Docket File
52-003

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 27, 1995

APPLICANT: Westinghouse Electric Corporation

PROJECT: AP600

SUBJECT: SUMMARY OF MEETING AND TELECONFERENCE TO DISCUSS PASSIVE CONTAINMENT COOLING SYSTEM (PCCS)

The subject meeting was held in Rockville, Maryland on August 16, 1995, between representatives of Westinghouse Electric Corporation and the Nuclear Regulatory Commission (NRC) staff. The purpose of the meeting was to discuss Westinghouse-proposed closure paths for issues associated with the PCCS program approach. Attachment 1 is a list of attendees. Attachment 2 is the meeting agenda.

On August 9, 1995, Westinghouse forwarded Tables 1 and 2, "PIRT Application to Evaluation Model Inside Containment" and "PIRT Application to Evaluation Model Outside Containment". These two tables and several other tables were provided at the meeting (Attachment 5).

The key issues discussed were noding sensitivity and mixing and stratification sensitivity. The NRC staff expressed the need for Westinghouse to show a nodal link between the large scaling test (LST) and the AP600 plant. To address this concern, Westinghouse is performing sensitivity studies at the Massachusetts Institute of Technology (MIT). The studies will include three noding cases to confirm that the AP600 would not be any more sensitive to noding than the LST. MIT will also provide the rationale for the applicability of LST-peak pressure insensitivity to noding perturbations to the AP600 using a simplified model. Westinghouse will also address time-step sensitivities by a study that will include using one-half the time-step for a loss of coolant accident (LOCA) sequence in the application report. To address mixing and stratification sensitivities, Westinghouse will perform a sensitivity study comparing one-half the flow area and the actual flow area between the upper and lower containment compartments.

During the meeting, action items from the previous meeting were reviewed and progress was discussed (Attachment 3). The staff and Westinghouse agreed to a number of action items during the course of the meeting. These action items were recorded by Westinghouse and collectively agreed to by the meeting participants (Attachment 4). Westinghouse committed to provide a schedule for the agreed upon deliverables at a later date.

On September 1, 1995, Westinghouse faxed a schedule for deliverables to the NRC. Attachment 6 is the Westinghouse-proposed schedule. On September 7, 1995, a teleconference was held to discuss the schedule. The participants on the call were Joel Woodcock and Jim Gresham of Westinghouse and Ed Throm of the NRC. The NRC staff noted that several documents did not appear on the schedule, including responses to low priority issues, the Application Report, and a f nal standard safety analysis report submittal based on the revised design basis accident approach. These documents would be necessary to complete the review for the final safety evaluation report. Westinghouse stated that they provided a schedule based on what they believe is needed for a supplemental draft safety evaluation report on testing and code applicability.

original signed by:
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Docket No. 52-003

Attachments:
As stated

cc w/attachments:
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Westinghouse Electric Corporation

Docket No. 52-003

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PASSIVE CONTAINMENT COOLING SYSTEM
ATTENDANCE SHEET
AUGUST 16, 1995

NAME	ORGANIZATION
John Butler	Westinghouse
Jim Gresham	Westinghouse
Joel Woodcock	Westinghouse
Paul Boehnert	ACRS
Jack Kudrick	NRC/SCSB
Ed Throm	NRC/SCSB
Tom Kenyon	NRC/PDST
Diane Jackson	NRC/PDST

Attachment 1

MEETING ON WESTINGHOUSE AP600
PASSIVE CONTAINMENT COOLING SYSTEM
MEETING AGENDA
AUGUST 16, 1995

1. STATUS OF ACTION ITEMS FROM JULY 27, 1995, MEETING

2. IDENTIFICATION AND DISCUSSION OF KEY PCS DBA ISSUES

   - WATER COVERAGE
   - UNCERTAINTIES
   - MIXING AND STRATIFICATION
   - NODING CONVERGENCE
   - USE OF SCALING

3. CLOSURE PROCESS

Attachment 2

ACTION ITEMS FROM JULY 27, 1995, MEETING

PROVIDED BY WESTINGHOUSE

AT THE AUGUST 16, 1995, MEETING BETWEEN

WESTINGHOUSE AND THE NRC ON

PASSIVE CONTAINMENT COOLING SYSTEM

Attachment 3

PCS MEETING
JULY 27, 1995

Meeting Actions:

1.	Blowdown Calculations	In response to questions on how the WGOTHIC calculation of blowdowns compares to more traditional code approaches, Westinghouse will perform WGOTHIC calculations using an approach which is consistent with standard SRP assumptions for blowdown.
2.	Riser (Viskanta) Issues	During discussion on Riser eddy current concerns raised by preliminary calculations performed by Dr. Viskanta, Westinghouse accepted a level of risk associated with not addressing the concerns at this time. NRC to identify the schedule for Dr. Viskanta's work. W to provide a basis for the statement in Table 1 of the meeting presentation material that notes "negligible effect" for item "C" (Flow field stability or stratification of external flow path). This basis should address the sensitivity to the effects of potential maldistributions, flow degradation and startup effects.
3.	Break Spectrum effects	W needs to address effects of break spectrum in "WGOTHIC APPLICATIONS DOCUMENT". As part of this, W should add discussion of how the effects of smaller LOCA breaks are addressed by model in addition to addressing effect of small MSLB.
4.	Code Uncertainty	Considerable discussion on the approach proposed by Westinghouse to address code uncertainty. NRC expressed high level of "uncertainty" with the proposed approach. Westinghouse took an action to evaluate alternative ways to address including replacing the code uncertainty approach and instead use a more traditional approach of using conservative heat transfer correlations.
5.	LOCA M&E Calculations	Westinghouse to provide rationale on why use of SATAN is appropriate for AP600 LOCA mass and energy releases. As part of this, Westinghouse to identify and discuss the parameters changed in M&E calculations from traditional core response calculations.
6.	Noding Sensitivities	Westinghouse to provide a discussion of MIT Noding Sensitivity activities (Scope and Schedule) at next NRC/Westinghouse meeting (planned for 8/16 or 8/17)

7.	Mixing and Stratification	During discussion on mixing and stratification concerns, Westinghouse identified that sensitivity calculations are being performed to address these concerns and that in combination with MIT noding studies should address most concerns. NRC noted that these sensitivity calculations should address velocity effects on mixing and stratification.
8.	Schedule & Deliverables	The schedule and deliverable content will be provided and discussed at next meeting (planned for 8/16 or 8/17).
9.	Scaling	W to establish role and status of PCS scaling analysis for AP600 and identify those items that scaling does not have to or cannot address. Scaling to be included as topic at next meeting (planned for 8/16 or 8/17).
10.	Water Coverage	W to evaluate results from code of Test 219 to assess code capability to conservatively predict pressure under relevant AP600 conditions of dryout and rewetting.
11.	WGOTHIC Documentation	NRC needs listing of GOTHIC models not being used by AP600 WGOTHIC so that NRC can exclude from their review/acceptance of WGOTHIC. W to facilitate revision of GOTHIC equation documentation errors/problems. Westinghouse to identify how WGOTHIC was modified to address items corrected in GOTHIC to yield version 4.0.
12.	Next Meeting	August 17th preferred but otherwise August 16th. Location open but can be in Monroeville.
13.	Open Items/RAIs	NRC (Ed Throm) to review proposed priority on RAIs (pages 53-54 of meeting handout). NRC (Ed Throm) and Westinghouse (Joel Woodcock) to discuss priorities and statuses of OIs on Monday PM (7/31/95) at 2:00 PM. Westinghouse to establish similar phone call on Hydrogen and Ex Vessel OIs and RAIs (hopefully set up next week).
14.	Miscellaneous	W to have remainder of Table 1 (meeting handout) a week before next meeting (August 11th) Fax typed up version of notes to NRC on Friday, July 28th.

AUGUST 16, 1995
WESTINGHOUSE/NRC MEETING ON AP600 PCS

Joel Woodcock
Jim Gresham
Paul Boehnert
Jack Kudrick
Ed Throm
John Butler
Diane Jackson

Action Items from Previous Meeting

1. Blowdown Calculations

   Westinghouse will perform WGOTHIC calculations using an approach which is consistent with standard SRP assumptions for blowdown.

   LOCA and SLB
   Few (possibly one) node
   Uchida heat transfer on internal heat sinks and shell

   NRC expecting to see simplistic nodalization (model)
   If differences appear between standard calculation and AP600 calculation Westinghouse to explain.

   NRC expecting AP600 margin to be at least as much as current plants. Westinghouse expressed concerns relative to how differences will be judged.

2. Riser (Viskanta) Issues

   No actions necessary at this time. Issue to be revisited if results of Viskanta calculations warrant.

3. Break Spectrum Effects

   SLB
   Westinghouse needs to provide basis in SSAR for why cases presented are limiting M&E cases (reference back to previous spectrum of breaks) (i.e., why is 1992 spectrum of break applicable to current model)

   LOCA
   Westinghouse to perform 0.6CD case to address spectrum effects and will include discussion on how spectrum effects are addressed.

   NRC believes proposed actions can address need to address spectrum of breaks

Attachment 4

4. Code Uncertainty

Westinghouse to replace "code uncertainty" approach and will instead conservatively bias heat transfer correlations used on internal and external sides of PCS shell..

NRC believes proposed approach adequately addresses (closes) concern.

5. LOCA M&E Calculations

Westinghouse to provide rationale which should identify that SATAN M&E calculations use "traditional" approach and why appropriate for AP600 noting that no changes were made to model AP600 specific features.

6. Noding Sensitivities
Noding sensitivity calculations which are being performed include:

1. Addressing extension of LST noding results to AP600 by setting up 3 AP600 noding cases.

2. Confirm that AP600 pressure is not sensitive to noding perturbations using simplified separate effects models and provide rationale for resulting sensitivity

3. Separate sensitivity to be provided to address time step sensitivity. Sensitivity will consist of cutting time step in half for LOCA event.

7. Mixing and Stratification

Westinghouse provided discussion of current modeling and why modeling being used conservatively addresses mixing. Current calculations bias flow area between upper compartment and lower compartments by using 1/2 of actual flow area. Sensitivity calculation will be performed using actual flow area to show level of bias.

Separate discussion: Staff currently believed to be calculating higher 24 hour pressure than Westinghouse. NRC to confirm and separate discussion needed to resolve difference.

9. Scaling

Recent changes in AP600 DBA methodology have lessened the importance of using scaling to scale LST test results to the plant. Scaling was used to understand the importance of various phenomena (PIRT). Key phenomena will now be addressed in a bounding approach.

Westinghouse will reassess what actions are needed and schedule to address past comments on existing scaling analysis. NRC believes this is a key item and should be addressed soon.

10. Water Coverage

Discussion on test 219 modeling provided by Westinghouse where water coverage is input as a boundary condition. NRC review of Westinghouse water coverage report is ongoing.

11. WGOTHIC Documentation

List of GOTHIC models not being used by AP600 WGOTHIC will be provided by Westinghouse.

Westinghouse will (with EPRI agreement) transmit WGOTHIC 4.0 documentation (3 volumes) and transmittal will identify those model excluded from AP600 WGOTHIC, identify other exceptions where 4.0 differs from WGOTHIC, identify how peer review comments are handled by WGOTHIC.

12. Next Meeting

13. Open Items/RAIs
Phone call held August 14, 1995

14. Miscellaneous

Revised Table 1 provided informally by Fed Ex prior to meeting and during meeting. NRC believes that the document is very useful. Table 1 will be revised to incorporate discussions of August 16, 1995, meeting and will be transmitted formally to NRC. Document will be maintained as a "living" document and will be revised as necessary. Revisions will clearly identify what has changed from previous revision.

15. Summary

Objective of the meeting was to go through all of the remaining issues relative to PCS DBA testing and analysis and with each of these issues agree to a path to resolution. There is agreement between Westinghouse and NRC that this objective was achieved. Schedules and deliverables were not discussed in any detail at the meeting. Westinghouse stated they need to go back and reevaluate priorities and establish a prioritized list of deliverable and schedules. NRC recommended that prioritization be based on early resolution of issues which could have significant impact on AP600 design and final closure. Once developed, the prioritized list will be discussed among Westinghouse, NRC and interested parties. It is expected that meeting will be held in approximately one month or less.

TABLES PROVIDED BY WESTINGHOUSE

FOR THE AUGUST 16, 1995, MEETING BETWEEN

WESTINGHOUSE AND THE NRC ON

PASSIVE CONTAINMENT COOLING SYSTEM

Attachment 5

Appendix A

Westinghouse / NRC Meeting on PCS Closure Paths
August 16, 1995 Rockville, MD

Table 1: PIRT Application to Evaluation Model: Inside Containment - All phases

Module	PIRT Phenomena	Ranking for Containment	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomena	Validation of Modeling Method and/or WGOTHIC	Use of Validation Results in this Evaluation Model	How Uncertainty is Handled
I. Volume	A. Multi-component Compressible Gasses	H	Gas constituents in the governing equations	All tests analyzed with WGOTHIC	Complete NTD-NRC-94-4260 Enclosure 1: GOTHIC Technical Manual describes governing equations Enclosure 2: GOTHIC User's Manual describes how to invoke various gasses Enclosure 3: GOTHIC Qualification Report provides large database of tests with air, hydrogen, and helium NTD-NRC-95-4462 EPRI Report RA-93-10, GOTHIC Design Review, Final Report WCAP-14382 validates WGOTHIC with separate effects, integral tests with steam, air, and helium	Effects of multicomponent compressible gasses are correctly included in governing equations	LST includes air, steam, and helium	WGOTHIC has been validated with the LST	Governing equations in WGOTHIC are a valid representation of compressible, multicomponent gas behavior Maximum Technical Specification pressure used in conjunction with 0% relative humidity.	Bounded
	B. Buoyancy	H	Buoyancy forces are included in the lumped parameter junction governing equations	LST Hugot tests Siegel & Norris tests	Complete WCAP-14382	Lumped modeling overmixes noncondensibles above operating deck thereby reducing heat removal from vessel when PCS is dominant Distributed parameter modeling shows good agreement with 550 node LST model. Modeling of buoyancy and entrainment is acceptable.	Steam injection point elevation and direction effects tests were performed LST has prototypical buoyancy driving forces and covered the range of Froude numbers for LOCA	WGOTHIC has been validated with the LST	Mixing and stratification resulting from buoyancy driven flow will be studied in the WGOTHIC Applications WCAP	Sensitivity to mixing will be provided in applications WCAP

Table 1: PIRT Application to Evaluation Model: Inside Containment - All phases

Module	PIRT Phenomena	Ranking for Containment	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomena	Validation of Modeling Method and/or WGOTHIC	Use of Validation Results in this Evaluation Model	How Uncertainty is Handled
	C. Flow Field Stability or Stratification	L	Mixing within the containment upper regions and mixing between the upper and lower portions of the containment	LST	NTD-NRC-95-4459, Stratification and Mixing Effects on AP600 Passive Containment Cooling System DBA WGOTHIC Applications Document ACRS T/H Subcommittee Meeting, March 29-30, 1995 (to be documented in letter report)	Blowdown is the same as standard plants. Long-term LOCA is driven by buoyant plume and LST covers range for AP600. MSLB is well mixed due to high velocity jet. Distributed parameter modeling shows good agreement with 550 node LST model. Modeling of buoyancy and entrainment is acceptable.	Upper and lower regions of containment represented in the LST	WGOTHIC model has been validated with the LST	Mixing and stratification resulting from buoyancy driven flow will be studied in the WGOTHIC Applications WCAP	Sensitivity to mixing and break size will be provided in applications WCAP
II. Surface	A. Liquid Film Heat Transfer	M	Thermal conductivity of liquid film for film temperature drop	Chun & Seban Wisconsin Condensation Tests	Complete NTD-NRC-94-4100, Enclosure 2 "Liquid Film Model Validations" WCAP-14382 §2	The Chun and Seban data provides a basis for film thermal conductivity.	Internal and external liquid film effects are represented in the LST	All validation performed with WGOTHIC includes the small effect of film temperature drop	Nominal wavy-laminar and turbulent Chun and Seban correlations used as appropriate	Negligible effect since resistance across film is small part of total resistance
	B. Liquid Film Stability/ Coverage	L	Condensation on the interior surface of containment	LST Wisconsin Condensation Tests	WCAP-13307 I.K. Huhtiniemi, "Condensation in the Presence of Noncondensible Gas: Effect of Surface Orientation," Ph.D. Thesis, Univ. Wisconsin, 1992	Internal films are stable since containment shell slope is in excess of 1°. Droplet formation improves mass transfer	Prototypical surfaces included in the LST Separate effects studied in Wisconsin Condensation Tests	WGOTHIC model has been validated with the LST	Shell slopes modeled with WGOTHIC exceed 1° Condensate on containment is returned to the IRWST Benefits of droplet formation neglected	Bounded
	C. Liquid Film Enthalpy Transport	M	Liquid film energy conservation equation	LST Wisconsin Condensation Tests	Complete WCAP-14382 §2.4, 2.5 show equations for liquid film WCAP-14190	Subcooling is negligible compared to energy transported to liquid field	Prototypical surfaces included in the LST Separate effects studied in Wisconsin Condensation Tests	WGOTHIC model has been validated via the LST and Wisconsin Condensation Tests	Temperature profile through film considered in solution	Negligible, film is at or near saturation temperature

Table 1: PIRT Application to Evaluation Model: Inside Containment - All phases

Module	PIRT Phenomena	Ranking for Containment	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomena	Validation of Modeling Method and/or WGOTHIC	Use of Validation Results in this Evaluation Model	How Uncertainty is Handled
	D. Free Convection Heat Transfer	L	McAdams Flat Plate Correlation Mixed convection	LST	WCAP-14190 page 2-7 WCAP-14326 page 4-1 WCAP-14382 §8	Free convection heat transfer is not significant in comparison to mass transfer	Prototypical internals Range of validation defined in WCAP-14382 §9.2	WGOTHIC model has been validated with the LST	Nominal correlation used	Negligible effect
	E. Forced Convection Heat Transfer	L	Lumped - not modeled Distributed - flat plate forced convection, mixed convection	LST	WCAP14190 page 2-7 WCAP-14326 page 4-1 WCAP-14382 §8	Convective heat transfer is not significant in comparison to mass transfer	Prototypical internals Range of validation defined in WCAP-14382 §9.2	WGOTHIC model has been validated with the LST	Lumped - Forced convection heat transfer not considered Distributed - Nominal flat plate correlation	Lumped - Bounded by neglecting forced convection Distributed - Bounded by code uncertainty
	F. Radiation Heat Transfer	L	Not modeled	LST	WCAP-14190 page 2-8	Temperature differences within containment are small enough that radiative heat transfer is low	Prototypical internals and temperature driving forces modeled in LST	WGOTHIC modeling of LST neglected radiative heat transfer	Not modeled	Bounded
	G. Free Convection Mass Transfer	H	Lumped - Heat and mass transfer analogy based on McAdams flat plate heat transfer correlation Distributed - Heat and mass transfer analogy using the mixed convection correlation	LST Wisconsin Condensation Tests	WCAP-14190 page 2-8 WCAP-14326 §3.8, 3.9, 4.3 WCAP-14382 §4.3, 8.2	Mass transfer conservatively biased mean=0.983 σ=0.187	Prototypical internals and temperature driving forces modeled in LST Range of validation defined in WCAP-14382 §9.2	LST internal data as a separate effect Wisconsin Condensation Tests	Lumped - Nominal free convection correlation used with conservative bias Distributed - Mixed convection correlation combining free and forced convection with a conservative bias	Bounds mean of the test data
	H. Forced Convection Mass Transfer	L	Lumped - Not modeled Distributed - Heat and mass transfer analogy based on flat plate forced convection in the mixed convection correlation	LST	WCAP-14190 page 2-8 WCAP-14326 §3.8	Mass transfer conservatively biased mean=0.968 σ=0.203	Prototypical internals and Froude numbers modeled in LST Range of validation defined in WCAP-14382 §9.2	Lumped - Validated WCAP-14382 §8 Dominant only during first seconds of transient Distributed - Dominant only during first seconds of transient	Lumped - Not modeled Distributed - Mixed convection correlation combining free and forced convection with a conservative bias	Lumped - Bounded Distributed - Bounded by code uncertainty

Table 1: PIRT Application to Evaluation Model: Inside Containment - All phases

Module	PIRT Phenomena	Ranking for Containment	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomena	Validation of Modeling Method and/or WGOTHIC	Use of Validation Results in this Evaluation Model	How Uncertainty is Handled
III. Solids	A. 1-D Transient Conduction Heat Transfer	H	GOTHIC conductors used to model internal heat sinks include a 1-D conduction solution	CVTR LST with internal heat sinks	NTD-NRC-94-4260 "GOTHIC Containment Analysis Package, Version 3.4e, Volumes 1-111," Volume 1, §6 describes the 1-D conduction solution used. WCAP-14382 provides validation with LST	Use of Uchida with 1-D conductor for internal heat sinks is conservative and consistent with SRP guidelines	Internal LST heat sinks are modeled using GOTHIC conductors with Uchida for condensation	WCAP-14382 shows validation results with internal heat sinks modeled with Uchida	SRP guidelines are an acceptable approach. Conservatively bounded material properties are used for AP600 internal conductors. Surface area and volume of internal heat sinks are conservatively underestimated.	Bounded
IV. Inter-Module	A. Convection	L	Governing equations for lumped parameter volumes connected with junctions and node-to-node connections for distributed parameter	LST	NTD-NRC-95-4459, Stratification and Mixing Effects on AP600 Passive Containment Cooling System DBA WCAP-14382 §5.3 WGOTHIC Applications Document WCAP-14190 §9	Lumped - Overmixing penalizes heat and mass transfer when PCS is dominant Distributed - 375 node LST is sufficiently accurate with slight bias towards overmixing	Applicable to above deck circulation and heat and mass transfer correlation validation	Sensitivity to large scale mixing to be studied in WGOTHIC Applications WCAP	Restrict mixing between upper and lower regions of containment when mixing is a benefit	Bounded
	B. Conduction	H	Climes include 1-D conduction model used for conduction through containment shell	Comparison to theoretical solutions	Complete. WCAP-14382 §2.5 shows the governing equation and discretization for 1-D conduction	The 1-D conduction model is correctly programmed into WGOTHIC	1-D conduction used to model heat transfer through the LST shell, which neglects the additional heat removal by azimuthal conduction from dry to wet surfaces.	WCAP-14382 §4.1 contains validation of the 1-D conduction equations in Clime subroutine	1-D conduction equation is part of the Clime subroutines used for heat transfer through the shell. Effects of degradation of inorganic zinc paint are included in material properties. Conservative material properties used. Using 1-D conduction conservatively neglects azimuthal conduction from dry to wet stripes.	Bounded

Table 1: PIRT Application to Evaluation Model: Inside Containment - All phases

Module	PIRT Phenomena	Ranking for Containment	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomena	Validation of Modeling Method and/or WGOTHIC	Use of Validation Results in this Evaluation Model	How Uncertainty is Handled
	C. Form and Friction Losses	L	Inter-compartment losses	Standard experimentally based loss coefficients	WGOTHIC Applications WCAP to be submitted	To be presented in WGOTHIC Applications WCAP	Not Applicable	Sensitivity to large scale mixing to be studied in WGOTHIC Applications WCAP	Restrict mixing between upper and lower regions of containment when mixing is a benefit	Sensitivity to mixing will be provided in applications WCAP

Table 2: PIRT Application to Evaluation Model: Outside Containment - LOCA - All Phases

PIRT Phenomenon	Ranking for Riser[1]	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomenon	Validation of Modelling Method and/or WGOTHIC	Use of Validation Results in Evaluation Model	How Uncertainty is Handled
I. Module Volume									
A. Multi component compressible gasses	H	Gas constituents in the governing equations	All tests analyzed with WGOTHIC	Complete NTD-NRC-94-4260 Enclosure 1: GOTHIC Technical Manual* describes the governing equations Enclosure 2: GOTHIC User's Manual describes how to invoke various gasses Enclosure 3: GOTHIC Qualification Report provides a large database of tests with air, hydrogen, and helium NTD-NRC-95-4462 EPRI Report RA-93-10, GOTHIC Design Review, Final Report WCAP-14382 validates WGOTHIC with separate effects and integral tests with steam, air, and helium gases. *Revision will be made to correct typographical errors.	Effects of multi-component compressible gasses are correctly included in governing equations.	LST includes air, steam, and helium	WCAP-14382	Governing equations in WGOTHIC are a valid representation of compressible, multi-component gas behavior	Included in code uncertainty
B. Buoyancy	H	Buoyancy forces are included in the lumped parameter - junction governing equations	- LST without fan running - Hugot tests - Eckert and Diaguila tests - Siegel and Norris tests	Complete WCAP-14382 §7.2.2 identifies the relevant priority test with fan off to support external annulus modelling. To be issued: Applications Report Document sensitivity to Kloss (uniform and nonuniform) and nominal delay time	The external annulus predictions provide reasonable agreement with LST and associated uncertainties can be accommodated in the DBA.	All LST in the HWRF program were run with the fan off. The LST priority test 214.1 has been used for validation.	WGOTHIC has been validated with LST with natural convection driving the annulus flows in WCAP-14382 §5, 6, 7, 8.	The external annulus is modelled with pressure boundary conditions at the inlet and outlet, such that the imposed ΔP is equal to the external density head. The momentum equation is solved, balancing the buoyancy driving head with the unrecoverable losses through the annulus. The initial annulus air flow is conservatively established at a negative value.	Nominal loss coefficient is used. Weak sensitivity to loss coefficient. Conservative initial air flow bounds postulated annulus flow start-up concerns
C. Flow field stability or stratification	L	External flow path is a 1D hydraulic model		Complete NTD-NRC-97?? RAI 952.102 response. WCAP-14190, Section 7.2 and 7.3 provide momentum and energy scaling for justification. WCAP-14382, §8 provides validation using 1D flow path for annulus. To be issued: Applications Report Document sensitivity to Kloss (uniform and nonuniform) and nominal delay time.	Potential for local recirculation to affect total air flow at AP600 operating conditions is negligible Small sensitivity to fairly large Kloss effects Since fully developed turbulent flow develops in annulus before baffle heats up, there is no impact on start-up of annulus air flow.	N/A	Use of 1D flow path is justifiable since heat transfer and momentum in the downcomer, relative to the riser, is so small that the possibility of downcomer instabilities is insignificant.	External flow path is modelled as 1D lumped parameter.	Negligible effect Weak sensitivity to loss coefficient

PIRT Phenomenon	Ranking for Riser[(1)]	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomenon	Validation of Modeling Method and/or WGOTHIC	Use of Validation Results in Evaluation Model	How Uncertainty is Handled
		Fog in annulus		Complete NTD-NRC-94-4100, Enclosure 1 "Radiation Heat Transfer Through Fog in the PCCS Air Gap"	Justification for neglecting effect of fog in annulus since effect of radiation capture by fog in AP600 has a negligible effect on the annulus air temperature and overestimates the heat transfer to the baffle.	Database consistent with AP600 expectations	Effect of fog neglected in WGOTHIC models	Negligible effect on answers	Negligible effect
		Effect of wind-induced recirculation and stratified atmosphere is neglected	Literature	Complete NTD-NRC-94-4166 "AP600 Containment Plume Investigation"	Quantification of potential for recirculation of effluent and thermally stratified atmosphere to affect cooling rates gave bounding recirculation fraction, and a resulting sensitivity showed no significant containment pressure effect.	LST was run in no-wind (<5 mph) conditions	External pressure boundary condition is unadjusted for these effects	Assumption of no recirculation due to these effects has negligible impact on pressure prediction	Negligible effect
		Effect of wind-induced turbulance is neglected	Wind tunnel tests	Complete NTD-NRC-95-4467 "Analysis of AP600 Wind Tunnel Testing for PCS Heat Removal"	Oscillating flows for worst case site with least positive mean wind coefficient slightly increase heat removal rates from containment. Less severe terrains with more positive wind coefficients show significant increases in heat removal.	Not applicable	External pressure boundary condition is unadjusted for these effects	Assumption of no wind is bounding for pressure prediction	Bounded
5. Module Surface									
A. Liquid film heat transfer	M	Thermal conductivity of liquid film for film temperature drop.	Chun and Seban	Complete NTD-NRC-94-4100, Enclosure 2 "Liquid Film Model Validation" WCAP-14382 §2 Scaling supplement will document consistent definition of resistances inside to outside shell	The Chun and Seban data provides a basis for film thermal conductivity. The liquid film temperature drop is small.	Internal and external liquid film effects are represented in the LST	All validation performed with WGOTHIC includes the small effect of film temperature drop.	Nominal Chun and Seban correlation is used, accounting for wavy laminar and turbulent liquid films.	Negligible effect since resistance across film is small part of total resistance.

PIRT Phenomenon	Ranking for Riser[1]	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomenon	Validation of Modelling Method and/or WGOTHIC	Use of Validation Results in Evaluation Model	How Uncertainty is Handled
B. Liquid film stability/coverage	H	Shell water coverage fractions	- Full scale, cold 1/8 sector tests - Hot LST measured coverage - Vendor age/contamination tests	Complete NTD-NRC-94-4247 "Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System" NTD-NRC-94-4286 "Supplemental Information on AP600 PCS Film Flow Coverage Methodology" To be issued Vendor report on effects of age and contamination. Note: An independent review by an industry expert is also planned	Water coverage on dome and sidewalls as a function of time is used to bound (Figure 2) cold, full scale data and heated data from LST. The model has been validated with cold and heated tests, and bounds test data. Model adequately accounts for effects of aging via its effect on the wetting angle. Aging increases the polarity of the surface and thus increases wetting. Surface contaminants will be minimal based on inspection and cleaning criteria. Sensitivities using ½ and ¼ of bounding SSAR coverage values show that the AP600 pressure response is relatively insensitive to further reductions in coverage below the bounding minimum evaluation model values.	Heated LST data has been used to assess heat flux effect on coverage fraction. Measured coverage fractions on the LST were used as input boundary conditions in the WGOTHIC validation runs to validate cooling rate prediction models with test data. The validated conservative water coverage model is used to calculate input boundary conditions for the PCS DBA Evaluation Model.	Water coverage is an input boundary condition	Bounding minimum water coverage fractions used	Bounded
		Shell wetting time delay	- Full scale, cold 1/8 sector tests	A written discussion will be provided in the applications report.	Since the outer surface is not hot until after water reaches surface in real time, cold tests are acceptable to determine delay times. Delay time to wet the external surface is conservatively bounded by using time to reach steady state coverage fractions from the cold full scale test. This conservative delay time thus neglects heat removal during about 5 minutes of actual water application when surface temperature has not significantly increased.	LST 219.1 has water onto hot surface and thermocouple temperatures show the surface readily rewets during the high flow portion of the non-prototypical oscillating flow. Videotapes of a shakedown LST with a somewhat higher flow rate show water behavior applied to 240F surface. The observations showed that the advancing film front sizzled as it was boiled away, and readily flowed down as wide stripes after the surface fell below the leidenfrost temperature.	Input Boundary Condition delay time produces a conservative result. Earlier water application does not adversely impact air flow initiation because there is a net improvement in evaporative cooling. The effect on annulus air temperature and vapor content of water applied to the surface is explicitly modeled in WGOTHIC 1D annulus calculation. A sensitivity based on actual chronology with earlier wetting will be provided in the Applications report.	Time delay used bounds all postulated effects	Bounded

PIRT Phenomenon	Ranking for Riser[1]	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomenon	Validation of Modelling Method and/or WGOTHIC	Use of Validation Results in Evaluation Model	How Uncertainty is Handled
C. Liquid film subcooling	M	Liquid film energy conservation equation	Large Scale Tests	Complete WCAP-14382 §2.4, 2.5 show equations for liquid film	Inclusion of convective term in energy equation accounts for liquid film subcooling effect on LST dome heat fluxes.	LST covers range of liquid film subcooling expected for AP600. Although a majority of the LST have higher fractions of energy removed by subcooling than AP600, the LST is valid for validation of physics and phenomena since a scalable liquid film enthalpy transport model is used.	WCAP-14382, p. 8-6 discusses validation of LST heat flux distribution predictions over the dome.	WGOTHIC uses an appropriate set of governing equations for liquid film. Subcooling accounts for a small fraction (~5%) of the AP600 heat removal.	Negligible effect since mechanism accounts for only small fraction of AP600 heat removal.
D. Free convection heat transfer	L	Mixed convection correlation which reduces to the McAdams correlation with characteristic length in Gr number based on channel diameter, at high Gr/Re^2	- Hugot tests - Eckert and Diaguila tests - Siegel and Norris tests - Westinghouse LST - dry external heat transfer	Complete WCAP-14190 Quantifies AP600 fraction of heat removed by convective heat transfer. NTD-NRC-95-4397 Supporting Information for the Use of Forced Convection in the AP600 PCS Annulus	Convective heat transfer accounts for a small fraction of total heat transferred. See also forced convection heat transfer	LST includes tests with and without fan on, covering the annulus from free convection through forced convection dominated regimes.	Mixed convection correlation provides good agreement with annulus conditions in the LST.	Mixed convection correlation reduces to forced convection at high Gr/Re^2	Negligible effect
E. Forced convection heat transfer	L	Mixed convection correlation which reduces to the Colburn correlation at low Gr/Re^2	- Hugot tests - Eckert and Diaguila tests - Siegel and Norris tests - Westinghouse STC dry flat plate tests - Westinghouse LST - dry external heat transfer	Complete WCAP-14190 Quantifies AP600 fraction of heat removed by convective heat transfer. WCAP-14326, §3.1, 3.2, 3.3, 3.4, 3.5, and 4.1 shows validation of the correlations with separate effects tests	Convective heat transfer accounts for a small fraction of total heat transferred. Correlation is biased 2.4% conservative about the mean over the range, with a relatively large scatter due to large measurement uncertainty with small ΔT. μ = 0.976 σ = 0.278	Dry LST has dominant annulus heat removal by convection	WCAP-14382, §3.2.1, 4.2 provide summaries of the validation. Although the comparisons with data show high scatter, it is attributable to high instrument uncertainty with small ΔT. The lack of any trend in the mean over the range indicates the correlation is reasonable as a basis for mass transfer analogy. Mass transfer validation, covering ΔT an order of magnitude higher, shows much less scatter.	Nominal correlation (with inherent conservative bias) used in WGOTHIC. Convective heat transfer is not a significa.t heat removal mechanism for AP600 DBA.	Uncertainty (scatter) is incorporated as an element of code uncertainty.
F. Radiation heat transfer	L	Wall-to-wall radiant heat transfer	- Westinghouse STC dry flat plate tests - Dry LST	Complete WCAP-14382, §2.5 describes the radiant heat transfer model used in Climes.	Dry external vessel heat transfer is validated.	Varying fractions of dry shell surface are included for all wet tests. The dry LST cases transfer a large fraction of heat by radiation to the baffle.	WCAP-14382 §7 shows selection of LST and §8 shows validation results.	Conservative property values are used in AP600 DBA.	Bounded
G. Free convection mass transfer	-	Empirical correlation for the Sherwood number, which is derived by dimensional analysis using the Reynold's analogy and Colburn j factors.	- Gilliland and Sherwood evaporation tests - Westinghouse STC flat plate evaporation tests - University of Wisconsin condensation tests	Complete See free convection heat transfer	See free convection heat transfer	See free convection heat transfer	See free convection heat transfer	See free convection heat transfer	Negligible effect

PIRT Phenomenon	Ranking for Riser[1]	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomenon	Validation of Modelling Method and/or WGOTHIC	Use of Validation Results in Evaluation Model	How Uncertainty is Handled
H. Forced convection mass transfer	H	Empirical correlation for the Sherwood number, which is derived by dimensional analysis using the Reynold's analogy and Colburn j factors	- Gilliland and Sherwood evaporation tests - Westinghouse STC flat plate evaporation tests - University of Wisconsin condensation tests	Complete NTD-NRC-95-4397 "Supporting Information for the Use of Forced Convection in the AP600 PCS Annulus"	AP600 shown to operate in forced convection dominant regime	LST covers range of AP600 Gr/Re2; including tests without the fan running		Forced convection correlation, modified for mixed convection effects is appropriate	Included in code uncertainty
		AP600 forced convection mass transfer correlation	- Gilliland and Sherwood Evaporation Tests - Westinghouse STC Flat Plate Evaporation Tests	Complete WCAP-14326 gives correlation (§2.0, 2.1), entrance effect used for separate effect test (§2.2), and correlation validation with tests (§3.6, 3.7)	Correlation is biased 6.4% conservative with reasonable scatter over the range μ = 0.936 σ = 0.139	WCAP-14382 LST includes tests which cover range of AP600 subcooling; predictions of total evaporation (p. 8-3) and wall heat flux (p. 8-6) validate models in an integral setting	WCAP-14382 summarizes WGOTHIC separate effects validation results (§3.2.1, 4.4)	Nominal correlation (with inherent conservative bias) used in WGOTHIC	Uncertainty (scatter) is incorporated as an element of code uncertainty
III. Module Solids									
A. 1D transient conduction heat transfer	H	GOTHIC conductors used to model a few external concrete heat sinks, using the GOTHIC 1D conduction solution	CVTR	NTD-NRC-94-4260 "GOTHIC Containment Analysis Package, Version 3.4e, Volumes I-III," Volume 1, §5 describes the 1D conduction solution used WCAP-14382 provides validation with LST	Use of Uchida for heat sinks is conservative and consistent with SRP guidelines	Not applicable	GOTHIC Qualification Report shows validation for the GOTHIC 1D conductor	Conservatively bounded material properties are used for AP600 external conductors Surface area and volume of heat sinks are conservatively underestimated	Bounded
IV. Inter-Module									
A. Convection	M	Governing equations for lumped parameter volumes connected with junctions	LST without the fan operating validate ability to calculate natural convective flows	External flow rate and ΔT comparisons between WGOTHIC and LST have been presented at several meetings. These will be provided in a letter report. Sensitivities to external Kloss, both uniform and non uniform, as well as sensitivity to air inlet blockages up to 50% were provided at the March 17, 1994 NRC PCS meeting. As part of the Applications report, these sensitivities will be evaluated using the final Evaluation Model.	For tests without the fan operating, external flow rate and ΔT is predicted well. Pressure response is relatively insensitive to loss coefficient, since the system is self-correcting. The highly non-linear relation of evaporation rate with surface temperature results in increased evaporative cooling with only moderate surface temperature increases.	LST without the fan operating are applicable for validation of natural convective flows through the annulus with the 1D annulus flow model	For tests without the fan operating, external flow rate and ΔT is predicted well.	A 1D lumped parameter model is used with an input nominal loss coefficient in WGOTHIC analyses. Buoyancy driven flows are balanced by the form and friction losses.	Negligible effect due to weak sensitivity to external Kloss

PIRT Phenomenon	Ranking for Risk[1]	AP600 BCs or Phenomena Models	Test Bases	Report Submitted to NRC	Report Conclusions	Applicability of LST with Respect to Phenomenon	Validation of Modelling Method and/or WGOTHIC	Use of Validation Results in Evaluation Model	How Uncertainty is Handled
B. Conduction	H	Climes include 1D conduction model used for conduction through containment shell	Comparison to theoretical solutions	Complete. WCAP-14382 §2.5 shows the governing equation and discretization for 1D conduction, as well as model validation.	The 1D conduction model is correctly programmed into WGOTHIC	1D conduction used to model heat transfer through the LST shell, which neglects the additional heat removal by azimuthal conduction from dry to wet surfaces.	WCAP-14382, §4.1 contains validation of the 1D conduction equations used in Clime subroutines.	1D conduction equation is part of the Clime subroutines used for heat transfer through the shell. Effects of corrosion of inorganic zinc paint are included in material properties. Using 1D conduction conservatively neglects azimuthal conduction from dry to wet stripes.	Conservatively bounded material properties are used for AP600 containment shell.
C. Form and friction losses	H	External flow path hydraulic resistance	Air flow path ΔP test, ~1/6 scale	Complete. See also the blocks on items I.C and IV.A.	Loss coefficient for external flow path		LST - used constant loss coefficient for all predictions	Nominal loss coefficient used; lack of sensitivity	Negligible effect due to weak sensitivity to external Kloss

Table A-3: Reports Issued to NRC on PCS DBA

Report Number	Report Title	Date Issued
NTD-NRC-94-4100, Enclosure 1	Radiation Heat Transfer Through Fog in the PCCS Air Gap	April 1994
NTD-NRC-94-4100, Enclosure 2	Liquid Film Model Validation	April 1994
NTD-NRC-94-4166	AP600 Containment Plume Investigation	June 1994
NTD-NRC-94-4174	AP600 PCS Design Basis Analysis (DBA) and Margin Assessment	June 1994
NTD-NRC-94-	AP600 Integrated Structure for Technical Issue Resolution (ISTIR) for Passive Containment Cooling System	July 1994
NTD-NRC-94-4247	Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System	July 1994
NTD-NRC-94-4260	Enclosure 1: GOTHIC Containment Analysis Package, Version 3.4e, Volume 1: Technical Manual Enclosure 2: GOTHIC Containment Analysis Package, Version 3.4e, Volume 2: User's Manual (EPRI Proprietary) Enclosure 3: GOTHIC Containment Analysis Package, Version 3.4e, Volume 3: Qualification Report (EPRI Proprietary)	August 1994
NTD-NRC-94-4271	WGOTHIC Lumped Parameter LST Input Definition and Input Deck	August 1994
NTD-NRC-94-4286	Supplemental Information on AP600 PCS Film Flow Coverage Methodology	August 1994
NTD-NRC-94-4287	Experimental Basis for the Convective Heat Transfer Correlations Selected for Modeling Heat Transfer from the AP600 Containment Vessel	August 1994
NTD-NRC-94-4327	Experimental Basis for the Mass Transfer Correlations Selected for Modeling Condensation and Evaporation on the AP600 Containment Vessel	October 1994
NTD-NRC-94-4318 WCAP-14190	Scaling Analysis for AP600 Passive Containment Cooling System	October 1994
NTD-NRC-95-4397	Supporting Information for the Use of Forced Convection in the AP600 PCS Annulus	February 1995
NTD-NSA-CRA-95-096	Blind Pre-test Prediction (NRC declined to receive this document.)	April 1995

Report Number	Report Title	Date Issued
NTD-NRC-95-4428 WCAP-14326	Experimental Basis for the AP600 Containment Vessel Heat and Mass Transfer Correlations	April 1995
NTD-NRC-95-4459	Stratification and Mixing Effects on AP600 Passive Containment Cooling System DBA	May 1995
NTD-NRC-95-4463	Large-Scale Test Data Evaluation	May 1995
NTD-NRC-95-4462	EPRI Report RA-93-10, GOTHIC Design Review, Final Report	May 1995
NTD-NRC-95-4489 WCAP-14382	WGOTHIC Code Description and Validation	May 1995
NTD-NRC-95-4467	Analysis of PCS Wind Tunnel Testing for PCS Heat Removal (PCS-T2C-059)	June 1995
NTD-NRC-95-4504 Enclosure 1	Proposed Draft/Markups of SSAR Section 6.2	July 1995

Table A-4: Westinghouse - NRC Meetings In Support of AP600 PCS DBA Review

DATE	TOPICS	MEETING CONTENT NOTES
February 23-24, 1994	Update on confirmatory PCS program status	WGOTHIC validation process overview PCS test data results overview Phenomenological model update WGOTHIC model changes since 1992 SSAR
March 16, 1995	ACRS T/H Subcommittee Mtg.	PCS analysis overview Phenomenological model and separate effects update
March 17, 1995	DSER preparation meeting	AP600 DBA codes and methods, including bounding value methods AP600 sensitivities LST sensitivities Content of June 30, 1994 letter report on margins and model assessment
May 25, 1994	- DSER/FSER supporting information plans - WGOTHIC development	- PCS analysis work plans - DSER information exchange schedule/content - Schedule for resolution of technical issues - TOC for June 30, 1994 report - TOC for scaling report - Summary of WGOTHIC development and versions - Outline of QA program for WGOTHIC - Relationship to EPRI GOTHIC development programs
July 26, 1994	PCS Scaling - SASM Iteration 1 Report Review Kickoff	Presentation of overview of methodology and results contained in SASM Iteration 1 report
July 27, 1994	- PCS Computer Code Validation (Mid Stage 2)	- WGOTHIC validation results and status based on distributed parameter modelling of LST (Status of "C" on p. 26 of May 25, 1994 meeting handouts) - input and modelling methodology - comparison to LST 212.1 - NRC CONTAIN validation results and status - input and modelling methodology - comparison to LST 212.1 (Data comparison formats per May 25, 1994 meeting) - Review status and NRC data needs

DATE	TOPICS	MEETING CONTENT NOTES
July 28, 1994	- Baseline Definition of Blind Test Lumped Parameter Input	- Detailed discussions of Table of Blind Test Input Parameters Rev. 0
September 27, 1994	PCS program overview	PCS analysis program and interaction of all relevant tests PCS analysis results and sensitivities M&E release assumptions Summary of Models and Margins Assessment report Reports schedules Closure paths for DSER Open Items
November 15-17, 1994	- PCS scaling - WGOTHIC model review at end of Stage 2 - Discussion of remaining issues, schedule - NRC AP600 results - Westinghouse open item review	Review of PCS scaling - Overview of conclusions from phenomenological reports - Detailed review of SASM Component 1 scaling - Discussion of PCS action items from March 16, 1994 ACRS meeting Model review prior to start of blind test prediction calculations Framework on usage of LST data Presentation of results of 550 node for 212.1 and 222.1 Discussion of noding studies done with LST distributed parameter model of a baseline test Velocity field predictions from WGOTHIC
March 17, 1995	- PCS test and analysis - NRC review results	NRC provide summaries of their consultants reviews Review drafts of Westinghouse presentation for ACRS
March 29-30, 1995	ACRS T/H Subcommittee Meeting	Overview of Westinghouse PCS approach Containment PIRT WGOTHIC formulation and governing equations Phenomenological models, water coverage models PCS scaling
April 11, 1995	ACRS and DSER issues	Presentation prepared for ACRS on WGOTHIC LST calculations Key ACRS issues Chapter 6.2 DSER Open Items
May 1, 1995	Overview of PCS methods	Review PCS methods Discuss water coverage sensitivities Discuss blind test results and steam flow boundary condition

DATE	TOPICS	MEETING CONTENT NOTES
July 27, 1995	Preliminary review and discussion of closure paths for PCS DBA	Drafts of the following - closure paths for all significant PCS phenomena, including bounding values for DBA - road map to information required for a supplemental DSER, with summary of Westinghouse approach for each topic - comparisons of margins with those in current operating plant analysis methods
August 16, 1995	Closure paths for PCS DBA	Program level discussions with NRC, focusing on closure of key PCS issues

Totals for PCS DBA meetings 1994-1995

13 Meetings
19 days

Table A-5 PCS Test Analysis / Code Validation Methodology - Priority of RAI's and DSER Ch 21 Open Items

Topic	DSER Ch 21 Open Items		RAI	
	High Priority	Detailed	High Priority	Detailed
Scaling	21.3.8.5-1 (High level statement)	21.5.8-7	952.100 (High level statement) 480.304 480.317 480.318	480.378-.380
LST Integral Test	21.3.8.1-1 (High level statement) 21.5.8-3	21.5.8-4 21.5.8-5		
Separate effects tests and correlations			480.279 480.363-.364 480.373-.374	480.277 480.310-.324 480.340 480.343-344 480.356-.357 480.358 480.359 480.360-.361 480.365-.368 480.369-.371 480.372 480.375
WGOTHIC	21.6-6 (High level statement) 21.5.8-1		480.281-.284 480.295-.301 480.314-.315 480.331-.332 480.337-.339 480.345	952.101 480.278 480.280 480.285-.287 480.289-.294 480.334 480.335-.336 480.341-.342 480.346-.351 480.362
PCS Annulus	21.5.8-6			952.102 480.329-.330
Water Distribution	21.3.9.3-1 21.5.9-1 21.5.9-2	21.3.9.1-1 21.5.8-2 21.5.9-3	480.325-.328 480.381	952.103 952.104

Topic	DSER Ch 21 Open Items		RAI	
	High Priority	Detailed	High Priority	Detailed
Wind Tunnel	21.5.7.4-1 (High level statement) 21.6-5			
WGOTHIC Application	DSER Ch 6.2 questions will be addressed after priority DSER Ch 21 and RAI questions on methods are addressed.		480.276 480.288 480.303 480.305-.307 480.308-.313 480.316 480.333 480.352 480.376-.377	480.302 480.353-.355

Notes for Table A-5
Prioritizing of DSER Open Items and RAI's

Open items for PCS DBA have been prioritized

- DSER Ch 21
- RAI's on code and methods
- DSER Ch 6.2 (After methods questions are resolved)

Prioritization is based on

- Most significant methodology questions required to understand the overall Westinghouse approach
- NRC top level concerns on methodology
- Methodology Issues not addressed in existing documentation

DSER Ch 6.2 Open Item responses on application of methodology will be provided after priority open items on methodology are addressed.

Table A-6 "Old" PCS TEST ANALYSIS AND CONTAINMENT PRESSURE DBA RAI SUMMARY

RAI #	SUBJECT
480.2 *	Mechanistic Heat/Mass Transfer Correlations
480.4	Dry Shell LST and SST Data
480.8	Natural Circulation of Air in the PCS
480.9 *	HT to Internal Structures and Mixing in the Containment
480.10 *	Jet Discharge: Location/Orientation/Scaling
480.11	1/8 Scale Facility Instrumentation
480.12	1/8 Scale Facility Test Matrix
480.13 *	Westinghouse Scaling Approach
480.14 *	Mechanistic Correlations in WGOTHIC
480.15 *	WGOTHIC Validation Using Test Data
480.16 *	WGOTHIC Numerics
480.17	External Film Pattern/Water Distribution Tests
480.18	Degree of "Rain" in the AP600 Containment
480.32	Hydrogen Control-Prediction of Hydrogen Distribution
951.2	WGOTHIC Condensation Model
480.66 *	Margin between max calc. and design containment pressure
480.67 *	HT coefficient sensitivity to node size near the wall
480.68	Postulated break size for subcompartment analysis
480.69	Use of TMD code for M&E releases
480.71 *	Testing of containment heat transfer
952.100	PCCS scaling analysis

RAI #	SUBJECT
952.101 *	Calculations of PCS interior velocities
952.102	Analysis of PCS annulus air flow
952.103	PCS film coverage when wall is hot
952.104	How water distribution model supports DBA analyses

Note

* Indicates an RAI that has been previously answered, but will need to be revised.

SCHEDULE PROVIDED BY WESTINGHOUSE

FOR THE SEPTEMBER 7, 1995, TELECONFERENCE BETWEEN

WESTINGHOUSE AND THE NRC ON

PASSIVE CONTAINMENT COOLING SYSTEM

Attachment 6

Proposed Schedule for PCS DBA

8/30/95 Provide road map table (inside and outside) revision based on 8/16/95 meeting

COMPLETE

(Related Priority RAI 480.318, 480.281, 480.284, 480.295, 480.345)

- Cross reference of bounding approach for each PCS PIRT phenomenon, internal and external

9/15/95 Rationale for use of SATAN for AP600

- Description of AP600 M&E related features relative to operating plants
- Document justification for use of SATAN for blowdown M&E calculation

9/15/95 Document role of scaling for AP600 PCS DBA
(Related Priority RAI 952.100, 952.102, 480.304, 480.317, 480.279)
(Related Priority DSER OI 21.3.8.5-1)

- Summary of PCS scaling results
- Usage of scaling for AP600 PCS DBA
- Summary of usage of LST to develop rationale for bounding approach

9/30/95 Provide updated GOTHIC documentation

- Westinghouse transmittal of EPRI GOTHIC 4.0 documentation
  - *Technical Manual*
  - *Qualification Manual*
- Identification of GOTHIC models excluded from AP600 review
- List of differences between GOTHIC 4.0 and WGOTHIC

9/30/95 Document bases for mass transfer correlation biases
(Related Priority RAI 480.363, 480.364, 480.373, 480.374)

- Reference to separate effects studies for correlations
- Method for bounding separate effects data
- Correlation biases to be used in PCS DBA evaluation model

10/31/95 Document GOTHIC Design Review results applicable to WGOTHIC (Related Priority RAI 480.337, 480.338, 480.339)

- Applicability of peer Design Review to WGOTHIC
- Summary of peer review results
- List of Design Review Report sections applicable to WGOTHIC
- List of Appendix B findings relevant to AP600 evaluation model and how resolved for WGOTHIC

10/31/95 Provide sensitivity to use of nominal internal deck flow area (Related Priority DSER OI 21.5.8-1)

- Sensitivity calculation using nominal internal deck flow area
- Comparison of steam concentration profile versus base case
- Summary of conservatism in bounding approach

10/31/95 Provide LOCA/MSLB few node SRP style calculation for blowdown

- Description of modelling method for SRP blowdown simulation
- Summary of results
- Comparions to base case
- Conclusions regarding AP600 blowdown performance relative to SRP methods

11/30/95 Provide LOCA with 0.6 Cd and document discussion of how spectrum is addressed

- Summary of AP600 postulated LOCA break spectrum
- Bases for break spectrum analyzed
- Discussion of postulated increased stratification for smaller breaks
- Results of LOCA sensitivity using 0.6 Cd
- Justification for selected DBA LOCA break size

11/30/95 Provide summary results of convergence studies (Related Priority RAI 480.298, 480.300, 480.301, 480.331, 480.332)

- Summary of convergence study results
- Conclusions from convergence studies relative to AP600 PCS DBA evaluation model

11/30/95 Document completion of responses to priority RAIs/DSER Open Items

- Essential information to assess priority issues is addressed by the above schedule
- Transmittals will be referenced, which close priority RAIs and Open Items