third steady-state period, the water coverage was 95%.



Distributed Parameter Comparison to LST 212.1 (550 cell model)

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- Global Comparisons
 - Vessel pressure
 - Condensate flow rate (Total heat transfer)
 - Excess PCS water flow rate (Total evaporation)
- Local Comparisons
 - Noncondensable concentrations
 - Velocity inside vessel
 - AT through vessel wall
 - Rake temperatures



- Global Comparisons
 - Vessel pressure
 - Condensate flow rate
 - Excess PCS water flow rate







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Global Comparison Conclusions

Good agreement between the code and measurements



- Local Comparisons
 - Noncondensable concentrations
 - Velocity inside vessel
 - ΔT through vessel wall
 - Rake temperatures









Noncondensable Comparison Conclusions

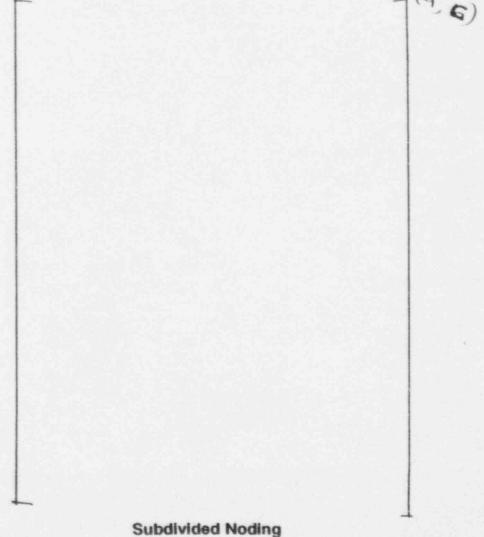
- Good agreement between measured and predicted
- Shows the code is modeling plume entrainment and mixing



Velocity Meter Measurements

- Dome 42" 165° anemometer read an average velocity of []ft./s
- A 90° anemometer read an average velocity of []ft./s
- Dome 42" 345° anemometer read an average velocity of []ft./s
- D 180° and E 30° anemometers have either failed or the velocities are below the sensor threshold













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- Vessel Velocity Conclusions:
 - The predicted velocities are consistent with the measured wall velocities of []ft./s
 - The model predicts the plume entrainment and mixing



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79.6)





76.5)



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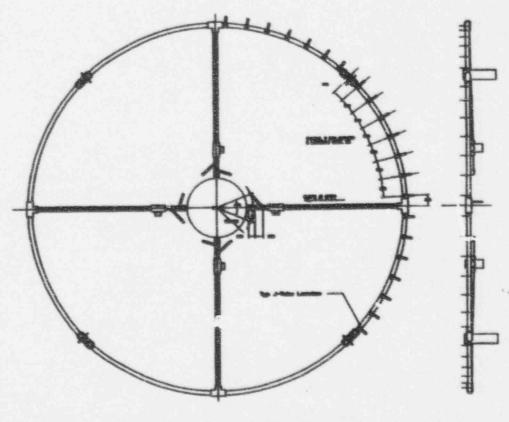


Average Wall Temperature Difference, Elevation D0-21

- This elevation is in between the two water distributer J-tube rings.
 It is not a valid point to model as 100% wet (or 95% wet for third steady-state).
- Represents small fraction of vessel surface area (<2%) and over prediction has a negligible impact on overall results.

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Water Film Distributor

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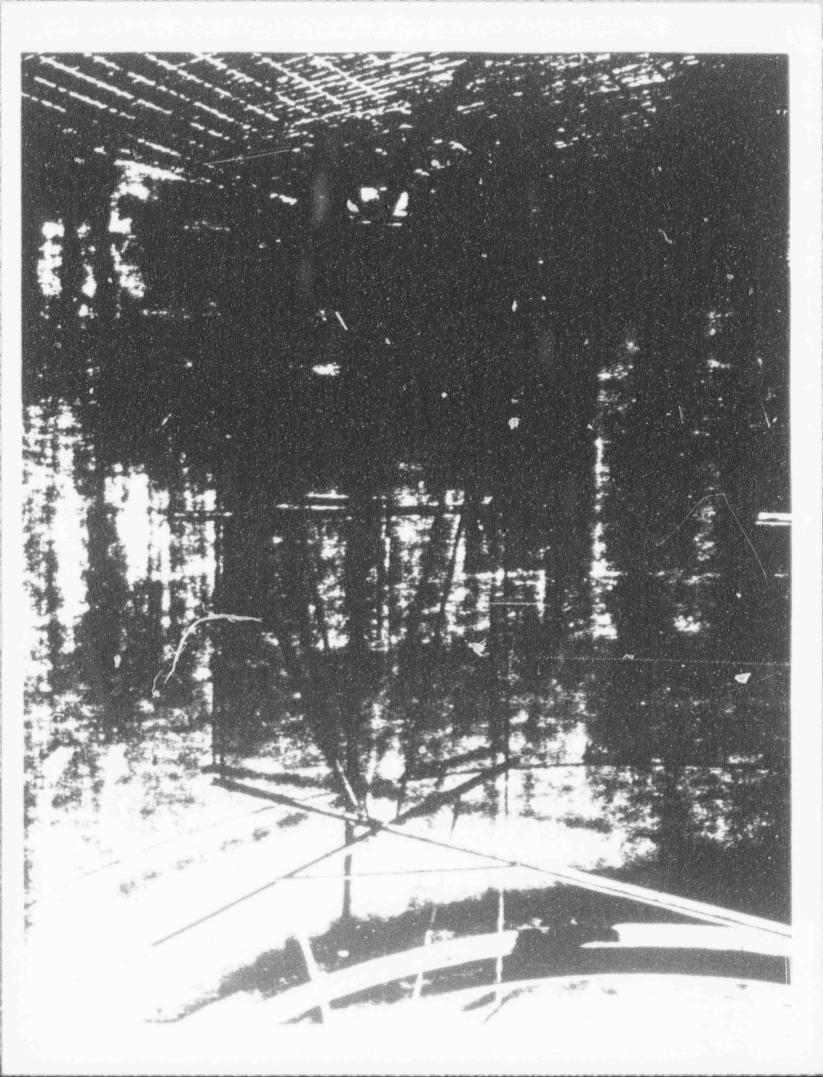


Vessel Wall AT Conclusions

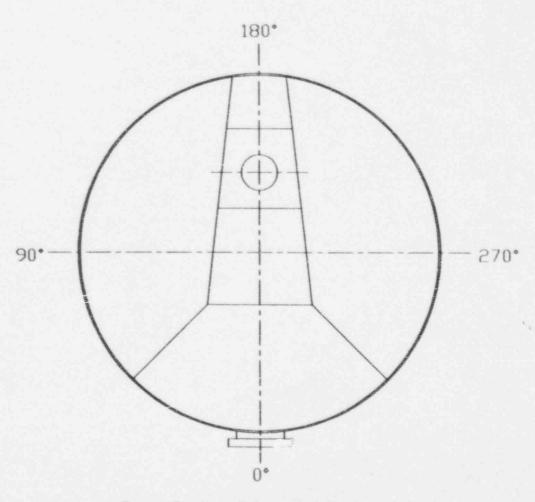
- Good agreement between measured and predicted results
- Support that getting vessel pressure agreement for the right reasons
- Small differences between code and measurements can be explained

Distributed Parameter Comparison to LST-Internal Rake









Cross Section Orientation Convention







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Internal Rake Temperature Conclusions

- Agreement is good between measurements and predictions.
- Predicted temperature in upper dome too hot as a result of modeling DO-21 as 100% wet (95% wet for third steady state).
 This has negligible impact on overall results. It is only a local disturbance.



Summary

- Global Comparisons
 - Show good agreement for total energy transferred
 - Illustrate that the primary parameter, vessel pressure, is predicted well
- Local Comparisons
 - Show good agreement for many independent parameters
 - Supports vessel pressure results (i.e., getting vessel pressure agreement for the right reasons)



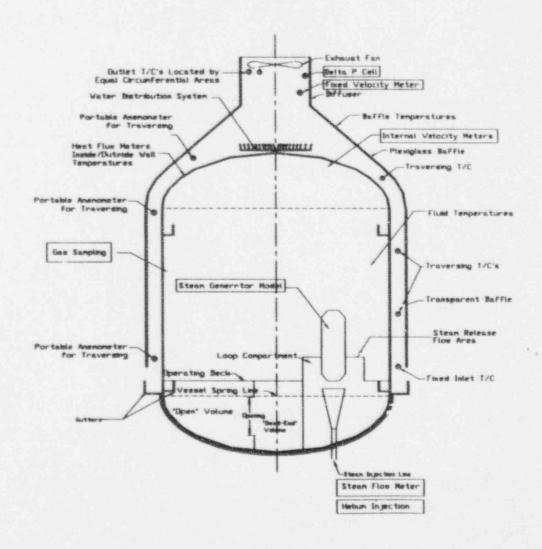
Distributed Parameter LST Sensitivity (550 cell model)



- Exploring Mixing Effects with Distributed Parameter Model
- To Address Nonprototypicality Identified in Scaling, a Flow Path was Modeled Between the Steam Generator and Dead-Ended Compartment in the LST Base Case Distributed Parameter Model

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Modeling a Path Between the Steam Generator Compartment and the Dead-Ended Compartment:

- Represented a configuration more like the plant
- Mixed noncondensables from below the deck
 - Penalize the heat and mass transfer in the vessel
 - Calculated pressure is increased



Optimized Distributed Parameter Model (375 cell model)

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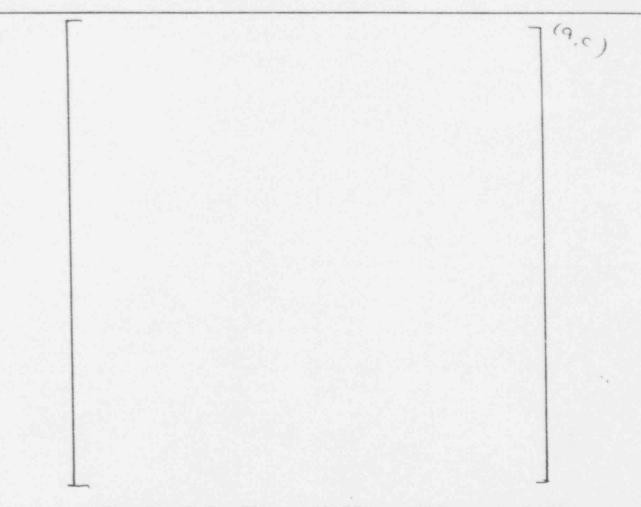
Optimized Distributed Parameter Model



- Noding of 550 cell distributed parameter model has been selectively reduced so the flow field is not distorted
- The optimized noding will be used to model the selected Phase 2 and 3 large-scale tests
- A similar AP600 distributed parameter model is being used to assess peak containment pressure

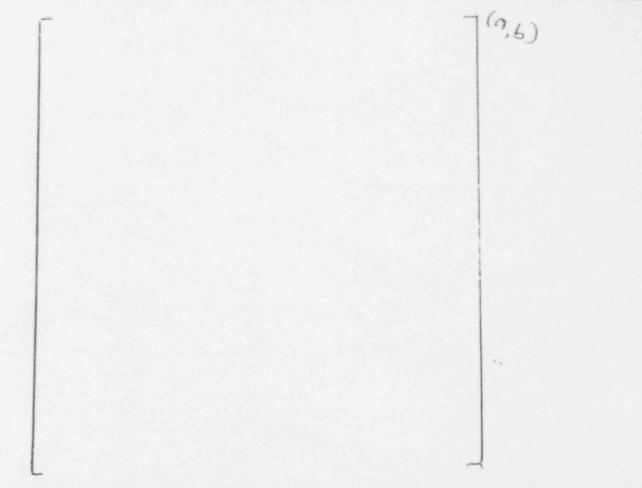






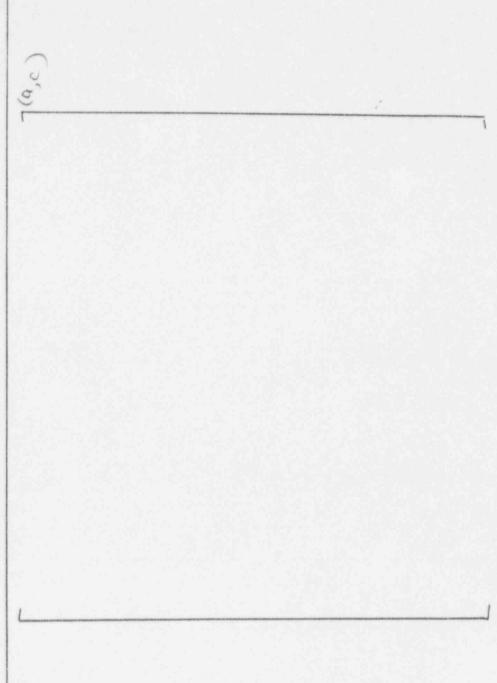
Elevation Noding Diagram of LST Lumped Parameter Model





Plan View of LST Vessel Lumped Parameter Noding from Operating Deck to Upper Internal Gutter

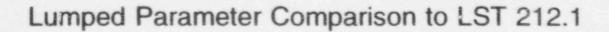




Plan View of LST Vessel Lumped Parameter Noding from Operating Deck to Upper Internal Gutter













- While vessel pressure is only overpredicted by 6% at steady state, the model is calculating over-mixing of the noncondensables in the vessel.
- The velocity predictions along the wall are too high. The predicted velocities are 5-8 ft./s. The measurements show the velocities are 1-3 ft./s along the vessel wall.



The lumped parameter model's tendency to over entrain and numerically drive circulation results in two competing effects:

- Over mixing of noncondensables in the vessel
- Over predicting the velocity

The competing effects result in a slight over prediction in vessel pressure.

To reduce the competing effect, only free convection is used to model heat and mass transfer inside the vessel. This conservatively biases the results.



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Conclusions

- Free convection will be used to model heat and mass transfer inside the containment vessel
- This conservatively biases the LST results
- A similar AP600 lumped parameter model with forced convection neglected inside the vessel will be used to assess long term containment cooling

WGOTHIC LST Code Validation Results



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WGOTHIC LST Code Validation Results



Conclusions Relative to AP600

- Maximize the strengths of the distributed and lumped parameter models
- Use the most accurate tool, distributed parameter, for the peak pressure calculations while the containment most nearly approaches containment design pressure for LOCA
- Use the lumped parameter for long term LOCA
 - Faster running time
 - Sufficient representation of the AP600 conditions: well mixed and dominated by free convection