October 2, 1996

Mr. Nicholas J. Liparulo, Manager
Nuclear Safety and Regulatory Activities
Nuclear and Advanced Technology Division
Westinghouse Electric Corporation
P.O. Box 355
Pittsburgh, Pennsylvania 15230

SUBJECT: STAFF UPDATE TO DRAFT SAFETY EVALUATION REPORT (DSER) OPEN ITEMS REGARDING THE WESTINGHOUSE AP600 ADVANCED REACTOR DESIGN

Dear Mr. Liparulo:

From the submittal of Revision 9 of Standard Safety Analysis Report (SSAR) and related information provided by Westinghouse, the status of several open items regarding the AP600 design have changed. Enclosed is the staff's open item status for the Quality Assurance and Maintenance Branch's review of SSAR Chapter 14 and the Containment Systems and Severe Accident Branch's review of SSAR Section 6.2.1 and Chapter 21.

Please update the open item tracking system database to reflect this information. If you have any questions regarding this matter, you can contact me at (301) 415-8548.

Sincerely,

original signed by:

Diane T. Jackson, Project Manager
Standardization Project Directorate
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: As stated

cc w/enclosure:
See next page

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Westinghouse Electric Corporation

Docket No. 52-003
AP600

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AP600 Open Item Tracking System Database: Executive Summary

Date: 10/1/96

Selection: [DSER Section] like '14*' And [NRC Branch] like 'NRR/HQMB' Sorted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
1243	nrr/hqmb	14.2.8-5	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify preoperational test abstract 14.2.8.1.97 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Item 1.h.(3).				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1244	nrr/hqmb	14.2.8-6	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify preoperational test abstract 14.2.8.1.100 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or provide appropriate justification for this exception to RG 1.68, Appendix A, Item 1.n.(14)(f).				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1245	nrr/hqmb	14.2.8-7	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should add additional criteria to startup test abstract 14.2.8.2.34 in Appendix 1A of the SSAR.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1246	nrr/hqmb	14.2.8-8	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify startup test abstract 14.2.8.2.38 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Items 5.b and 5.y.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1247	nrr/hqmb	14.2.8-9	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify startup test abstract 14.2.8.2.41 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Item 5.j.j.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1248	nrr/hqmb	14.2.8-10	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify startup test abstract 14.2.8.2.47 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Item 5.i.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1249	nrr/hqmb	14.2.8-11	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify startup test abstract 14.2.8.2.51 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Item 5.n.n.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1250	nrr/hqmb	14.2.8-12	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify startup test abstract 14.2.8.2.52 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Item 5.h.h.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
1251	nrr/hqmb	14.2.8-13	DSER-OI		8/13/96	Closed	Action W N	
				Westinghouse should modify startup test abstract 14.2.8.2.55 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Item 5.l.l.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				

Enclosure

Item No.	Branch	DSER Section/ Question	Type	Title/Description / Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
1252	nrr/hqmb	14.2.8-14	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should revise Section 14.2.8 of the SSAR to reconcile its contents with that of Section 14.2.2 of the SSAR, as discussed above in relation to Q260.24.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1253	nrr/hqmb	14.2.8-15	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should revise Section 14.2.8 of the SSAR, as well as the individual test methods or performance criteria, to provide specific references to the basis for determining acceptable system and component performance.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1254	nrr/hqmb	14.2.8-16	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should either expand the test abstracts of Section 14.2.8 of the SSAR to address the issued identified in Appendix A to RG 1.68, or revise Appendix 1A of the SSAR to provide technical justification for any exceptions taken.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1255	nrr/hqmb	14.2.8.3-1	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should acceptably address the issues identified in Q260.30.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1256	nrr/hqmb	14.2.8.4-1	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should acceptably address the issues identified in Q260.31.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1257	nrr/hqmb	14.2.9-1	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should acceptably address the issues identified in Q260.32.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1258	nrr/hqmb	14.2.9-2	DSER-OI		8/13/96	Closed	Action W N		
				Westinghouse should acceptably address the issues identified in Q260.25.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1828	nrr/hqmb	14.2.7-1	DSER-CN		8/13/96	Closed	Action W N		
				14.2.7-1 Westinghouse will revise the SSAR to state that the startup administrative manual (procedures) will be the responsibility of the COL applicant, as will other documents that delineate the test program schedule for the initial fuel load and for each major test program.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
1829	nrr/hqmb	14.2.8-1	DSER-CN		8/13/96	Closed	Action W N		
				14.2.8-1 Westinghouse will make the appropriate changes to the preoperational and startup test abstracts, pending satisfactory resolution of Q210.53 and Q210.58.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					

Selection: [DSER Section] like '14*' And [NRC Branch] like 'NRR/HQMB' Scrted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
1963	nrr/hqmb	14.2.2-1	DSER-COL	14.2.2-1 The COL applicant should provide for staff review, the scoping document (i.e., preoperational and startup test specifications) containing testing objectives and acceptance criteria applicable to Westinghouse's scope of design responsibility. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1964	nrr/hqmb	14.2.2-2	DSER-COL	14.2.2-2 The COL applicant should provide for staff review, the scoping document, and any related documents, which delineate plant operational conditions at which tests are to be conducted, testing methodologies to be utilized, specific data to be collected, and acceptable data reduction techniques to be utilized. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1965	nrr/hqmb	14.2.2-3	DSER-COL	14.2.2-3 The COL applicant should provide for staff review, the scoping document that delineates any reconciliation methods needed to account for test conditions, methods, or results if testing is performed at conditions other than representative of design operating conditions. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1966	nrr/hqmb	14.2.2-4	DSER-COL	14.2.2-4 The COL applicant should provide for staff review, the approved preoperational test procedures (to be provided approximately 60 days before their intended use, and startup test procedures (to be provided approximately 60 days before fuel loading). Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1967	nrr/hqmb	14.2.2.2-1	DSER-COL	14.2.2.2-1 The COL applicant should provide the startup administrative manual, which will delineate the review, evaluation, and approval of test results, for staff review. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1968	nrr/hqmb	14.2.8-1	DSER-COL	14.2.8-1 The COL applicant will provide the identified information associated with startup test abstract 14.2.8.2.34. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2035	nrr/hqmb	14.	DSER-OI50	39. Initial Test Program The NRC is not satisfied with the detail and scope of Chapter 14 (Initial Test Program). The most significant issues fall into four categories. - Westinghouse has taken the position that thirteen tests have to be performed on the first plant only. The NRC staff have requested further justification for this position. - The NRC has proposed an additional 36 tests to be performed to fulfill the requirements of Reg Guide 1.68 revision 2. - The NRC is requesting the Chapter 14 abstracts include a basis for test acceptance criteria or test methods. - The NRC requests a detailed description of AP600 design not tested in the initial test program. Discussed at 2/9/95 SMM) Meeting established to discuss Chapter 14 issues. 5/2/95 Status: Meeting held February 28, 1995. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		

Selection: [DSER Section] like '14*' And [NRC Branch] like 'NRR/HQMB' Sorted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description / Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2543	NRR/HQMB	14.	RAI-OI	260.35 Initial Test Program (ITP) Test Abstract 14.2.8.1.25, Reactor Coolant System (RCS) Hydrostatic Test: The Acceptance Criterion should be revised to clearly indicate that if there is any evidence of leak within the hydrostatic test boundaries, the leak should be repaired and retested prior to final inspection. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	
2544	NRR/HQMB	14.	RAI-OI	260.36 ITP Test Abstract 14.2.8.1.26, Chilled Water System: (1) Use of system nomenclature should be consistent. This abstract and/or SSAR Section 9.2.7, Central Chilled Water System of the Standard Safety Analysis Report (SSAR) should be re-labeled accordingly; (2) The Objective subsection should be revised to include verification of proper performance of the system components. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	
2545	NRR/HQMB	14.	RAI-OI	260.37 ITP Test Abstracts 14.2.8.1.26, Chilled Water System and 14.2.8.1.61, Circulating Water System: The Test Method and Acceptance Criterion subsections of these abstracts should be revised to incorporate verification of integrated system testing requirements at rated volumetric flow conditions, pressure, and temperature as specified in the applicable SSAR sections. These abstracts should demonstrate, as a minimum, (1) proper operation of instrumentation and system controls in all logic combinations, (2) proper operation of all motor-operated and air-operated control valves, including open/closure cycling and timing, and position indicator verification and isolation functions (when applicable), (3) proper operating conditions (flow, vibration, bearing temperature) of system pumps in design mode of operations, including verification of acceptable net positive suction head (NPSH) under the most limiting design flow conditions, and (4) proper operating conditions and system performance capability (design bases) during all operational (normal and abnormal) modes. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	
2546	NRR/HQMB	14.	RAI-OI	260.38 ITP Test Abstract 14.2.8.1.27, Containment Recirculation Cooling System: The Objective subsection should be revised to incorporate verification of integrated system testing requirements at rated volumetric flow conditions, pressure, and temperature as specified in SSAR Section 9.4.6. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	
2547	NRR/HQMB	14.	RAI-OI	260.39 ITP Test Abstract 14.2.8.1.30, Feedwater Control System: The Test Method subsection should be revised to incorporate verification that automatically initiated valve open/closure cycling and timing meets the system design basis requirements. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	
2548	NRR/HQMB	14.	RAI-OI	260.40 ITP Test Abstract 14.2.8.1.40, Reactor Coolant Pump Initial Operation: The Test Method subsection should specify the system and pump operating parameters to be tested or measured. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	
2549	NRR/HQMB	14.	RAI-OI	260.41 ITP Test Abstract 14.2.8.1.41, Reactor Coolant System: (1) The Test Method subsection should specify the data and parameters to be verified during control systems circuitry and system valves operation; (2) The Performance Criteria subsection should specify (i) acceptance criteria for the measured parameters, including response times, for the control systems and valves, and (ii) acceptance criteria for the head vent system operation. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N	

Selection: [DSER Section] like '14*' And [NRC Branch] like 'NRR/HQMB' Sorted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2550	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		
				260.42 ITP Test Abstract 14.2.8.1.42, Normal Residual Heat Removal System: The Test Method subsection should specify the functional requirements, parameters to be measured, and data to be recorded for each test objective and each mode of operation.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2551	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		
				260.43 ITP Test Abstract 14.2.8.1.49, Thermal Expansion: Westinghouse should revise this abstract to provide a commitment that this test will be conducted in accordance with the American Society of Mechanical Engineers (ASME) OM Standard, Part 7 (Ref.: Draft Safety Evaluation Report (DSER) Confirmatory Item 3.9.2.1-3).					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2552	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		
				260.44 ITP Test Abstract 14.2.8.1.64, Reactor Coolant System Flow Measurement: (1) The Objective subsection should be modified to include verification of proper operation of the RCS at conditions approaching rated operating temperature and pressure. Baseline RCS pressure drops will also need to be established; (2) The Test Method subsection needs to be modified to include closer coordination of the performance of this test with that of 14.2.8.1.41, Reactor Coolant System, in order to adequately demonstrate proper integrated system response and operation; (3) The Performance Criteria subsection needs to be revised to include acceptance criteria for the RCS pressure drop, flow rate (accounting for measurement uncertainty allowances), or provide reference to the appropriate SSAR sections delineating such acceptance criteria.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2553	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		
				260.45 ITP Test Abstract 14.2.8.1.67, Reactor Coolant System Hot Functional Test: (1) The Objective subsection should outline all preoperational tests that will be performed (or encompassed) as part of this test, and (2) In response to request for additional information (RAI) 210.59, Westinghouse agreed to implement a monitoring program at the first AP600 plant to record temperature distributions, thermal displacements and other pertinent parameters of the pressurizer surge line for verifying assumptions used in the surge line thermal stratification analysis. Therefore, the implementation of this monitoring program should be reflected in this abstract and/or in another section of the ITP, accordingly. In addition, DSER Open Item 3.12.5.10-1 requests identification of other piping systems susceptible to thermal stratification, and a description of the methods used to assure their structural integrity. If a monitoring program is intended to be implemented by Westinghouse during the hot functional test for resolving this open item, the program should also be included in the ITP.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2554	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		
				260.46 ITP Test Abstract 14.2.8.1.75, Boric Acid Batching Operation: Westinghouse should clarify whether the test is to be performed with or without boric acid.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2555	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		
				260.47 ITP Test Abstract 14.2.8.1.91, Startup Feedwater Control System: (1) The Objective subsection should be revised to incorporate verification of the startup feedwater control system automatic initiation capability, and (2) The Test Method subsection should be revised to require verification of the automatic initiation of the startup feedwater control system upon receipt of a loss of main feedwater supply signal.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2556	NRR/HQMB	14.	RAI-OI	260.48 ITP Test Abstract 14.2.8.1.93, Reactor Containment Structural Integrity Test: In the Objective subsection, the reactor containment building should be changed to reactor containment vessel. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2557	NRR/HQMB	14.	RAI-OI	260.49 ITP Test Abstracts 14.2.8.1.96, Passive Containment Cooling System and 14.2.8.1.97, Passive Containment Cooling System (First Plant Only): These test abstracts should be modified to encompass the Objective of 14.2.8.1.97 into a single comprehensive test abstract based upon 14.2.8.1.96. Such abstract would then be applicable to all plants, not just the prototype. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2558	NRR/HQMB	14.	RAI-OI	260.50 ITP Test Abstract 14.2.8.2.1, Initial Fuel Loading Test Sequence: (1) The Prerequisites subsection of this abstract should: (i) include the Objectives in 14.2.8.2.2, Initial Fuel Loading, and in 14.2.8.2.3, Fuel Loading Prerequisites and Periodic Checkoff, and (ii) outline all systems required for the initial fuel loading; (2) The performance criteria for 14.2.8.2.2 and 14.2.8.2.3 should be included in the Performance Criteria subsection of this abstract. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2559	NRR/HQMB	14.	RAI-OI	260.51 Westinghouse should revise the following AP600 SSAR Chapter 14 test abstracts in order to provide specific acceptance criteria or design basis functional requirements traceable to the appropriate SSAR sections: a. 14.2.8.1.40, Reactor Coolant Pump Initial Operation b. 14.2.8.1.42, Normal Residual Heat Removal System c. 14.2.8.2.11, Rod Drop Time Measurement d. 14.2.8.2.32, Bank Worth Measurement e. 14.2.8.2.55, Plant Trip from 100 Percent Power Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2560	NRR/HQMB	14.	RAI-OI	260.52 ITP Test Abstracts 14.2.8.2.2, Initial Fuel Loading, and 14.2.8.2.3, Fuel Loading Prerequisites and Periodic Checkoff: The objectives of these two tests appears to be redundant. Westinghouse should amalgamate them with 14.2.8.2.1. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2561	NRR/HQMB	14.	RAI-OI	260.53 ITP Test Abstract 14.2.8.2.4, Reactor System Sampling for Fuel Loading: Verification of the requirements in the Objective of this abstract should be included in its prerequisites. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2562	NRR/HQMB	14.	RAI-OI	260.54 ITP Test Abstract 14.2.8.2.6, Inverse Count Rate Ratio Monitoring for Fuel Loading: The requirements in the Prerequisites, Test Method and Performance Criteria subsections do not appear to be consistent with the Objective of the test abstract. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		
2563	NRR/HQMB	14.	RAI-OI	260.55 ITP Test Abstract 14.2.8.2.7, Post-Fuel Loading Precritical Test Sequence: (1) The Prerequisite subsection should be revised to include specific plant system conditions; and (2) The information in the Test Method and Acceptance Criteria subsections is inadequate. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action W N		

AP600 Open Item Tracking System Database: Executive Summary

Date: 10/1/96

Selection: [DSER Section] like '14*' And [NRC Branch] like 'NRR/HQMB' Sorted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2564	NRR/HQMB	14.	RAI-OI	260.56 ITP Test Abstract 14.2.8.2.14, Reactor Coolant System Flow Coastdown: (1) The Objective subsection should include measurement of the coastdown flow characteristics of tripping of various RCS pump combinations in addition to tripping of all RCS pumps; (2) The Performance Criteria subsection should specify acceptable RCS flow coastdown rates and delay times, or reference the appropriate loss of flow transients safety analysis section in SSAR Chapter 15, Accident Analysis. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action	
2565	NRR/HQMB	14.	RAI-OI	260.57 ITP Test Abstract 14.2.8.2.31, Isothermal Temperature Coefficient Measurement: It appears that the isothermal temperature coefficient (ITC) measurement will be limited to just two end-point rod configurations (near fully withdrawn or near fully inserted) while the reactor coolant system boron concentration remains constant. Westinghouse should revise the Prerequisite and/or Test Method subsections of this abstract to perform ITC measurements at various rod configurations and boron concentrations which would more conservatively reflect actual reactor coolant system behavior or should provide justification to establish that the proposed measurement in the current abstract would yield similarly conservative values. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action	
2566	NRR/HQMB	14.	RAI-OI	260.58 ITP Test Abstract 14.2.8.2.47, Rod Cluster Control Assembly Out of Bank Measurement (First Plant Only): (1) The Test Method subsection requires that a group of selected rod cluster control assemblies (RCCA) be inserted "first to the technical specification limit of misalignment." However, SSAR Chapter 15 currently specifies RCCA alignment limits. Westinghouse should revise the text in the abstract accordingly; (2) The test Method subsection should specify parameters to be measured and describe expected power distributions; and (3) The Performance Criteria subsection should specify the acceptance criteria for the sensitivity of the incore and excore instrumentation to RCCA misalignment. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action	
2567	NRR/HQMB	14.	RAI-OI	260.59 ITP Test Abstract 14.2.8.2.49, Load Swing Test: (1) The Test Method subsection should identify the plant parameters to be monitored and recorded; and (2) The Performance Criterion subsection should specify the acceptable ranges of the primary and secondary pressure, level, temperature, etc. at various power levels, or provide specific acceptance criteria or design basis functional requirements traceable to the appropriate SSAR sections. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action	
2568	NRR/HQMB	14.	RAI-OI	260.60 ITP Test Abstract 14.2.8.2.50, 50 Percent Load Rejection: The Performance Criterion subsection should specify the acceptable ranges of the primary and secondary pressure, level, temperature, etc. or provide specific acceptance criteria or design basis functional requirements traceable to the appropriate SSAR sections. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action	
2569	NRR/HQMB	14.	RAI-OI	260.61 ITP Test Abstract 14.2.8.2.51, 100 Percent Load Rejection (First Plant Only): The Test Method subsection should identify the plant parameters to be monitored and recorded. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action	

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Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2570	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		

260.62 The staff has identified the following systems, components, and/or features that do not appear to have been incorporated within the AP600 ITP:

a. Ventilation System through Fire Walls and Smoke Removal
b. Fire Dampers and Doors
c. Onsite Standby Power System (Onsite Standby Diesel Generator Support System)
d. Containment Igniters
e. Annex/Auxiliary building Non-Radioactive HVAC System
f. Health Physics and Hot Machine Shop HVAC System
g. Turbine Building Ventilation System
h. Reactor Vessel Flooding System/Vessel Insulation Arrangement (testing should not involve flooding the cavity, but would encompass confirming: (1) flow paths/areas between the IRWST and the cavity, (2) drainage paths into the cavity, (3) flooder valve operability, (4) gaps/openings in the insulation system for water ingression and egression, (5) integrity of insulation support system and outer surface of vessel lower head)

For the items listed above, Westinghouse should identify and revise the pertinent test abstracts or summaries to encompass them, or create additional abstracts accordingly.

Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2571	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		

260.63 Westinghouse should include a pre-operational test abstract for (a) the 480V non-Class 1E transportable ac generator and its distribution panel, including the incoming and outgoing feeder circuit breakers and plug-in type twist lock connectors pre-wired to outgoing feeder circuit breakers; and (b) the Digital Metal Impact Monitoring System.

Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2572	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		

260.64 ITP Test Abstract 14.2.8.2.53, Hot Full Power Boron Endpoint: (1) The Test Method subsection specifies that measurement of the RCS critical boron concentration be only performed for a single RCCA configuration (all rods out, hot full power, and equilibrium xenon). Westinghouse should revise the Prerequisite and/or Test Method subsections of this abstract to perform critical boron concentration measurements at various RCCA configurations which would more conservatively reflect actual reactor coolant system behavior, or should provide adequate justification to establish that the proposed measurement in the current abstract would yield similarly conservative values; and (2) The Test Method requires the renormalization of the predicted boron concentration as a function of core burnup using the corrected (or resultant) measured boron concentration. The Acceptance Criterion should specify the difference between the measured and predicted boron concentrations expected after renormalization or provide specific acceptance criteria traceable to the appropriate SSAR sections.

Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2639	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action N		

260.65 Chapter 14 - Initial Test Program
14.2.8.1.2, Class 1E Uninterruptible Power Supplies: This test abstract does not reflect the design and configuration of the AP600 Class 1E DC distribution system. Specifically, SSAR Section 8.3.2.1.1.1, Class 1E DC distribution, states that there are four independent, Class 1E 125Vdc divisions (A, B, C, and D) each comprised of one battery bank (designated as 24hr battery bank) that provides power sources to the loads required for the first 24 hours following a loss of all ac power concurrent with a design basis accident (DBA). The second battery bank in divisions B and D (designated as 72hr battery bank) is used to supply those loads requiring power for 72 hours following a DBA. No load shedding or load management program is needed to feed the essential loads during the required safety actuation periods.

All subsections of this test abstract need to be revised to reflect the unique design features of the AP600 dc power systems as described in the SSAR.

Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.

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2640	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action W N		
				260.66 Chapter 14 - Initial Test Program 14.2.8.1.17, Process Computer: The Performance Criteria subsection of this test abstract should be revised to provide specific acceptance criteria or design basis functional requirements traceable to the appropriate SSAR section(s).					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2641	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action W N		
				260.67 Chapter 14 - Initial Test Program 14.2.8.1.18, In-Plant Communication System: The Test Methods and Performance Criterion subsections of this abstract need to be revised to demonstrate acceptable performance of all subsystems encompassed by the In-Plant Communication System as described in SSAR Section 9.5.2.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2642	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action W N		
				260.68 Chapter 14 - Initial Test Program 14.2.8.1.51, Operations and Control Center System: This test abstract does not reflect the design and configuration of the AP600 Operations and Control Center System. Specifically, the primary plant control system operator interface is a set of "soft" control units that replace conventional switch/light or potentiometer/meter assemblies used for operator interface with control systems. The function-based test analysis serves as the basis for determining the alarms, displays, controls, and procedures in the main control area. The Test Methods and Performance Criterion subsections of this abstract need to be revised to demonstrate acceptable performance of, and to encompass, these unique AP600 design features.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2643	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action W N		
				260.69 Chapter 14 - Initial Test Program 14.2.8.1.59, Engineered Safety Features Actuation Cabinets Test Capability: This test abstract does not reflect the configuration of the AP600 computer based protection system design. This section is a subset of Section 14.2.8.1.72, "Protection and Safety Monitoring." The primary purpose of Section 14.2.8.1.72 is to demonstrate the acceptability of reactor trip logic functions while the primary purpose of this section is to demonstrate acceptable performance of the Engineered Safety Features Actuation System (ESFAS). This test needs to be revised to encompass and properly verify acceptable performance of the isolated fiber-optic data/communication links, including associated protocols, of (a) the Integrated Protection Cabinets to/from Engineered Safety Features Actuation Cabinets, (b) the Engineered Safety Features Actuation Cabinets to/from the Protection Logic Cabinets, and (c) the Protection Logic Cabinets to/from the Protection Multiplexer Cabinets.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					
2644	NRR/HQMB	14.	RAI-OI		8/13/96	Closed	Action W N		
				260.70 Chapter 14 - Initial Test Program 14.2.8.1.68, Resistance Temperature Detector Cross Calibration: Westinghouse should revise the subsections of this test abstract as follows: (a) the Objective subsection should include verification of response times, and accuracy requirements consistent with the safety analysis included in Chapter 15 of the SSAR; (b) the Prerequisites subsection should be revised to describe the in-situ or laboratory calibration testing that will be performed to verify the manufacturer's calibration data (including range, accuracy, repeatability, dynamic response, environmental qualification, calibration reference, and calibration intervals); (c) the Test Method subsection should be revised to clearly establish bounds for RTD calibration. Particularly, the dependency of the data on uniform coolant temperature and flow should be emphasized; and (d) the Performance Criteria subsection should be revised to include the basis for the acceptance criteria and values of cross-calibration points monitored in-situ throughout the RTD range, to assure that the data is adequate for detecting degradation or systematic drift.					
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.					

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2645	NRR/HQMB	14.	RAI-OI	260.71 Chapter 14 - Initial Test Program 14.2.8.1.72, Protection and Safety Monitoring System: This test abstract does not reflect the configuration of the AP600 computer based protection system design. See item 260.69 above. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2646	NRR/HQMB	14.	RAI-OI	260.72 Chapter 14 - Initial Test Program 14.2.8.1.81, Pressurizer Pressure and Level Control: The Test Method subsection does not include testing of signal selector and isolation devices. Westinghouse should revise this subsection to encompass testing of these devices or should identify the test abstract that encompasses such testing. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2647	NRR/HQMB	14.	RAI-OI	260.73 Chapter 14 - Initial Test Program 14.2.8.1.95, Reactor Trip System and Engineered Safety Features Actuation Cabinets System Response Time Test: This abstract should be revised as follows: (a) the Objective subsection should incorporate verification of "Real-Time Performance" of the digital system (the architecture of the digital system affects the response time of the RTS and the ESFAS performance); (b) the Prerequisites subsection should incorporate the determination of sensor delays and actuator delays (by setpoint study). Since real-time deadlines for the digital part of the reactor protection system are computed by subtracting sensor delay and actuator delay from the maximum response times established by analysis of Chapter 15 events, software units timing limits should be available to demonstrate that software units adequately meet their timing specifications. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2648	NRR/HQMB	14.	RAI-OI	260.74 Chapter 14 - Initial Test Program 14.2.8.2.46, Plant Control System: The scope of this test should be expanded to encompass all other Plant Control System subsystems as identified in SSAR Chapter 7.1. Alternatively, Westinghouse should identify the test abstracts that currently encompass such subsystems. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2931	NRR/HQMB	14	RAI-OI	260.75 Westinghouse will develop criteria to be used in its graded approach to testing to determine if identified testing should be included in preoperational testing program or "acceptance testing" program. Westinghouse will provide the criteria for staff review by March 31, 1995. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2932	NRR/HQMB	14	RAI-OI	260.76 Westinghouse will develop criteria for determining if an ITP test should be performed on the first AP600 only or on all AP600 plants. Westinghouse will provide the criteria for staff review by March 31, 1995. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
2933	NRR/HQMB	14	RAI-OI	260.77 Westinghouse will provide the method(s) that will be used to prevent strainer clogging in the passive safety systems. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		

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2934	NRR/HQMB	14	RAI-OI		8/13/96	Closed	Action W	
				260.78 Westinghouse will provide additional information on testing of the passive containment cooling, which will include the feasibility of testing with a heated shell and the determination of air velocity as it relates to differences in temperature.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
2935	NRR/HQMB	14	RAI-OI		8/13/96	Closed	Action W	
				260.79 Westinghouse will provide additional information on the testing requirements for the hydrogen igniters.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
2936	NRR/HQMB	14	RAI-OI		8/13/96	Closed	Action W	
				260.80 Westinghouse will provide the testing requirements for the passive autocatalytic recombiners.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
2937	NRR/HQMB	14	RAI-OI		8/13/96	Closed	Action W	
				260.81 Westinghouse will provide a test abstract for the diverse actuation system.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				
2938	NRR/HQMB	14	RAI-OI		8/13/96	Closed	Action W	
				260.82 Westinghouse will provide a test abstract for the loose parts monitoring system.				
				Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.				

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972	NRR/SCSB	6.2.1-1	DSER-OI	The new method for calculating the source term for the AP600 is currently under staff review. Closed: The source term originally proposed in the SSAR is being abandoned in favor of the source term defined in NUREG-1465 (the historical source term as defined in TID 14844 and RG 1.4 has been superseded by the source term described in NUREG-1465).	03/03/96	Closed	Active	
973	NRR/SCSB	6.2.1-2	DSER-OI	Because the AP600 design does not have containment sprays, natural deposition on surfaces in containment is far more important than in past designs. The elimination of containment sprays from the design requires further staff review. Active: Communication ongoing between Westinghouse and NRC relative to the concept of aerosol removal capability that could be used for severe accident mitigation.	06/03/96	Active	Active	
974	NRR/SCSB OK EDT	6.2.1-3	DSER-OI	Westinghouse should submit values for the peak calculated external pressure. Closed - Peak calculated external pressures are provided SSAR	01/31/96	Closed	Action N	
975	NRR/SCSB OK EDT	6.2.1-4	DSER-OI	Westinghouse is still validating the performance of the PCCS, and staff review is continuing. Closed - Westinghouse activities supporting WGOTHIC verification and validation have been completed.	01/30/96	Closed	Action N	
976	NRR/SCSB	6.2.1-5	DSER-OI	The staff will perform confirmatory calculations after Westinghouse resolved the issue of powering the thermal recombiners with non-safety grade ac. ISSUE MODIFIED BASED ON 7/31/95 INPUT FROM NRC The staff will perform confirmatory calculations for system incorporating PARs. Closed - Adoption of PARs changes this issue. NRC confirmatory calculations will be performed on the design utilizing PARs.	01/30/96	Closed	Action N	
977	NRR/SCSB OK EDT	6.2.1.1-1	DSER-OI	The staff is currently reviewing the analyses-related portions of the August 10, 1994 Westinghouse submittals (EPRI reports on GOTHIC, including the Technical Manual, Users Manual, and Qualification Report), as well as the applicable test qualifications. Closed - Westinghouse has completed necessary submittals to support staff review.	01/30/96	Closed	Action N	
978	NRR/SCSB OK EDT	6.2.1.1-2	DSER-OI	Pertaining to the modeling of the passive cooling features. the staff will review the input assumptions, along with the calculated results. Closed - Submittals supporting staff review have been completed Westinghouse will provide sensitivity cases for initial conditions (temperature and humidity) in May 1995 preliminary SSAR Section 6 markups. NRC agrees to cases per 2/21/95 phone call.	03/03/96	Closed	Action N	
979	NRR/SCSB OK EDT	6.2.1.1-3	DSER-OI	Westinghouse's review of the data from the Large Scale Tests (LSTs) is ongoing, as is the staff's review of the analytical models and input assumptions. Closed - Westinghouse has completed necessary submittals to support staff review.	01/30/96	Closed	Action N	
980	NRR/SCSB OK EDT	6.2.1.1-4	DSER-OI	The treatment of metal-water reaction energy should be considered as an energy source. Closed - Energy from 1% metal-water reaction (per Appendix K) credited.	01/30/96	Closed	Action N	

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981	NRR/SCSB OK EDT	6.2.1.1-5	DSER-OI		03/03/96	Closed	Action N	
				The input assumptions for WGOTHIC 1.0 in the SSAR containment model are under staff review.				
				Closed - Westinghouse has completed necessary submittals to support staff review.				
982	NRR/SCSB OK EDT	6.2.1.1-6	DSER-OI		01/30/96	Closed	Action N	
				Westinghouse is still conducting the WGOTHIC computer code verification and validation (V&V), which is concurrently under staff review.				
				Closed - Westinghouse has completed necessary submittals to support staff review.				
983	NRR/SCSB OK EDT	6.2.1.1-7	DSER-OI		01/30/96	Closed	Action N	
				Westinghouse should include in the SSAR a table demonstrating compliance with the requirements of GDC 38.				
				Closed: Pressure at 24 hours shown to meet 50% of design in SSAR section 6.				
984	NRR/SCSB	6.2.1.1-8	DSER-OI		08/02/96	Action W	Action W	
				Westinghouse stated in the SSAR that the external pressure condition was combined with dead and live loads during normal operation; however, it was not clear whether this also included the loads associated with DBA or severe accident conditions.				
				Action W - Westinghouse to clarify basis and justification for external pressure loads.				
985	NRR/SCSB	6.2.1.2-1	DSER-OI		03/03/96	Closed	Action N	
				Westinghouse should clearly state in the SSAR exactly which subcompartments were analyzed, and what the design pressures of the walls are.				
				Closed - Section 3.8.3.4 of the SSAR Rev. 3 indicates that subcomparments containing high-energy piping are designed for a pressurization load of 5 psi. Compartments analyzed included in SSAR section 6.2.				
986	NRR/SCSB	6.2.1.2-2	DSER-OI		01/30/96	Closed	Action N	
				Westinghouse should state in the SSAR the reasons for not applying the 7.62-cm (3-in.) DEG break, as was done with the other subcompartments.				
				Closed - No high-energy piping is present within the IRWST and reactor cavity. Table 3.6-2 of SSAR revised to include all high-energy piping to be considered for subcompartment pressurization.				
987	NRR/SCSB	6.2.1.2-3	DSER-OI		01/30/96	Closed	Action N	NTD-NRC-95-4464
				Westinghouse should state in the SSAR the design capability of the walls.				
				Closed - Section 3.8.3.4 of the SSAR Rev. 3 indicates that subcomparments containing high-energy piping are designed for a pressurization load of 5 psi.				
988	NRR/SCSB	6.2.1.2-5	DSER-OI		01/30/96	Closed	Action W	
				The staff is currently reviewing the use of the TMD and SATAN- VI codes as they apply to the AP600, as well as the modeling assumptions made by Westinghouse.				
				Closed - Westinghouse has completed necessary submittals to support staff review.				
989	NRR/SCSB OK EDT	6.2.1.3-1	DSER-OI		01/30/96	Closed	Action N	
				The short-term mass/energy release data and methodology are currently under review by the staff as they apply to the AP600.				
				Closed - Westinghouse has completed necessary submittals to support staff review.				
990	NRR/SCSB OK EDT	6.2.1.3-2	DSER-OI		01/30/96	Closed	Action N	
				The long-term LOCA mass/energy release data, and methodology are currently under review by the staff as it applies to the AP600.				
				Closed - Westinghouse has completed necessary submittals to support staff review.				

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991	NRR/SCSB	6.2.1.3-3	DSER-OI		01/30/96	Closed	Action N		
	OK			The staff is currently reviewing the methods and assumptions used to release the various energy sources during the blowdown phase.					
	EOT			Closed - Westinghouse has completed necessary submittals to support staff review.					
992	NRR/SCSB	6.2.1.3-4	DSER-OI		01/30/96	Closed	Action N		
	OK			The staff is currently reviewing the post-blowdown model as it applies to the AP600.					
	EOT			Closed - Westinghouse has completed necessary submittals to support staff review.					
993	NRR/SCSB	6.2.1.3-5	DSER-OI		03/03/96	Closed	Action N		
				The staff is currently reviewing passive system reliability and its application to the AP600.					
				Closed - Westinghouse has completed necessary submittals to support staff review.					
994	NRR/SCSB	6.2.1.3-6	DSER-OI		01/30/96	Closed	Action N		
	OK	[SAME AS 980]		Westinghouse should address the treatment of metal-water reaction energy as an energy source.					
	EOT			Closed - Energy from 1% metal-water reaction (per Appendix K) credited.					
995	NRR/SCSB	6.2.1.4-1	DSER-OI		01/30/96	Closed	Action N		
	OK			The staff is currently reviewing the significant parameters affecting steamline break mass and energy releases, as they apply to the AP600.					
	EOT			Closed - Westinghouse has completed necessary submittals to support staff review.					
996	NRR/SCSB	6.2.1.4-2	DSER-OI		01/30/96	Closed	Action N		
	OK			The staff is currently reviewing the application of the blowdown model methodologies to the AP600.					
	EOT			Closed - Westinghouse has completed necessary submittals to support staff review.					
997	NRR/SCSB	6.2.1.5-1	DSER-OI		01/30/96	Closed	Action N		
				The staff is currently reviewing the application of a constant backpressure of 14.7 psia in performance capability studies of the AP600 ECCS.					
				Closed - SSAR section 6.2.1.5 revised to address.					
998	NRR/SCSB	6.2.1.5-2	DSER-OI		01/30/96	Closed	Action N		
	OK			The staff is currently reviewing the application of the methodology pertaining to the mass and energy release data.					
	EOT			Closed - Westinghouse has completed necessary submittals to support staff review.					
999	NRR/SCSB	6.2.1.6-1	DSER-OI		01/30/96	Closed	Action N		
				The staff is currently reviewing the issue of containment- related testing and inspection.					
				Closed - Westinghouse has completed necessary submittals to support staff review. Vent areas inside containment: The subject vent areas are structural openings between compartments/areas and should not require periodic inspection. The COL's 10CFR 50.59 will control plant modification to preclude unacceptable changes to the vent areas. SSAR 3.8.3.7 specifies "There are no in service testing or inspection requirements for the containment internal structures." Containment outer surface: See response to RAI 252.25. Baffles: Commitment made in the Tech Specs, to verify the air flow path is unobstructed; if the NRC needs additional commitments we will discuss.					

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1000	NRR/SCSB	6.2.1.7-1	DSER-OI	The staff is currently reviewing the containment-related instrumentation requirements. Closed - Westinghouse has completed necessary submittals to support staff review.	01/30/96	Closed	Action N		
1001	NRR/SCSB	6.2.1.8-1	DSER-OI	The staff is currently reviewing the issue of filtering corrosion products, dust, and other debris in the IRWST and containment sump, to prevent the clogging of strainers and screens. Closed - Westinghouse has completed necessary submittals to support staff review. The IRWST sump and the containment recirculation sump of the AP600 are designed and located to have small potential for plugging. The two types of sumps are in different areas and have separate flooding conditions. IRWST Sump The IRWST sump is at the bottom of the IRWST tank and separated from the remainder of containment. The IRWST tank is fully enclosed (except for vents and condensate collection pipes) and is lined with stainless steel. The water has a high cleanliness as it is filtered (by the spent fuel system) each refueling for use in the refueling canal. Sludge will be minimal and the COL cleanliness program will prevent foreign debris from being introduced into the tank. During a LOCA vented RCS steam will condense on the containment shell and be directed by gutters to 4 inch pipes which drain into the IRWST. Containment paint or other lose debris will have to be smaller than 4 inches to be drained into the tank. Since the tank is normally full floating debris will stay on the surface, containment paint has a high specific gravity and will quickly sink to the bottom of the tank. Various curbs in the gutters and inside the IRWST will trap the heavier debris preventing migration to the sump. With the low velocities of gravity injection no significant transport of heavy debris is expected. When the tank is fully empty (if possible) then floating debris will be trapped by the screens but heavy settled debris will not be transported into the IRWST lines. Containment recirculation sump The intakes for containment recirculation are located on the walls above the floor elevation at 83 feet. This is 11.5 feet above the waste sump below the reactor vessel (at elevation 71.6 feet). The bottom of the inlet screen is one foot off the floor, this provides a curb function. During a LOCA, water will flood the vessel cavity and adjacent floors up to the 107 foot elevation. The containment recirculation line is not opened until the water level in the IRWST reaches a low level setpoint. Water level in the flooded containment when IRWST reaches the setup is above the top of the recirculation inlet screens. Thus during floodup there is not a transport of floating debris to the screens and heavy materials will have settled to the waste sump level or the 83 foot level. During recirculation the water level in containment will not change significantly nor will it drop below the screens. Thus the recirculation screens will be not be clogged by floating debris or by heavy debris. The loss of non safety coating will not have an effect on sump operation. In addition the COL will implement a cleanliness program to eliminate other potential clogging debris.	08/05/96	Closed	Action N		
1646	NRR/SCSB	6.2.1.2-4	DSER-OI	The LBB concept is currently under staff review, as it specifically applies to the AP600. Closed - Westinghouse has provided necessary submittal to support staff review.	01/30/96	Closed	Action N		

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Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
31	NRR/SCSB OK EOT	21.	RAI-OI	**Question 952.100 (PCS Scaling Analysis)** Provide a commitment to submit a complete PCCS scaling analysis. The report should describe how the scaling analysis will be used in validation of the analysis codes. The scaling report should describe how the large scale tests analysis will translate to the AP600 design. An explanation of how this analysis would be used in the code validation process should be included. Closed - Response provided via Westinghouse letter NTD-NRC-95-4602, dated 11/30/95.	01/30/96	Closed	Action N	NTD-NRC-95-4602	11/30/95
32	NRR/SCSB OK EOT	21.	RAI-OI	**Question 952.101 (PCS Analysis)** Provide a commitment to submit calculations of PCCS interior velocities using the WGOTHIC code. Closed - Response provided by NSD-NRC-96-4696.	05/13/96	Closed	Resolved	NSD-NRC-96-4696	11/07/94
33	NRR/SCSB OK EOT	21.	RAI-OI	**Question 952.102 (PCS Analysis)** Provide a commitment to submit an analysis of air flow in the annulus (both wet and dry cases). Closed - Response provided via Westinghouse letter NTD-NRC-95-4414.	01/30/96	Closed	Action N	NTD-NRC-95-4414	03/13/95
34	NRR/SCSB OK EOT	21.	RAI-OI	**Question 952.103 (PCS Water Distribution Model)** Provide a commitment to submit an analysis demonstrating the validity of the (cold wall) water distribution tests to predict percent film coverage when the wall is hot. Closed - Response provided via NTD-NRC-94-4337	01/30/96	Closed	Action N	NTD-NRC-94-4337	11/07/94
35	NRR/SCSB OK EOT	21.	RAI-OI	**Question 952.104 (PCS Water Distribution Model)** Provide a commitment to submit information on how the water distribution model findings support the design-basis accident analyses. Closed - Response provided via NTD-NRC-94-4337.	01/30/96	Closed	Action N	NTD-NRC-94-4337	11/07/94
485	NRR/SCSB EOT	21.	MTG-OI	**NRC Meeting on PCS (11/15/94)** Westinghouse will use the tools developed in the scaling work to include consideration of stratification for steam line breaks. Closed - Tools that can be used to address stratification effects are presented in the scaling analysis1, Section 10. The evaluation of stratification for steam line breaks is presented in the mixing and stratification report2, Section 4. References: 1. D. R. Spencer, "Scaling Analysis for AP600 Containment Pressure During Design Basis Accidents," NSD-NRC-96-4762, July 1, 1996. Westinghouse Electric Corporation, Proprietary Class 2. 2. J. S. Narula, "Assessment of Mixing and Stratification Effect on AP600," NSD-NRC-96-4763, July 1, 1996. NOTE: (1) R1 & R2 drafts are under review by staff.	07/26/96	Closed	~~Action~~ N		

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486	NRR/SCSB EOT	21.	MTG-OI		07/26/96	Closed	Action XN		

NRC Meeting on PCS (11/15/94)
Westinghouse will use the scaling analysis to look at uncertainty / bounding analyses.

Closed - The PIRT1 and scaling analysis2 identified the components and phenomena that dominate pressurization of the AP600 containment during design basis accidents (DBA). The dominant phenomena are those that must be bounded in the evaluation model. The bounding approach used on the AP600 evaluation model was described in the DBA Road Maps3. Mixing and Stratification4 and external water coverage5 are dominant phenomena that were resolved and incorporated in the evaluation model by biasing boundary conditions and inputs.

References:

1. D. R. Spencer, "Accident Specification and Phenomena Evaluation for AP600 Passive Containment cooling System", NSD-NRC-96-4643, February 12, 1996.

2. D. R. Spencer, "Supporting Information for the Use of Forced Convection in the AP600 PCS Annulus, "NTD-NRC-95-4397, February 16, 1995, Westinghouse Electric Corporation, Proprietary Class 2.

3. "AP600 PCS Design Basis Accident Road Maps," NTD-NRC-95-4545, August 31, 1995.

4. J. S. Narula, "Assessment of Mixing and Stratification Effect on AP600," NSD-NRC-96-4763, July 1, 1996.

5. R. P. Ofstun, "AP600 PCS Film Coverage Model", NSD-NRC-96-4728, Westinghouse Electric Corporation.

NOTE1
(2) R4 FRS under review
(3) RS out of date -- new PCS flow rate 440 gpm.

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487	NRR/SCSB EOT	21.	MTG-OI		07/26/96	Closed	Action XN		

NRC Meeting on PCS (11/15/94)
Westinghouse will provide additional information on the comparison of LST and AP600 Froude numbers.

Closed - A comparison of AP600 and LST Froude numbers is presented in the scaling analysis1, Section 10. These test-to-prototype comparisons are among the considerations used to address the effects of mixing and stratification2 on the evaluation model.

References:

1. D. R. Spencer, "Scaling Analysis for AP600 Containment Pressure During Design Basis Accidents," NSD-NRC-96-4762, July 1, 1996, Westinghouse Electric Corporation, Proprietary Class 2.

2. J. S. Narula, "Assessment of Mixing and Stratification Effect on AP600," NSD-NRC-96-4763, July 1, 1996.

NOTES
(1)

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488	NRR/SCSB EOT	21.	MTG-OI		07/26/96	Closed	Action X N	NTD-NRC-95-4397	

NRC Meeting on PCS (11/15/94)
Westinghouse will provide additional information or point to previously submitted information which addresses NRC concern on use of forced convection correlation in the annulus.

Closed - Forced convection was determined1 to dominate heat transfer in the PCS riser. The effect of buoyancy is less than 5% of the forced convection value for shell temperatures 2 oF or more above the ambient air temperature.

References:

1. D. R. Spencer, "Supporting Information for the Use of Forced Convection in the AP600 PCS Annulus, "NTD-NRC-95-4397, February 16, 1995, Westinghouse Electric Corporation, Proprietary Class 2.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
489	NRR/SCSB EOT	21.	MTG-OI		07/26/96	Closed	Action X N		

NRC Meeting on PCS (11/15/94)
Westinghouse will look at the normalization of steam sources. Joining inside and outside containment on a similar basis to look at condensation and evaporation.

Closed - The normalization of the steam source is described in the June 1996 scaling analysis1, Section 6.0. In the scaling analysis, Sections 3.3 and 6.6, the inside of containment was coupled to the outside (the riser) using effective heat transfer coefficients derived from energy equations.

NOTES (1)

References:

1. D. R. Spencer, "Scaling Analysis for AP600 Containment Pressure During Design Basis Accidents," NSD-NRC-96-4762, July 1, 1996, Westinghouse Electric Corporation, Proprietary Class 2.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
490	NRR/SCSB EOT	21.	MTG-OI		07/26/96	Closed	Action X N		

NRC Meeting on PCS (11/15/94)
Westinghouse will provide information to clarify the normalization basis for the LST and AP600 Pi groups used in the scaling analysis.

Closed - The basis for normalizing dimensionless groups is clarified in the June 1996 scaling analysis1. Normalization of the rate of pressure change equation is described in Section 6.0, the heat sink energy equations and conductances are normalized in Sections 6.6.1 to 6.6.6, and PCS air flow path momentum equation is normalized in Section 8.1.

NOTES (1)

References:

1. D. R. Spencer, "Scaling Analysis for AP600 Containment Pressure During Design Basis Accidents," NSD-NRC-96-4762, July 1, 1996, Westinghouse Electric Corporation, Proprietary Class 2.

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491	NRR/SCSB EOT	21.	MTG-OI	NRC Meeting on PCS (11/15/94) Westinghouse will provide information on a more detailed break d n of the Pi groups used in the scaling analysis. Closed - The June 1996 scaling analysis1 provides a detailed breakdown of the pi groups. The rate of pressure change pi groups are presented in Section 7.3, conductance pi groups in Section 7.1, heat sink energy transfer characteristic frequencies in Sections 7.2.1 to 7.2.5, and PCS air flow path momentum pi groups in Section 8.3. (1) References: 1. D. R. Spencer, "Scaling Analysis for AP600 Containment Pressure During Design Basis Accidents," NSD-NRC-96-4762, July 1, 1996, Westinghouse Electric Corporation, Proprietary Class 2.	07/26/96	Closed	Action N		
492	NRR/SCSB EOT	21.	MTG-OI	NRC Meeting on PCS (11/15/94) Westinghouse/NRC to arrange a teleconference to discuss the test analysis and validation reports which Westinghouse will be submitting to support WGOTHIC V&V. MOST LIKELY DID OCCUR	06/25/96	Closed	Action W CLOSED		
493	NRR/SCSB ok EOT	21.	MTG-OI	NRC Meeting on PCS (11/15/94) Westinghouse to provide water distribution data measured during the LST tests which was not included in final test data report.	06/03/96	Action W	Action W		
500	NRR/SCSB	21.	TEL-OI	Teleconference (11/21/94) on ADS Testing. Westinghouse to provide NRC with road map of their activities on Air clearing loads, condensation loads, Vacuum Breaker concerns. Indications are that there are no showstoppers, but only that the information needs to be presented in a fashion that is organized / optimized for SER input.	08/20/95	Action W	Action W		
1622	NRR/SCSB ok EOT	21.3.8.1-1	DSER-OI	Westinghouse should submit all outstanding large scale test (LST) documentation. All outstanding LST documentation has been sent, including PCS-T2R-050, "Large Scale Test Data Evaluation," dated May 1995. 21.3.8.1-1* NRC STATUS PROVIDED IN SDSER (4/30/96) Westinghouse submitted all outstanding large scale test documentation.	05/13/96	Closed	Closed		
1623	NRR/SCSB EOT	21.3.8.5-1	DSER-OI	Resolution of the LST facility scaling issue is a primary staff concern. LST facility Phenomena Identification and Ranking Table and scaling via energy partitioning have been issued for NRC review via WCAP-14190. 21.3.8.5-1* - This DSR open item identified the staff's concern with the scaling of the Large-Scale Test (LST) facility. The staff has identified the following specific SDSER open items (21.3.8.5-1a - 21.3.8.5-1f) to clarify its concerns: NEW OI's	05/14/96	Closed	Action W	NTD-NRC-94-4318	10/27/94
1624	NRR/SCSB EOT ok	21.3.9.1-1	DSER-OI	The water distribution test reports contain only a matter-of-fact presentation of the data, and contain no evaluation or conclusions. Closed - DISCUSSED W/ NRC IN 2/6/95 TELECON:NRC agreed closed, referencing response to RAI 952.104 21.3.9.1-1* NRC STATUS PROVIDED IN SDSER (4/30/96) Westinghouse submitted reports that contain evaluations and conclusions for the water distribution tests.	05/13/96	Closed	Closed	NTD-NRC-94-4337	

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1625	NRR/SCSB	21.3.9.3-1	DSER-OI		05/13/96	Closed	Closed	
	ok Eor			None of the tests conducted in the water distribution tests, Phases 1-3, examined the heated-surface effect. Westinghouse was made aware of this staff concern before the commencement of the water distribution test program.				
				21.3.9.3-1* NRC STATUS PROVIDED IN SDSER (4/30/96) DSER Open Item 21.3.9.3-1 concerning the lack of a heated surface is subsumed under DSER Open Item 21.5.9-2.				
1630	NRR/SCSB	21.5.7.4-1	DSER-OI		05/13/96	Closed	Closed	
	ok Eor			The staff is interested in determining whether the external wind helps containment cooling natural convection air flow, has no effect, or tends to counteract the flow (wind-positive, wind- neutral, and wind-negative, respectively).				
				21.5.7.4-1* NRC STATUS PROVIDED IN SDSER (4/30/96) The staff reviewed Westinghouse's methodology for assessing the wind neutrality of the AP600 containment and finds acceptable both the conclusion that no imposed wind conditions are conservative for the AP600 containment loss-of-coolant-accident (LOCA) analysis and the decision to use this methodology in the design-basis analysis.				
1631	NRR/SCSB	21.5.8-1	DSER-OI		06/03/96	Action N	Action N	NTD-NRC-95-4459
	ok Eor			The treatment of noncondensables in the LST program is still under staff review.				
				Proposed in reports: WCAP-14326 (NTD-NRC-95-4428) which validates the correlations over the AP600 range, and Letter NTD-NRC-95-4459 providing a framework to assess mixing and stratification in the PCS evaluation model. 21.5.8-1* - The staff is still reviewing the treatment of noncondensible gases in the LST testing program, the treatment of mixing and stratification in the AP600 design-basis accident (DBA) evaluation model, and the use of the LST data to support the evaluation model in the LST program.				
1632	NRR/SCSB	21.5.8-2	DSER-OI		06/03/96	Resolved	Action N	
	ok Eor			The applicability of the water coverage test results from both the water distribution and large scale tests, as they relate to the input used for the WGOTHIC code, is still under staff review.				
				Resolved - This item is resolved pending submittal of SSAR analysis which will outline details of water coverage assumptions. 21.5.8-2* - The staff is still reviewing the applicability of the water coverage test results from both the water distribution and large scale tests, as they relate to the input used for the WGOTHIC computer program for the AP600 SSAR.				
1633	NRR/SCSB	21.5.8-3	DSER-OI		06/03/96	Resolved	Action ~~N~~ W	SCALING & PIRT REPORT!
	Eor			The staff believes that more measurements may be needed to quantify the mixed-convective flow field. This is an issue which could be of importance in the scaling of results to predict the prototypical containment performance.				
				Resolved - the internal velocity field information as it relates to WGOTHIC validation has been presented in November 1994 and April 1995 meetings with the NRC. No additional measurements are needed. Westinghouse will provide this information within WCAP-14382, WGOTHIC V&V. 21.5.8-3* - The concern whether the LST provides sufficient information to assist in developing a conservative, bounding analysis, aas identified in Open Items 21.3.8.5-1b and 21.3.8.5-1e, remains. As such, DSER Open Item 21.5.8-3 remains open until the scaling and PIRT issues are resolved.				
1634	NRR/SCSB	21.5.8-4	DSER-OI		06/03/96	Resolved	Action ~~N~~ W	
	Eor			The measurement of condensate forming within the containment vessel must be considered when addressing the question of the ability of the WGOTHIC code to predict containment performance.				
				Resolved - presentations in November 1994 and April 1995 showed good agreement with instantaneous condensation rates as a function of time rather than time averaged values. This informaiton will be included in the WGOTHIC V&V WCAP-14382. 21.5.8-4* - Westinghouse indicated that the heat balance analysis would be reviewed to address staff concerns about condensate formation in the containment vessel. The staff considers this commitment to be part of DSER Open Item 21.5.8-4, and therefore, this item remains open.				

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1635	NRR/SCSB Ent ok	21.5.8-5	DSER-OI	The lack of adequate instrumentation in the LST annular region makes it difficult to evaluate the evaporation rate from the containment shell. 21.5.8-5* NRC STATUS PROVIDED IN SDSER (4/30/96) WCAP-14382 and Westinghouse Report PCS-T2R-050 contains an evaluation of the large-scale passive containment cooling system (PCS) test data.	05/13/96	Closed	Closed	
1636	NRR/SCSB ok Ent	21.5.8-6	DSER-OI	The LST model does not include a downcomer region, and uses a chimney-installed fan to model circulation in the annular region, both of which are non-prototypical of the AP600. Closed - WCAP-14190, section 7.2 and 7.3, scaling of the external flow path shows no significant contribution of the downcomer to either energy or momentum partitioning of external PCS. NRC is evaluating whether to raise a specific question related to 2D effects on external flow path loss coefficients. 21.5.8-6* - The staff is still reviewing the acceptability of the nonphototypicality of the design of the LST model, which does not include a downcomer region, and uses a chimney-installed fan to model circulation in the annular region.	05/14/96	Closed	Action N	NTD-NRC-94-4318
1637	NRR/SCSB ok Ent	21.5.8-7	DSER-OI	The LST modeling of the long and short term heat sinks, flow paths, and internal volumes in containment, especially in relation to their representation in WGOTHIC, are still under staff review. Action NRC - Westinghouse awaiting specific questions. 21.5.8-7* - The staff is still reviewing the modeling of the long- and short-term heat sinks, flow paths, and internal volumes in the containment, especially in relation to their representation in WGOTHIC.	06/03/96	Action N	Action N	
1638	NRR/SCSB Ent	21.5.9-1	DSER-OI	There is no time-dependent film coverage model. There is a concern as to whether the 40-percent-60-percent-70-percent coverage model is valid at much later times after a design- basis accident (DBA). Action W - SSAR submittal will include bounding water coverages throughout the 24 hour transient. 21.5.9-1* - Westinghouse needs to demonstrate the validity and conservatism, if applicable, of using the same coverage fraction for all times and of the 660-second time delay before initiation of PCS flow in the WGOTHIC DBA anaylsis.	06/03/96	Action N	Action X W	NEW PCS DESIG
1639	NRR/SCSB Ent	21.5.9-2	DSER-OI	Under actual DBA conditions, when the shell is heated, coverage fractions could be different from the 40-percent-60-percent-70- percent distribution assumed in the SSAR. Active - discussions with NRC and ACRS are ongoing with regard to water coverage fractions assumed in the SSAR 21.5.9-2* - Westinghouse needs to demonstrate how water coverage data obtained from an unheated surface can be extrapolated to represent film behavior on the AP600.	06/03/96	Action N	Action X W	NEW PCS DESI
1640	NRR/SCSB Ent	21.5.9-3	DSER-OI	The staff is also concerned that the supporting arms of the baffle wall of the PCCS, surface irregularities, and the possible effect of clogging of the weirs with foreign material are not modeled in the WGOTHIC analysis. Progress - need to schedule discussions with NRC on approach for this item. 21.5.9-3* - Westinghouse needs to address if and how the baffle-wall standoffs are treated in the coverage model, and if the degree of conservatism present in the coverage fractions includes a reduction in PCS flow due to clogging of weirs with debris.	06/03/96	Action W	Action X W	

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1644	NRR/SCSB	21.6-5	DSER-OI	No predictions between the wind tunnel test data and any computer code analysis will be made. The acceptability of the data from these tests as input to the AP600 safety analysis is still under review. Action W - will be addressed in Wind Tunnel Test Analysis Letter Report 21.6-5* - Westinghouse needs to demonstrate the acceptibility of the data from the wind tunnel tests to establish the boundary conditions input into WGOTHIC for the AP600 containment analysis. Closed - Discussed at 6/6/96 NRC meeting.	06/07/96	Closed	Action N	
1645	NRR/SCSB	21.6-6	DSER-OI	The staff has not yet completed its review and final evaluation of the WGOTHIC code. Action W - DISCUSSED W/ NRC IN 2/6/95 TELECON: This is a top level item that will be closed after related specific issues are closed. Scheduled PCS test analysis reports should address this item. 21.6-6* - The staff is still reviewing the WGOTHIC code. Closed - Discussed at 6/6/96 NRC meeting. Covered by other SDSER open items.	06/07/96	Closed	Action N	
1651	NRR/SCSB	21.	TEL-OI	12/13/94 Telecon Action Item Westinghouse is to provide a detailed outline of the content of the PCS Test Analysis Report by "mid-February".	08/18/95	Closed	Closed	02/15/95
2397	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide LST nodal sensitivity calcs with WGOTHIC to show noding convergence and discuss how this addresses numerical diffusion NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	08/18/95	Closed	Closed	
2398	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide a copy of the GOTHIC peer review documenation. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	08/18/95	Closed	Closed	
2399	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide LST blind test boundary conditions being used by Westinghouse. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	08/18/95	Closed	Closed	
2400	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide experimental basis for heat transfer correlations under the conditions of late phase dryout of shell (beyond design basis). NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	

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2401	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide the experimental basis for treatment of the effect of noncondensible concentrations on mass transfer, both separate effects and LST. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2402	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide the basis for the effects of steam generator comparment connectivity to other below deck compartments on evaluation model pressure predictions. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2403	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide calculations to justify overmixing is conservative for LOCA long term cooling. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2404	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide calculation to show how much water is needed to turn over second hump and to assess margin is in the 220 gpm PCS water flow rate. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2405	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide experimental basis for evaporation taking place on the AP600 dome, as it relates to the degree of subcooling on the LST dome. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2406	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Clarify what validation means: are we validating a best estimate code or a conservative evaluation model. Closed - WGOTHIC evaluation model is a conservative evaluation model.	06/25/96	Closed	Action ~~W~~ N	
2407	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (3/17/95) Provide an explanation of the mixed convection correlation as it represents a purely free convection condition and highlight which correlations are used in each analysis. Closed - Free convection used.	06/25/96	Closed	Action ~~W~~ N	
2408	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Justify the well mixed assumption in the scaling model in light of observed stratification in the LST. NRC PCS Telecon of 5/9/95: Agreement on description and closure path. Closed - This question is the same as RAI 480.378. The response to RAI 480.378 resolves this meeting open item.	07/26/96	Closed	Action ~~W~~ N	

AP600 Open Item Tracking System Database: Executive Summary   Date: 09/11/96

Selection: [DSER Section] like '21*' And [NRC Branch] like 'NRR/SCSB' Sorted by NRC Branch

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2409	NRR/SCSB	21.	MTG-OI		07/26/96	Closed	Action		
2410	NRR/SCSB	21.	MTG-OI		07/26/96	Closed	Action		
2411	NRR/SCSB	21.	MTG-OI		06/03/96	Action W	Action W		

2409

NRC Meeting on PCS (4/11/95)
Justify the use of internal energy in the pressure equation used in scaling analysis.

NRC PCS Telecon of 5/9/95: Agreement on description and closure path.

Closed - This question is the same as RAI 480.379. The response to RAI 480.379 resolves this meeting open item.

2410

NRC Meeting on PCS (4/11/95)
Justify the use of Re rather than Nu in the annulus for scaling and show the range of parameters is covered.

NRC PCS Telecon of 5/9/95: Agreement on description and closure path.

Closed - The air flow in the PCS riser was shown1 to be forced convection dominated for shell temperatures 2 oF or more than the ambient air temperature. Calculations for the riser in Appendix B of the scaling analysis2 show the riser Reynolds number is 35,000 for a shell temperature of 117.5 oF with air and baffle temperatures of 115 oF. The predicted Reynolds numbers from Reference 1 and the scaling analysis are similar, although the scaling analysis is more conservative. Consequently, the Nusselt number in the riser annulus is expected to be well correlated as a function of the Reynolds number. The heat and mass transfer validation report3 shows this correlation is valid, and the scaling analysis shows the Reynolds number range in AP600 is covered by the range of test data.

It is necessary, but not sufficient, that the range of Nusselt numbers in the plant be covered by the test data. Sufficiency is provided by achieving Nusselt numbers in the correct flow regime, and the correct flow regime is forced convection. Forced convection Nusselt numbers are achieved by simulating the annulus Reynolds number. Consequently, simply scaling the Nusselt number is not sufficient.

References:

1. D. R. Spencer, "Supporting Information for the Use of Forced Convection in the AP600 PCS Annulus," NTD-NRC-95-4397, February 16, 1995, Westinghouse Electric Corporation.

2. D. R. Spencer, "Scaling Analysis for AP600 Containment Pressure During Design Basis Accidents," NSD-NRC-96-4762, July 1, 1996, Westinghouse Electric Corporation.

3. R. P. Ofstun, "Experimental Basis for the AP600 Containment Vessel Heat and Mass Transfer Correlations", WCAP-14326, March 31, 1995, Westinghouse Electric Corporation.

2411

NRC Meeting on PCS (4/11/95)
External cooling / coverages / wetted fraction:
Evaluate development of wetting coverage model in light of:
- preheating of dome
- scalability of film model to AP600 - coverage of entire range
- different coverage in model (stripes continue to narrow) vs LST observation (stripes constant width)
- uncertainties
- further sensitivities to coverage

NRC PCS Telecon of 5/9/95: Agreement on description and closure path.

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2412	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) For LST 219.1, at Level C the temperature "quivers". Attempt to assess whether it is a indication of dryout, a lasting effect of preheating, or an indication of the thermocouple being on the edge of a water stripe. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2413	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Provide sensitivities to noding for the AP600 distributed parameter model. Some logic might conclude, same phenomenon => same size node. The alternative is for the NRC to consider this an additional (big) uncertainty. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2414	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Evaluate separately for the AP600 the effects of: - heat sinks - interior condensation model - stratification NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2415	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Provide information on water coverage model: - model application to coating and aging - rewet after dryout NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2416	NRR/SCSE	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Margin vs Uncertainty: - Look at M&E releases in conventional vs AP600 - Long term integrated heat, Best Estimate vs PCS evaluation model - Margin between calculated conditions and those used in EQ and radiological as compared to conventional plants. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2417	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Add 3D temperature comparisons to add confidence to WGOTHIC predictions of internal fields and transport processes. Need to look at this for the 6 priority LSTs. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	
2418	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (4/11/95) Include an assessment of the agreement between WGOTHIC and LST for all 6 priority LST with local comparisons of heat flux (via delta-T) as a function of elevation. NRC PCS Telecon of 5/9/95: Agreement on description and closure path.	06/03/96	Action W	Action W	

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Selection: [DSER Section] like '21*' And [NRC Branch] like 'NRR/SCSB' Sorted by NRC Branch

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2420	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (5/1/95) Explain the low sensitivity of AP600 pressure response to reductions in external heat removal; put it in terms of the energy partitioning to internal heat sinks, internal volume, and external heat removal.	06/03/96	Action W	Action W		
2421	NRR/SCSB	21.	MTG-OI	NRC Meeting on PCS (5/1/95) Provide to NRC the revised post-test steam parameters for the LST blind test.	06/03/96	Active	Action W		

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2483	NRR/SCSB	21	RAI-OI		08/08/96	Action W	Action W	NSD-NRC-96-4751

Grr

(WGOTHIC MODELS AND PHENOMENA)ADEQUACY OF THE MIXED CONVECTION TREATMENT

The model used for mixed convection is defined in the report documenting the experimental basis for WGOTHIC heat transfer correlations ("Experimental Basis for the Heat Transfer Correlations Selected for Modeling Heat transfer from the AP600 Containment Vessel," PCS-GSR-004, Westinghouse Electric Corp., August 31, 1994). For opposed mixed and forced convection, the Nusselt number, Nuc is stated there to be given by

NUc = (NUfree**3 + NUforc**3)**(1/3) (1)

where Nufree and Nuforc are the Nusselt numbers calculated for free and forced convection, respectively. For assisting mixed convection, the correlation is

NUc = Max((abs(NUfree**3 - NUforc**3))**(1/3);NUfree;0.75NUforc) (2)

No reason was given for applying the multiplier 0.75 to Nuforc but not to Nufree. Note also that Eq. (2) represents a change from the WGOTHIC mixed convection correlation as previously cited in response to NRC Question 480.14 (Ref. ET-NRC-93-3966, letter from N.J. Liparulo, Westinghouse responses to requests for additional information on the AP600, Question 480.14, September 10, 1993.) where in equation (4) both Nuforc and Nufree were multiplied by 0.75 based on the Eckert and Diaguila data base. A justification is required since Eq. (2) will never give Nuc less than Nufree while it seems to be well established that, in general, assisted mixed convection can give rise to heat transfer rates that are less than those implied by either free or forced convection correlations alone, when Nufor… Nufree.

No statements have been made by WEC as to whether either the LST or the AP600 analyses correspond to the opposed or assisted convection case. It is expected that the assisted convection case applies except, possibly, in regions where the rising plume is contacting the containment shell wall. In any event, since including mixed convection appears to result in significant increases in heat transfer, it is evident that the forced convection contribution is important.

In the older code version, the user was required to specify whether the free or forced convection correlation was to be used. However, it is not clear whether the results cited for WGOTHIC 1.0 were obtained with free or forced convection being specified. WEC needs to clarify this point.

In a presentation to the NRC (November 15-16, 1994) results of LST analyses (Test 212.1) were compared using the mixed convection treatment versus the treatment with free convection only. At the end of the calculation, the gauge pressure was about 20% higher in the case with free convection only. The effect is of the same order of magnitude as the margin claimed for the AP600 analyses. Hence the mixed convection effect could be very important to the AP600 certification case.

The pressure calculated assuming mixed convection was considerably closer to the experimental value than was the calculation assuming free convection only (even the mixed convection overpredicted the pressure somewhat). However, integral results alone may not constitute an adequate test of model validation as there are many ways that compensating effects can yield reasonable integral result comparisons even when some of the important phenomena are not being well represented.

This concern is heightened by the velocity comparisons presented in the November 1994 meeting. The mixed convection calculated by WGOTHIC will be sensitive to the forced flow velocities WGOTHIC calculates, since it is these velocities the code will use in evaluating the forced flow component of the mixed convection correlation. For Test 212.1, the calculated velocities were 5-8 ft/s, while the measured velocities were only 1-3 ft/s. For Test 222.1, the discrepancy was even larger, 10 ft/s (calculated) vs 1 ft/s (experimental). Assuming saturated conditions and a 10 K driving temperature difference (it is not known if these assumptions are correct for Test 212.1), it is estimated that Nufree and Nuforc should be about the same magnitude for velocities of 3 ft/s, and Nuforc < 0.5 Nufree for a velocity of 1 ft/s. For these conditions, Nuc should not be significantly greater than Nufree and Nuc might even be less than Nufree (although not in WGOTHIC with Eq. (2) being used).

The situation is not very clear. The calculation including mixed convection definitely yielded better agreement with the experimental pressures, but the velocities calculated by the code for use in the mixed convection correlation do not agree well with the experimental values and, furthermore, the latter imply that the free convection correlation should have been more nearly correct. It is possible that the velocity measurements are inaccurate, or that they do not correspond well with the velocities that should be used in the correlations. However, even if this were to be the case, there is still no validation for the velocities being calculated by the code and that are used in the correlations. The fact that the mixed correlation gives better agreement with the experimental pressure is not very convincing, since there are many possible reasons why the free-convection calculation may be overpredicting the pressures and the mixed convection calculation may merely be introducing a compensating error. For example, the calculation with only free convection may be overpredicting pressures because it overpredicts mixing and, hence, underpredicts steam concentrations and thus underpredicts heat and mass

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transfer rates on the LST shell. If this explanation is correct, the mixed convection correlation is simply introducing a compensating error that cancels the effects of the error in steam concentrations.

480.277 In Eq. (2) above, what is WEC's justification for applying the multiplier 0.75 to Nuforc but not to Nufree?

480.278 What heat transfer regime does WGOTHIC predict in the LST and AP600 calculations? Do the LST and AP600 analyses correspond to the opposed or assisted convection case?

480.279 Integral results alone may not constitute an adequate test of model validation; compensating effects can yield reas[illegible] integral result comparisons even when important phenomena are not well represented, and there is no guarantee that compensation occurr[illegible]ST analyses will necessarily occur in AP600 analyses. For example, the fact that the mixed correlation gives better agreement with the experimen[illegible]al pressure than the free correlation does not prove that the mixed correlation is more correct; there are many possible reasons why the free-convection calculation may be overpredicting the pressures and the mixed convection calculation may be introducing a compensating error. How is WEC using the LST data to establish the validity of individual models such as the models for heat transfer, evaporation and condensation, and flow velocities? WEC should examine the performance of individual models at a greater level of detail, rather than relying entirely on integral results.

480.280 What is the explanation for the large differences between calculated and measured velocities in tests 212.1 and 222.1?

480.281 What would be the effect of these velocity differences on the behavior of the heat transfer model and on the predicted pressures? The forced component is important to the calculation, and is dependent on the velocities used in the correlation.

480.282 Why are the pressure results in better agreement with the experiment when WGOTHIC uses a mixed convective correlation with velocities that disagree with experimental measurements?

480.283 Why are the pressure results in better agreement when WGOTHIC uses a mixed convective correlation rather than a free convective correlation, when the experimentally measured velocities indicate that the free convection correlation should have been more nearly correct?

480.284 If the experimentally measured velocities are inaccurate or do not correspond well to the velocities used in the WGOTHIC correlations, how will the velocities calculated by the code and used in its correlations be validated?

480.285 Are the older (i.e., Version 1.0) results cited in the model and margin assessment report (PCS-GSR-001) and in the SAR, obtained using free convection or forced convection?

Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96. RAI response provided via Westinghouse letter NSD-NRC-96-4788, dated 8/5/96.

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2484	NRR/SCSB	21.	RAI-OI		07/19/96	Action W	Action W	NSD-NRC-96-4751	

(WGOTHIC MODELS AND PHENOMENA)WGOTHIC VELOCITIES AND FORCED CONVECTION
For the shell interior (and also the internal heat sinks), the forced convection correlation used by WGOTHIC is

NUx = 0.0296*(REx**(4/5))*(PR**(1/3)) (3)

This appears to be defined and used as a local Nusselt number, not a global average. Since the heat transfer coefficient is given by h(x) = kNux/x, Eq. (3) yields a heat transfer coefficient that varies as x-0.2 and therefore decreases with increasing x.

WEC has indicated that the spatial coordinate x is measured from the point at which the steam plume impacts the dome. The fact that the rising plume is off-center is also taken into account (that is, the zero point is not taken to be the dome center). Details of this treatment require documentation. There are questions concerning the accuracy of this approach for AP600 and LST analysis because the correlation is based upon x=0 corresponding to the leading edge of a plate, while in AP600 and LST, x=0 is actually a stagnation point (or would be if the surface were perpendicular to the plume velocity). The treatment used will mean that, other things being equal, the forced flow Nusselt number will be higher on the dome than on the walls. Since steam concentrations may be highest in the dome, and the external subcooling is highest on the dome, the nonuniform distribution of the heat transfer coefficient may give higher total heat transfer than would be obtained if an average value of Nu were used throughout.

Since x=0 in the AP600 does not represent the leading edge of a plate, as assumed in the correlation, WEC needs to either defend this treatment or else show that the uncertainties involved have little effect. Also the effect of subcooling on the dome is much greater for the LST than the AP600, and a higher heat transfer coefficient for the dome may therefore have different effects for LST analysis than for AP600 analysis.

480.286 Additional justification and documentation is needed on the treatment of the spatial dependence in Eq. (3) above, particularly on the selection of the zero-point.

480.287 The accuracy of the WGOTHIC wall heat transfer approach for AP600 and LST analysis needs to be examined; the WGOTHIC correlation assumes that x=0 corresponds to the leading edge of a plate, while in AP600 and LST x=0 is actually a stagnation point.

480.288 In the WGOTHIC approach the forced flow Nusselt number will be higher on the dome than on the walls. However, the effect of subcooling on the dome is much greater for LST than AP600, and a higher heat transfer coefficient for the dome may therefore have different effects for LST analysis than for AP600 analysis. How does this affect code validation for AP600 applications?

480.289 For each node, is Eq. (3) integrated over the range of x values represented by the node, or is a characteristic value of x defined to represent an entire range of nodes?

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

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2485	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(WGOTHIC MODELS AND PHENOMENA)FLOW RESISTANCES AND VELOCITIES

In WGOTHIC analyses of AP600, the relatively open volume above the operating deck has been nodalized considerably more finely than is normally attempted in analyses using lumped-parameter model (LPM) codes, even though the WGOTHIC LPM mode is being used; the same is true of WGOTHIC LPM analyses for the LST calculations. There are many questions to be answered concerning the validity of such calculations, including questions as to how to define the intercell flow resistances.

The issue was discussed with WEC and leads to the following description, which could be in error. WEC needs to provide a detailed hardcopy description of how this is done for the specific case of interest.

For nodes in the interior (i.e., no solid surfaces), the flow resistances are set to zero. For other nodes, the flow resistances are governed by a friction length and a hydraulic diameter, Dh. For nodes along the shell interior, the friction length is taken to be the distance (measured along the surface) from the center of the two cells connected by the flow junction. The value of Dh specified is based upon the surface area of the shell included in the node. A description is not available but it is thought that Dh would be calculated as for a duct of noncircular cross section; i.e., Dh = 4Ax/p, where Ax is the flow cross section for the node and p is the length of shell surface within the node (measured perpendicularly to the direction of flow along the surface). This definition of Dh yields a well-defined result when applied to an actual duct bounded by solid surfaces. However, in the present instance, the only "real" node boundary is the shell inner surface; the opposing node boundary is a virtual boundary separating the wall node from the adjacent open-volume node, and the location of this boundary is essentially arbitrary.

The value of Dh, and hence the flow resistance, would therefore appear to depend upon the thickness of the node, y, measured perpendicularly to the shell surface (Dh 4 y, for simple node shapes). Current WGOTHIC practice is to use thinner nodes along the walls, but the node th[illegible] is still probably greater than the turbulent convective boundary layer thickness. In any case, it is not clear that the correct thickness is being used to cap[illegible] "true" velocities along the wall. Even if this could be demonstrated, there would remain the question of whether it is appropriate to use a velocity [illegible]en by global free convection effects in a local forced convection calculation.

It is also necessary to assume a value of the friction factor in applying this approach. WEC has indicated that the code calculated this value; it is not an input. This should be described in the GOTHIC technical reference and has not been changed in WGOTHIC. The closest approach to a description found in Appendix A of WCAP-13246 is that, for annular flow (liquid film on a tube or pipe wall), fl = 0.005(1 + 75 l), where l is the liquid volume fraction, which would presumably be very small for this case. No definition of fl was found but, from the usage, it appears to be equal to (1/4)[P/(v2/2)], which means it would be equal to 1/4 the numerical value of the friction factor used in the Darcy equation, P=f(L/D) v2/2. Given this definition, the friction factor in the limit l = 0 is equal to what was assumed in the CONTAIN calculation of free convection from a plate.

The vertical component of the velocity in either a lumped parameter or subdivided volume is determined from Equation 8.16 on page 8-5 of EPRI TR-1030503-V1, or page A-107 of WCAP-13246. It appears that a factor of two may be missing from this equation: Consider a cell where there are two vertical junctions, one on top of the volume and one on the bottom, if there exists equal flow in and out of the cell then the equation appears to double count this flow. WEC needs to examine this description of the flow velocity model and, if the model as described is in error, WEC needs to determine whether the error actually exists in the code itself.

480.290 A detailed description needs to be provided showing how intercell flow resistances are calculated for cells in an open volume. The LST model could serve as an example.

480.291 Does the value of the flow resistance for cells along the shell interior depend upon the thickness of the node measured perpendicularly to the shell surface?

480.292 If the flow resistance is dependent on an arbitrary cell thickness, does this imply that the velocities, and hence the heat transfer coefficients, calculated in cells along the shell interior are dependent on the cell thickness?

480.293 Is there a missing factor of two in the equation for the vertical component of the velocity (Equation 8.16 on page 8-5 of EPRI TR-1030503-V1, or page A-107 of WCAP-13246)? Do these equations properly represent what is actually used in the code?

480.294 Is the flow resistance along the shell interior surface given by Eqs. (7.29) and (7.31) of Appendix A of WCAP-13246? If so, how is Dh defined? If these are not the governing equations, how is the flow resistance defined?

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2486	NRR/SCSB	21	RAI-OI		07/30/96	Closed	Action XN	NSD-NRC-96-4751

Enr

(WGOTHIC MODELS AND PHENOMENA)POTENTIAL FOR A FUNDAMENTAL INCONSISTENCY IN HEAT TRANSFER MODELING
The concept of using the buoyancy-driven flows calculated by WGOTHIC in a forced flow correlation may result in a fundamental inconsistency, as may be seen by considering the following:

Suppose that the WGOTHIC approach were used to model heat transfer from an open infinite volume of gas, with zero free-stream velocity, to a vertical free plate. The applicable WGOTHIC correlation should be the McAdams free convection correlation. However, suppose that the problem were to be nodalized as is the vertical portion of the AP600 shell interior (or the LST wall) in the WGOTHIC analyses, with nodes whose linear dimensions are small compared with the plate length but large compared with the turbulent free convection boundary layer thickness. Let all the gas initially be at rest, with the wall temperature maintained at a value lower than the gas temperature. As the wall cools the adjacent nodes, WGOTHIC would be expected to calculate that a downward velocity along the wall develops, due to the negative buoyancy of the cooler gas in these nodes. WGOTHIC would interpret this velocity as a free stream velocity, which it would use in the forced flow correlation; it would also continue to use the McAdams correlation to evaluate a natural convection component which would be combined with the forced flow component according to the WGOTHIC mixed convection model. However, in reality, there is no forced flow and no free-stream flow velocity; the only flow in the problem is the flow within the turbulent free convection boundary layer whose effects are already taken into account by the McAdams free convection correlation. In this problem, any contribution that WGOTHIC might calculate from forced flow would be spurious.

It is also doubtful that even the older WGOTHIC treatments were valid if the user-specified the forced flow option, rather than the free-convection option. Page 102 of WCAP-13246 specifies the forced flow option is preferred for the shell interior in LST analyses with external cooling, and it seems likely that this option could have been used in AP600 analyses.

In the more complex situation of an enclosure such as the AP600 containment, global circulation (i.e., flow outside the wall boundary layer) may actually exist as the result of the combined effects of wall cooling and the entering steam plume. However, there is no reason to expect that the spurious forced flow effect in the free plate problem would go away as a result of the complexities of the real AP600 containment analysis. It is possible that the spurious effects would be small compared with the forced flow velocities that WGOTHIC calculates and that the latter correspond to an actual free-stream velocity for which a forced flow correlation is appropriate. However, WEC has not shown this to be true nor has any similar evaluation been found in documentation available to the staff.

Even if the spurious forced flow effect discussed here can be shown to be negligible, it would remain to be shown that the forced flow velocities calculated by WGOTHIC are correct in the sense that it is appropriate to use them in the forced flow correlation.

Have Ans

480.295 It can be argued that the use of a free convective velocity in a forced flow correlation can leads to a significant spurious enhancement of heat transfer on the shell interior. Given this, explain why the WGOTHIC approach and results are valid for a free convection problem?

480.296 Given that the flows in the LST and AP600 are considerably more complex than in a simple free convective problem, can WEC show that any spurious enhancement to heat transfer caused by the use of a free convective velocity in a forced flow correlation is small?

480.297 In which LST/AP600 analyses was the forced flow option specified? What option was specified for the WGOTHIC 1.0 calculations cited in the model and margin assessment report (PCS-GSR-001)?

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

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2487	NRR/SCSB	21.	RAI-OI		07/19/96	Action W	Action W	NSD-NRC-96-4751

(WGOTHIC MODELS AND PHENOMENA)SENSITIVITY TO NODALIZATION IN THE LUMPED PARAMETER MODE (LPM)
The preceding discussions provide examples of the need for Westinghouse to examine sensitivity to nodalization, even in the LPM calculations. This includes sensitivity to the practice of defining relatively thin nodes in the volume adjacent to the shell inside surface (e.g., 0.25 ft for the shell inside surface versus 2.2 ft for the bulk interior, in the LST LPM analysis). At the November WGOTHIC review meeting, WEC indicated that their intention for the LST was to adjust the nodalization scheme for cells adjacent to the interior of the shell until the predicted velocities matched the experimentally measured velocities. The LST nodalization scheme would then be scaled directly to create the WGOTHIC AP600 input deck. However, it is not clear that a nodalization scheme developed to generate velocities that match the LST velocities would necessarily predict the correct velocities in the AP600. If nothing else, it would seem that scaling distortions and different initial and boundary conditions would ensure that LST velocities could not be scaled directly to the AP600. Furthermore, if the velocities in the AP600 are functions of the nodalization scheme, there is no way to validate those velocities in the plant calculations.

Numerical simulations with CONTAIN for the free plate problem (described above) indicate that the magnitude of the spurious heat transfer enhancement can depend upon the nodalization used. The magnitude of this effect depends upon how flow resistances along the wall are assumed to depend upon the node thickness.

480.298 WEC needs to examine the sensitivity of WGOTHIC results to the nodalization scheme, particularly for the cells adjacent to the shell interior.

480.299 Does WEC intend to adjust the thickness of cells adjacent to the shell interior until the predicted velocities match the experimentally measured velocities?

480.300 Will the nodalization scheme used for the WGOTHIC AP600 input deck be similar to a scaled-up version of the LST nodalization scheme?

480.301 Can a nodalization scheme developed to generate velocities that match the LST velocities predict the correct velocities in the AP600?

480.302 If the velocities in the AP600 model are functions of the nodalization scheme, how will those velocities be validated in the plant calculations?

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

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2488	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	Action	NSD-NRC-96-4751

(WOOTHIC MODELS AND PHENOMENA)STRATIFICATION

The model and margin assessment report (PCS-GSR-001), the AP600 scaling analysis document (D. R. Spencer, "Scaling Analysis for the AP600 Passive Containment Cooling System," WCAP-14190, Westinghouse Electric Corp., October, 1994), and other Westinghouse presentations generally postulate that the well-mixed containment assumption will be conservative (i.e., that any effects of stratification will reduce containment pressures). In support of this belief, the model and margin assessment report (PCS-GSR-001) presents free and forced convective mass transfer coefficients illustrating the well-known increase in steam condensation rates with increasing steam mole fraction. Because stratification is expected to increase steam concentrations above the operating deck, where the PCS surfaces are, it is assumed that stratification will increase cooling efficiency. However, this oversimplifies the actual situation because stratification can have a number of effects, and not all of these will increase PCS efficiency. For example:

1. The argument just cited implicitly presumes an above-deck/below-deck dichotomy, with a well-mixed atmosphere above the deck; however, some LST data indicate that there is some stratification above the deck and Froude number scaling indicates that the tendency toward stratification should be greater in the AP600. Above-deck stratification tends to reduce the PCS area over which heat transfer is fully effective. While this effect probably cannot be large enough on the shell interior to defeat the enhanced condensation effect of the higher steam
concentrations, the reduced effective area will also affect the heat transfer from the shell exterior. If the latter is limiting to the total heat transfer, the net effect of stratification could be reduced heat transfer. Under these conditions, assuming a well-mixed containment could be nonconservative rather than conservative. CONTAIN calculations have been performed that illustrate this potential for nonconservatism, albeit for a very nonprototypic problem.

2. On the other hand, stratification could mean that, for a given pressure, the dome is hotter than it would be for a well-mixed containment (this would necessarily be true if the atmosphere were saturated everywhere). Since evaporation rates are a steep function of temperature, this effect could enhance heat removal from the dome exterior. The well-mixed calculation would neglect this effect, which would tend to make the calculation conservative.

3. Stratification could reduce steam concentrations below the operating deck where much of the containment internal heat sink capacity is located. Thus, stratification could reduce the effectiveness of these heat sinks, perhaps significantly. While the resulting effects may not be important for steady-state analysis, they could be very important for transients, including the calculation of the peak pressure reached following core reflood.

It is evident that there are a number of effects, some tending to make the well-mixed assumption conservative and some tending to make it nonconservative. Hence no blanket conclusions are likely to be possible as to whether the well-mixed assumption will yield conservative results. The concern must be considered for the specific scenarios of interest.

With the exception of the third effect enumerated above, the importance of the various effects of stratification may be reduced by the fact that the dominant factor controlling heat rejection from the containment is the latent heat of the external film evaporation. During the critical time period at which the pressure transient following reflood is turned around, all of the water applied to the shell is being evaporated. Increases in the PCS heat and mass transfer processes cannot increase this component of the heat rejection, and decreases in these processes will not reduce this component unless the decreases are sufficient that all the water is no longer being evaporated, something that is thought to be unlikely. Note that the LST experiments are quite nonprototypic in this regard, in that the amounts of water applied to the shell substantially exceeded evaporation rates, and the effect of water subcooling is much more important than in the AP600.

For the third item noted above (reduced internal heat sink efficiency), this insensitivity argument does not apply. Reduced heat uptake by the internal heat sinks necessarily increases the amount of heat that must be rejected by the PCS in order to turn the pressure transient around. Furthermore, the very fact that the dominant external heat transfer process (water evaporation) is fixed independently of the containment temperature could mean that a relatively large increase in containment temperature (and hence the pressure) might be needed before the other processes involved could increase total PCS heat rejection sufficiently to compensate for impaired internal heat sink efficiency.

The scaling analysis in WCAP-14190 provides additional insight into the potential importance of the internal heat sinks. The maximum AP600 pressure is calculated to be at about 1000 s. The -group for the internal heat sinks at 1000 s is 0.31 while the -group for the external evaporation at 1000 s is 0.382; thus, the internal heat sinks are almost as important at this time as is the evaporation and both processes are more important than any others. Furthermore, the internal heat sink -group is greater than the shell evaporation group at times less than 1000 s. Hence, the internal heat sinks may play an important role in the containment response up to and including the time of the peak pressure. Anything that could defeat this role could have important implications. The LST experiments cannot in themselves resolve this issue for several reasons: (1) it is primarily important for transients and the LST experiments did not simulate the reflood transient closely; (2) the internal heat sink capacity in LST was underscaled relative to AP600; and (3) the AP600 is expected to be more subject to stratification than the LST facility for some accident conditions.

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The current WEC arguments need to be extended to show that either the potentially non-conservative effects of neglecting stratification are minor, or else appropriately designed sensitivity studies to bound stratification effects should be performed.

HAVE ANS

480.303 WEC has stated that a well-mixed containment assumption is conservative. However, some of the effects of stratification may be non-conservative, making it difficult to support a blanket claim that a well-mixed atmosphere will yield conservative results. WEC needs to identify the potentially non-conservative effects of stratification and demonstrate that they do not compromise the case for design certification.

480.304 Does WEC agree that some LST data indicate that there is some stratification above the deck and Froude number scaling indicates that the tendency toward stratification could be greater in the AP600?

480.305 The effects of stratification in the LST experiments are quite nonprototypic in that the amounts of water applied to the shell substantially exceeded evaporation rates, and the effect of water subcooling was much more important than in the AP600. These issues need to be addressed as to their impact on the AP600 analyses.

480.306 The WEC scaling analysis indicates that internal heat sinks are almost as important in determining the peak pressure as is evaporation, and both processes are more important than any others up to the time of peak pressure. As a result, the effect of stratification in reducing the effectiveness of internal heat sinks is potentially important and needs to be addressed.

480.307 The LST experiments cannot in themselves resolve the issue of stratification reducing the effectiveness of internal heat sinks because the effect is primarily important for transients and the LST experiments did not closely simulate the reflood transient. In addition, the internal heat sink capacity in LST was underscaled relative to AP600, and the AP600 is expected to be more subject to stratification than the LST facility for some accident conditions. The effect of these issues on scaling LST results to the AP600 needs to be addressed.

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2489	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	Action XN	NSD-NRC-96-4751

(WGOTHIC MODELS AND PHENOMENA)THE MSLB ACCIDENT SCENARIO
Much of the analysis effort has emphasized the double-ended cold-leg guillotine (DECLG) accident, and the MSLB accident merits equal attention. Margins claimed for the MSLB using WGOTHIC 1.0 are actually smaller than those claimed for the DECLG. Other analyses, including some highly preliminary CONTAIN results, also imply very small margins for the MSLB.

The difference between the WGOTHIC 1.2 and WGOTHIC 1.0 results for the MSLB that were noted in the model and margin assessment report (PCS-GSR-001) suggest that the mixed/forced convection issue could be especially important for MSLB. (Results presented indicate that the net effect of these changes is a significant increase in the calculated margin, e.g., from 12.2% to 18.9% of design pressure for the DECLG LOCA and from 8.4% to 23.6% for the MSLB at full power using SAR conservative initial/boundary conditions in all cases.) Due to steam jets impinging on structure surfaces, it is to be expected that a forced (or mixed) convection treatment actually will be the most appropriate model to use for at least some times and locations during a MSLB. However, WEC needs to explore sensitivity to forced flow velocities used in the calculation, and to validate the values used in calculations intended to support design certification. In addition, there may be locations for which the difficulties with the forced/mixed convection treatment that were discussed previously apply to MSLB also.

Stratification needs to be addressed for the MSLB as well as for the DECLG. The steam source is at a higher elevation in MSLB than in the DECLG, which could favor stratification. In addition, arguments given by WEC (D. R. Spencer, "Scaling Analysis for the AP600 Passive Containment Cooling System," WCAP-14190, Westinghouse Electric Corp., October, 1994) as to why mixing can be expected in the AP600 are based upon a steam source location in the steam generator compartment and would not apply to the MSLB, even if these arguments are accepted for the DECLG. However, steam sources during the MSLB may be strong enough to result in turbulent mixing of the containment atmosphere, precluding stratification. WEC needs to provide more analyses of the potential for stratification in the MSLB.

480.308 What analyses and sensitivity studies has WEC performed (or is planning to perform) for the main steam line break (MSLB) accident scenario?

480.309 For MSLB, how important are the mixed/forced convection issues discussed previously?

480.310 What are the flow velocities assumed at various heat sink locations within the containment for the MSLB analyses?

480.311 For the MSLB, what is the validation basis for the velocities calculated by WGOTHIC for use in the correlations for forced and/or mixed convection?

480.312 What is the potential for stratification to occur in the MSLB?

480.313 If stratification does occur in the MSLB, what are the implications for the maximum containment pressure that results?

HAVE ANS

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Date
2490	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	Action N	
2491	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	Action N	NSD-NRC-96-4751

Item 2490

(WGOTHIC MODELS AND PHENOMENA)EFFECT OF EXTRA FLOW PATH
At the November 1994 meeting, WEC refereed to a WGOTHIC calculation run in the finite difference mode for Test 212.1(A) in which a flow path is added to
connect the steam generator compartment to the dead-ended compartment. (No
such path exists in the actual LST configuration, but analogous paths do exist
in the AP600.) Considerably more mixing between the above-deck and below-deck volumes results when the flow path is present, as might be expected. However, the steady-state pressure is increased significantly, by about 3 psi, which is almost 30% of the base case gauge pressure (11 psig; at the November 1994 meeting, WEC reported this increase as being only 13%, but this appears to be relative to the absolute pressure and is a little misleading.)

No explanation is given for this rather substantial difference. One question that arises is whether similar results would be obtained if the extra flow path were to be added to the lumped parameter mode calculation. This behavior and its implications for the AP600 analyses needs to be explained, for both the finite difference mode and the lumped parameter mode, as appropriate.

480.314 In the finite difference WGOTHIC calculation for Test 212.1(A) a flow path is added to connect the steam generator compartment to the dead-ended compartment. Why does the steady-state pressure increase by almost 30% of the base case gauge pressure?

480.315 Is the pressure increase noted above an artifact of the finite difference approach? Does the same effect occur with WGOTHIC in the LPM?

480.316 What are the implications of this behavior for the AP600 analyses?

Closed - Response provided via Westinghouse letter NTD-NRC-95-4602, dated 11/30/95

Item 2491

(WGOTHIC MODELS AND PHENOMENA)APPLICABILITY OF THE SCALING ANALYSIS
Based upon results presented to date the WGOTHIC code does tend to yield conservative results in the LST analyses. Given an adequate methodology for scaling the results of the LST experiments to the AP600, it may be possible to build an acceptable case for the conservatism of the WGOTHIC calculations for the AP600. However, the effects of stratification and the mixed/forced convection treatment are potentially very important, but the scaling analysis is based upon a well-mixed containment and includes only natural convection after the initial blowdown period. Hence, the scaling analysis does not permit inferences to be drawn from the LST results as to what the effects of the stratification and/or mixed convection phenomena might be in the AP600.

Only the more detailed WGOTHIC model seems to be capable of analyzing these effects. It will therefore be necessary to assess or bound the uncertainties these effects produce in the WGOTHIC results.

480.317 The WEC scaling analysis is based upon a well-mixed containment and includes only natural convection. As a result, the scaling analysis does not permit inferences from the LST results to be applied to the effects of stratification and/or mixed convection phenomena in the AP600. This issue needs to be addressed.

480.318 If LST results concerning the effects of stratification and/or mixed convection phenomena are not applicable to the AP600, WEC needs to assess or bound the uncertainties these effects produce in the WGOTHIC results is needed. How will WEC address these uncertainties for the AP600 analyses?

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2492	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

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(WGOTHIC MODELS AND PHENOMENA)ENTRANCE EFFECTS

In "Experimental Basis for the Heat Transfer Correlations Selected for Modeling Heat transfer from the AP600 Containment Vessel," PCS-GSR-004, Westinghouse Electric Corp., August 31, 1994, WEC describes a formalism for treating enhanced heat transfer at the entrance of the external annulus, but insufficient detail is given to permit inference as to the values of the governing input parameters that would be specified for either the LST or the AP600 analyses. It is not clear that the treatment is based upon entrance geometries sufficiently similar to the AP600 geometry (two right-angle bends at the base of the downcomer adjoining the base of the riser) to permit applicability to the AP600 analysis.

Entrance effects in the external annulus are discussed on p 76 where it is argued that they are small (4% for LST, 2% for AP600) and thus introduce no more than a 2% distortion in LST vs AP600 comparisons. Only effects enhancing heat transfer are considered; possible reductions (e.g., due to a laminar region) are not considered. It would be desirable to present sensitivity calculations in order to illustrate the effect of the entrance effects being assumed in the more recent WEC modeling efforts. WEC needs to give a better justification for the treatment to take credit for these effects.

WEC acknowledges in PCS-GSR-004 that there may be a region near the entrance for which the flow is laminar rather than turbulent as assumed in the WGOTHIC model. Neglecting the laminar regime is stated to be conservative for the shell inner surface and nonconservative for the outer surface. However, WEC asserts that the effect in either direction is minor and that it may be neglected. It is not clear, however, that neglecting this effect in the exterior channel is really consistent with taking credit for the enhanced entrance heat transfer, since the enhancement factors assumed are applied to the Colburn heat transfer values, which are for turbulent flow, while it is presumably in the entrance region that any laminar region exists.

A preliminary analysis of the LST experimental configuration, in which a much more detailed hydrodynamic model was used, is of interest here. In this simulation, there is a high local Nusselt number in the immediate entrance region, which rapidly decreases to a low value in a laminar region whose extent is considerably greater than the region of enhanced Nu at the entrance; Nu eventually increases substantially as the result of the onset of turbulence. It is not at all clear that the net effect integrated over the channel length is enhancement relative to what would be obtained by simply using the Colburn turbulent correlation with no entrance effects throughout, and it seems quite likely that the treatment allowing for enhancement at the entrance while neglecting the laminar region may be nonconservative. However, this preliminary calculation is for the LST and it may be that neither the entrance effect nor the laminar region are as important for the AP600.

480.319 What values of the governing input parameters for treating entrance effects would be specified for the LST and AP600 analyses, and what justification is available for the values chosen?

480.320 The data base cited for entrance effects involves a geometry rather different from the AP600 geometry; how is applicability to the AP600 geometry established?

480.321 What sensitivity studies have been performed to demonstrate the magnitude of the entrance effect?

480.322 Since the enhancement factors are applied to the Colburn heat transfer values for turbulent flow, while a laminar region may exist in the entrance region, how is neglecting the effect of a laminar region in the exterior channel consistent with taking credit for enhanced entrance heat transfer?

480.323 Based on the preliminary results of a detailed hydrodynamic model it is likely that a treatment allowing for enhancement at the entrance while neglecting the laminar region may be nonconservative. This issue needs to be addressed by WEC.

480.324 Are entrance effects and the laminar region as important for the AP600 as they are in the LSTs?

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2493	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	Action ~~A~~ N		

(WGOTHIC MODELS AND PHENOMENA)SHELL WETTING
The peak pressure following reflood appears to be relatively insensitive to incomplete wetting of the shell (striping, etc). Concerns have been raised, however, that the "full-scale" scale wetting tests actually are not full height representations of the vertical part of the PCS, and that these tests were performed for a cold surface; only reduced-scale tests are available for heated surfaces.

What may also be important is how WEC plans to demonstrate that the shell will exhibit adequate wetting characteristics after 10, 20, or 40 years of service. For example, the channel will not be closed to circulation of ambient air through it, which raises the possibility that a variety of environmental contaminates may deposit on shell surfaces over the years, changing the wetting characteristics. In the model and margin assessment report (PCS-GSR-001), WEC does note that the containment is designed to allow inspection of heat transfer surfaces to "verify adequate heat transfer capability" but it is not explained how this will actually be demonstrated or what will be done of it is found wettability has been degraded.

Sensitivity studies to determine the minimum extent of wetting required to turn the transient around might be useful in this context.

480.325 No full-scale wetting tests for a heated surface have been performed; is this limitation of the data base significant?

480.326 How will WEC demonstrate that there will be acceptable wettability of the shell after many years of service?

480.327 If, after years of service, shell wettability is found to be degraded, are there any means by which acceptable wettability can be recovered?

480.328 Have any sensitivity studies been performed to determine the minimum extent of wetting required to turn around the pressure transient? If none are available, they should be performed.

Closed - Response provided via Westinghouse letter NTD-NRC-95-4602, dated 11/30/95

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2494	NRR/SCSB	21	RAI-OI		06/03/96	Action W	Action W		

(WGOTHIC MODELS AND PHENOMENA)DOWNCOMER
There is no downcomer in the LST experiments. It needs to be established that the effects of the downcomer are either negligible or are being modeled adequately. While downcomer phenomena are not likely to be as important as phenomena in the riser, there is no quantitative information available. The margin claimed (between calculated values and the design value) is only of the order of 10% of the total pressure in some cases, and therefore large effects are not required in order to be of potential concern.

480.329 Can WEC demonstrate that the effects of a downcomer are adequately modeled?

480.330 Does WEC consider that the effects of the downcomer are negligible, and if so how has this been demonstrated? How can the effects of a downcomer be quantified without experimental validation?

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5495	NRR/SCSB	21.	RAI-OI		07/31/96	Closed	Action W	NSD-NRC-96-4780

(WGOTHIC MODELS AND PHENOMENA)FINITE DIFFERENCE (FD) CALCULATIONS

An assessment of the finite difference methods employed in the WGOTHIC code, including an examination of the material Westinghouse has provided in presentations concerning their use of WGOTHIC in the finite difference mode, has been completed. The numerical solution scheme used in WGOTHIC's finite difference mode, first order upwind spatial differencing for the advection terms, is a concern. This differencing technique, although widely used in the past, is known to produce significant artificial (numerical) viscosity in advection dominated problems. Unless a very fine grid in the solution domain is used, the artificial viscosity can dominate the real laminar and turbulent viscosity in the simulation. Similarly, first-order differencing of the advection terms in the energy equation can cause unrealistically high thermal conductivity, leading to unreasonably high heat transfer rates between cells. In addition, the extra mixing caused by the first order method reduces the ability of the code to predict stratification.

Leaving aside more fundamental concerns about the underlying numerical solution scheme in WGOTHIC, the spatial grid resolution used by Westinghouse in the AP600 finite difference calculations appears to be inadequate to give confidence in the predictions. Accurate 3-D finite difference solutions typically require on the order of 50,000 to 100,000 grid points, while the Westinghouse AP600 model employs on the order of 500 grid points. To demonstrate the adequacy of their nodalization scheme, Westinghouse needs to perform a grid resolution study to assess errors in the solution due to nodalization.

WEC may argue that since the finite difference results give reasonable comparisons with experimental pressure and temperature measurements, the finite difference solutions must also be reasonably accurate. Unfortunately, when numerical results are produced from only one grid a good comparison with experimental data only demonstrates qualitative validation, not quantitative validation. Any numerical solution, produced on any size grid, contains a combination of physical modeling errors and numerical solution errors. Only when a grid resolution study is conducted can an indication of the grid errors be estimated, allowing physical modeling accuracy to be evaluated.

Westinghouse needs to clarify the the use of the finite difference WGOTHIC calculations in the AP600 design certification. If they are to be used for the LST analyses, it will be necessary for WEC to both demonstrate their validity for LST (including demonstrating grid convergence) and establish the "bridge" to the AP600 validity.

480.331 To demonstrate the adequacy of the nodalization scheme for WGOTHIC in the finite difference mode, WEC needs to perform a grid resolution study to assess errors in the solution due to nodalization.

480.332 Is WEC aware that demonstrating convergence of first order upwind methods is considered to be very difficult, to the point, for example, that the ASME Journal of Fluids Engineering will not accept papers that utilize this numerical scheme? How will WEC demonstrate convergence for WGOTHIC analyses?

480.333 What is the role of finite difference calculations in the AP600 certification process?

480.334 Has WEC assessed the impact of the first order method on the ability of the code to predict stratification?

Closed - Response to 480.331 - 480.333 provided by NSD-NRC-96-4696. Response to 480.334 provided in Westinghouse letter NSD-NRC-96-4780, dated July 26, 1996.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2496	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(WGOTHIC MODELS AND PHENOMENA)DIFFERENCES BETWEEN FINITE DIFFERENCE (FD) AND LUMPED PARAMETER (LPM) MODES

There has been some discussion as to just how different the WGOTHIC finite difference and LPM modes actually are, other than the fact that mesh sizes are smaller in the FD mode calculations. In particular, it is uncertain as to whether there might be a momentum advection term in the flow equations solved by WGOTHIC even in the LPM mode, in which case WGOTHIC LPM modeling could be significantly different from that of other LPM codes, including CONTAIN and MELCOR. When this topic was raised at the November 1994 WGOTHIC review meeting, WEC indicated that the code did indeed capture momentum advection in the LPM. However, this is not the case according to a paper by R. P. Ofstun, J. Woodcock, and D. L. Paulsen ("Westinghouse-GOTHIC Modeling of NUPEC's Hydrogen Mixing and Distribution Test M-4-3," Proc. 3rd Int. Conf. on Containment Design, Toronto, Canada, October 19-21, 1994) which, in discussing LPM calculations in connection with WGOTHIC, states:

A lumped parameter solution conserves mass and energy within a control volume. Mass, energy, and momentum are exchanged between volumes through flowpaths which connect them to one another. Momentum in the flowpaths connecting lumped parameter volumes is a scaler, not a vector quantity. Perfect mixing is assumed for each component phase within a lumped parameter control volume. Momentum of the incoming components is dissipated within a lumped parameter control volume. Therefore, to calculate natural circulation flow within a given region using lumped parameter volumes requires a specially designed set of volumes and flowpaths. The creation of this noding structure may also require an a-priori knowledge of the expected flow direction and magnitude; something which in general, is not known ahead of time. (Emphasis supplied.)

This description not only indicates that the momentum advection term is not included but also seems to show awareness of some of the concerns that have been expressed about nodalizing open volumes in LPM codes. To date, however, the WEC AP600 presentations do not seems to show much consideration of these problems, especially in connection with the flow velocities to be used in the mixed convection correlations applied to the shell inner surface. In addition, the acknowledged fact that the LPM calculation overpredicts mixing provides another reason to question the LPM velocity calculations, since it is these velocities that govern the calculated mixing rates.

Further examination of the WGOTHIC documentation also seems to indicate that it is not possible for WGOTHIC to transfer momentum through a string of lumped parameter cells. In the LPM, cells only have mass and energy conservation equations (page 3-7 of EPRI TR-1030503-V1, or page A-37 of WCAP-13246). The junctions that connect the cells may include momentum advection terms (page 4-1 of EPRI TR-1030503-V1, or page A-39 of WCAP-13246). Thus one might envision the code structure as a staggered grid. However, the advection terms are only weakly transported into the connecting momentum cells, unless the connecting cells are part of a subdivided volume. The manuals state that the momentum advection terms should not be included "for flow paths connecting two lumped parameter volumes or a lumped parameter volume to a subdivided volume" (page 8-7 of EPRI TR-1030503-V2).

480.335 In the November 1994 meeting, WEC stated that WGOTHIC captures momentum advection in the lumped parameter mode (LPM). Based on an examination of the WGOTHIC documentation, the code does not capture momentum advection terms in the LPM. Definitive clarification of this issue is required.

480.336 The WGOTHIC documentation states that in the LPM, the creation of the noding structure may also require an a-priori knowledge of the expected flow direction and magnitude; something which in general, is not known ahead of time. This does not appear to be consistent with WEC's attempt to calculate velocities along the inner shell surface for use in a mixed convective correlation, and needs to be addressed.

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2497	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	Action N		

(WCAP-13246)
The following questions relate to "Westinghouse-GOTHIC: A Computer Code for Analyses of Thermal Hydraulic Transients For Nuclear Plant Containments and Auxiliary Buildings," WCAP-13246, Westinghouse Electric Corp., July 1992.

In an EPRI document, "GOTHIC Design Review Final Report," RA-93-10, prepared under EPRI Contract RP4444, September 30, 1993, numerous deficiencies in the documentation provided in Appendix A of WCAP-13246 were identified. In addition, coding errors were identified that may also be in the GOTHIC version WEC used to develop WGOTHIC. It appears that the changes required as a result of the design review report could impact the validation and verification data base.

480.337 How will WEC address the documentation errors in WCAP-13246, Appendix A? Appendix A does not adequate describe some of the GOTHIC code features. A schedule needs to be developed for submitted a final, complete code description.

480.338 How will WEC address the coding errors in the base version of GOTHIC (version 3.4) that was used to develop WGOTHIC?

480.339 How will WEC address the validation and verification data base for those experiments that where analyzed with the GOTHIC version found to contain errors? Where there any instances when a fix to the GOTHIC portion of WGOTHIC resulted in different results when compared to the previously performed analyses?

The staff cannot complete the review of the WGOTHIC computer program until these issues are resolved and the Version 1.2 documentation is submitted. However, the following questions related to WCAP-13246 also need to be addressed.

Closed - Response provided via Westinghouse letter NTD-NRC-95-4602, dated 11/30/95

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2498	NRR SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(WCAP-13246)TURBULENT BOUNDARY LAYER THICKNESS
On p. 7, Eq. (2.1) is given for the turbulent (momentum) boundary layer thickness:

delta(x) = 0.37(x)/(REx**0.2)

while p. 55 infers a turbulent boundary layer thickness at the base of the shell interior in LST of 0.33" or 0.0084 m. The base of the shell corresponds to x 3 m, in which case the above equation gives a boundary layer thickness of about 0.08 m, for the stated conditions; i.e., an order of magnitude greater than the 0.33" estimate. The text on p 8 also notes that Eq. (2.1) gives a thickness of 2.3 inches (0.063 m) for x=5 ft under LST conditions. If the boundary layer thickness is a significant parameter for the actual calculations, this apparent discrepancy needs to be resolved. For example, if flow velocities calculated for the nodes adjacent to the shell interior are to be used as free-stream velocities in a forced flow correlation, the boundary layer thickness should be much less than the wall node thickness. However, the boundary layer thickness given by Eq. (4) is about equal to the wall node thickness, for the LST analysis.

480.340 There is an apparent discrepancy between Eq. 2.1 on page 7 and the text on page 8, versus the text on page 55. WEC needs to resolve this apparent discrepancy.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2499	NRR/SCSB	21.	RAI-OI		07/31/96	~~Closed~~ ACTION W	Action W	NSD-NRC-96-4780

(WCAP-13246)FOG FORMATION IN THE EXTERNAL ANNULUS
On p. 52, it is noted that fog (i.e., water aerosol) can form in the riser of the annulus. It is stated that some of this water aerosol may collect on the baffle and run down but will re-evaporate before reaching the bottom; why it necessarily re-evaporates is not made clear nor is it clear whether this is an important assumption. The mass of the water present as fog should be taken into account in calculating the gas densities. If not, buoyancy forces driving the flow in the annulus may be overestimated somewhat.

NO — 480.341 Why is water that collects on the baffle assumed to evaporate before reaching the bottom?

YES — 480.342 How does WGOTHIC model fog formation? Is the mass of the water present as fog taken into account in calculating the gas densities? Is its effect upon buoyancy taken into account?

Closed - Response provided in Westinghouse letter NSD-NRC-96-4780, dated July 26, 1996.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2500	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W	

(WCAP-13246)STEAM DIFFUSIVITY IN AIR
The treatment of the diffusivity of steam in air requires clarification. The diffusivity, Dv, is stated on p. 78 to be given by

Dv = 0.892(14.21/P)*(T/460)**1.81

Although the nomenclature list states that T is temperature in degrees F, this equation only makes sense (and only gives reasonable results) if T is in degrees Rankine, in which case it gives values of Dv about 10% larger than those given by the Wilke-Lee modification of the Hirschfelder, Bird, and Spotz (WL-HBS) model, for use when accurate values of binary diffusivities are desired (Ref: R. H. Perry and C. H. Chilton (eds), Chemical Engineers' Handbook, Fifth Edition, McGraw-Hill Book Co., 1973). WEC needs to clarify the equation given for the diffusivity and justify its selection.

480.343 The treatment of the diffusivity of steam in air requires additional clarification based on the differences as compared to the WL-HBS model.

480.344 Should the temperature in the diffusivity equation on page 78 be given in degrees Rankine, rather than degrees F?

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2501	NRR/SCSB	21.	RAI-OI		12/17/95	Closed	~~Action W~~ N	

(WCAP-13246)MODELING OF SUBCOOLING
This version of WGOTHIC did not have a model for subcooling of the water applied to the shell. The description and motivation (p 100) of the approach used to simulate subcooling was not very clear. However, if this approach, and the results obtained using it, are now considered obsolete, clarification is not necessary. What is required is a description of how subcooling is being modeled in the current code.

480.345 Where is a description of how subcooling is modeled in the current code?

Closed - Response provided via Westinghouse letter NTD-NRC-95-4602, dated 11/30/95

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2302	NRR/SCSB	21.	RAI-OI		08/08/96	Action W	Action W	NSD-NRC-96-4751

(PCS-GSR-001)
The following questions relate to "AP600 Passive Containment Cooling System Design Basis Analysis Model and Margin Assessment," PCS-GSR-001, Westinghouse Electric Corp., June 30, 1994.

LST COMPARISONS
The information given consists of comparison of peak pressures and some axial temperature distributions for four baseline LST tests (R7, R11, R12, R9). WGOTHIC pressure results are given for both the old version (Version 1.0) and the new version (Version 1.2). Insufficient discussion is given concerning these results to permit many conclusions to be drawn as to their significance, either in terms of the comparisons with experiment or comparisons between the two code versions. For example, Version 1.2 gives somewhat higher pressures than does Version 1.0 for three of the four experiments. Note that the acknowledged model changes are such as to eliminate what are claimed to be excess conservatisms in the Version 1.0 results, implying that Version 1.2 would be expected to give lower pressures than 1.0. The AP600 comparisons presented in this document show lower pressures with the new version. Hence the fact that Version 1.2 can give higher pressures than Version 1.0 for these experimental analyses needs to be explained.

In test R9, the calculated pressures are somewhat lower than the experimental values (calc. 6.2 and 8.0 psig for Versions 1.0 and 1.2, respectively; experiment is 8.7 psig). It is unclear why the experimental pressures for this test are so much lower than for R11 (28.1 psig) and R12 (29.0 psig); the test conditions given don't seem to explain such a large difference.

Temperature comparisons show the tendency of WGOTHIC to overpredict mixing (underpredict stratification) even in the baseline tests, which had an open geometry (no operating deck). Except for the failure to predict the lower temperatures at elevations below the operating deck elevation, it is asserted that WGOTHIC predicts the temperatures "very well". Even aside from the poor results at low elevations, some of the calculations differ from the experimental results by 10 K or more. There is no discussion as to what these results mean in terms of the potential accuracy and/or conservatism of WGOTHIC for the AP600.

480.346 Insufficient discussion is given concerning the LST analysis results to permit many conclusions to be drawn as to their significance. A better discussion in terms of the comparisons with experiment or comparisons between the two code versions is needed.

480.347 If the acknowledged model changes eliminate excess conservatisms in the Version 1.0 results, why does Version 1.2 give somewhat higher pressures than Version 1.0 for three of the four experiments?

480.348 In test R9, why are the calculated pressures somewhat lower than the experimental values? What is the significance of this result in connection with claims of unconditional conservatism?

480.349 In test R9, why is the calculated WGOTHIC temperature highest at the lowest elevation?

480.350 Why are the experimental pressures in test R9 (8.7 psig) so much lower than for R11 (28.1 psig) and R12 (29.0 psig), since test conditions don't seem to explain such a large difference?

480.351 What standard of "goodness" is being used to decide what constitutes a "good agreement" between measured and calculated temperatures?

480.352 What do the WGOTHIC results for the LST experiments mean in terms of the potential accuracy and/or conservatism of WGOTHIC for the AP600?

Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96. RAI response provided via Westinghouse letter NSD-NRC-96-4788, dated 8/5/96.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2503	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(PCS-GSR-001)AP600 ANALYSES
On p 24ff, results obtained using Version 1.2 are compared with SAR results, but the reasons for the differences are not well identified; in particular, sensitivity studies illustrating which of the model changes are primarily responsible would be helpful in focusing attention on the more important issues.

In the plots of MSLB results, some of the line types are the same and it is therefore difficult to determine which curve corresponds to which case.

480.353 The reasons for differences between the Version 1.2 and SAR results need to be identified, and the dominant effects need to be highlighted and discussed. What is the relative influence of the various modeling changes made in WGOTHIC on the pressure predictions?

480.354 Has WEC performed any sensitivity studies that demonstrate the importance of various modeling changes?

480.355 The plots of the MSLB results should be clarified.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2504	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(PCS-GSR-004)
The following questions relate to "Experimental Basis for the Heat Transfer Correlations Selected for Modeling Heat transfer from the AP600 Containment Vessel," PCS-GSR-004, Westinghouse Electric Corp., August 31, 1994

HUGOT TESTS
These tests are stated to involve heated parallel plates under assisting mixed convection conditions. Five tests were analyzed. A table summarizing test data includes values of a Grashof number, "Grd" and a Reynolds number, "Red"; it is not clear how these are defined (specifically, it isn't clear what the characteristic length is taken to be: usage generally implies it should be based upon plate spacing or hydraulic diameter Dh but "Grd" doesn't show the expected variation with "L/Dh" assuming L is the same in all tests as is implied in the text). Grd ranges from 2.4x109 to 5.18x109, Red ranges from 1.1x104 to 3.54x104. (AP600 riser values of Red and Grd are stated to range up to 105 and 4x109, respectively.) The ratio of predicted to experimental local values of Nu is plotted against x/d (x and d undefined). The predicted local Nu is considerably too high for the smallest x/d values, suggesting that the entrance effect treatment is inappropriate for the experimental configuration. Outside the entrance region, the predicted/experimental (P/E) ratio averages 1.08 (mild nonconservatism) with moderate variability [standard deviation (SD) of 0.16]; trends as a function of x/d are predicted well for two tests and less well for two tests, with a fifth being intermediate.

480.356 How is the characteristic length defined?

480.357 The predicted local Nu is considerably too high for the smallest x/d values. Does this suggest that the entrance effect treatment is inappropriate for the experimental configuration?

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2505	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(PCS-GSR-004)ECKERT AND DIAGUILA TESTS
These studied assisting and opposing mixed convection in a heated tube, height = 13.5 ft and ID = 23.25"; ten assisted convection cases (no opposed convection cases) were analyzed. Inlet and outlet air pipes and "dense screens" were located at each end; evidently, the ends were not free and probably didn't look much like the AP600 riser entrance either. The potential significance of the "dense screens" is not discussed. GrdPr values range 6.9x109-7.2x1010 (i.e., higher than prototypic), Red ranges 3.6x104-3.77x105 (i.e., prototypic).

P/E ratios average 1.028, SD = 0.272; it is stated that the experimental data show "large, unexplained variations" in the original report and the SD in P/E is therefore not considered excessive. P/E ratios are stated to be 1 for three tests with Red < 105 and to decrease with increasing Red; inspection of the detailed plots suggests this is the dominant trend but other effects may also be involved. The experimental heat transfer coefficients were based upon a measured centerline temperature, not a bulk gas temperature, and this is suggested (without details) as an explanation for the observed trend. Entrance effects are not overpredicted to nearly the degree that was found for the Hugot tests but the difference appears to be in the calculation, not the data.

480.358 What is the potential significance of the "dense screens"?

AP600 Open Item Tracking System Database: Executive Summary

Date: 09/11/96

Selection: [DSER Section] like '21*' And [NRC Branch] like 'NRR/SCSB' Sorted by NRC Branch

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2506	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(PCS-GSR-004) SIEGEL AND NORRIS TESTS

These involved heated parallel vertical plates with a constant wall heat flux, height = 5.833 ft; 8 tests with the test section open to the bottom were analyzed. L/Dh ranged from 3.0 to 24.00, Grd from 6.43x105 to 6.1x108, and Red from 1.65x103 to 1.13x134; thus, both Grd and Red are subprototypic. Convection was treated as assisted mixed convection. P/E values averaged 0.857 with SD = 0.0903. It is stated that predicted Nu matches experimental values fairly well at low L/Dh but increasingly underpredict Nu as L/Dh is increased. It is also stated that four tests performed at constant L/Dh illustrate the effect of progressively increasing the loss coefficient from 1.5 to 35.6 (no information is given as to how this was done); Nu is increasingly underpredicted as flow is reduced.

480.359 It is stated that four tests performed at constant L/Dh illustrate the effect of progressively increasing the loss coefficient from 1.5 to 35.6; how was this done?

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2507	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(PCS-GSR-004)EXPERIMENTAL COMPARISONS (GENERAL)

Experimental comparisons are presented in a way that needs more explanation. All the comparisons are for channel geometry (heated vertical parallel plates or pipe geometry. The comparisons are plots of calculated and experimental local Nu values versus a dimensionless distance, x/d. Neither x nor d are defined but x appears to be distance along the channel and d related to channel width or pipe diameter. The local Nu values increase approximately linearly as a function of x/d and would therefore yield heat transfer coefficients approximately independent of distance if one uses these values in a relation of the form h = kNu/x. This is the expected behavior: except near the entrance, the heat transfer coefficient should be approximately independent of distance down the channel. For channels, however, it is more usual to define the controlling nondimensional numbers in terms of a width or hydraulic diameter (d), and evaluate h from h = kNu/d, thus defined these Nusselt numbers should be independent of x/d, except for entrance effects. In general the presentation seems to imply that this convention is being used in the text when discussing channel geometries; e.g., Reynolds and Grashof numbers are represented as "Red" and "Grd". However, the values of local Nu plotted in the figures would make no sense if they were interpreted in this way (h would increase linearly with distance up the channel if h = kNu/d were to be used). Clarification is needed.

In the presentations of the experimental comparisons, clarification is required as to what correlation is used to obtain the predicted values of Nu (Colburn, flat plat forced flow, etc) in the various cases and what value of the characteristic length is being used to evaluate Re and Gr. Justification for the treatments chosen is also needed because, while all experiments are based upon channel geometry, the L/D values vary over a wide range, with some of the values being too small to permit fully-developed channel flow.

480.360 Clarification of the convention being used in discussing channel geometries is needed.

480.361 Clarification is required as to which correlations (e.g., Colburn versus flat plate) are being used to analyze the various experiments, what values of the characteristic lengths are specified for the analyses, what are the justifications for the values chosen.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2508	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

(PCS-GSR-004) EXPERIMENTAL COMPARISONS (GENERAL)

Comparisons between WGOTHIC and experiment are stated to yield "acceptable results" and the calculated local heat transfer coefficients "demonstrate the proper trends"

480.362 In comparisons between WGOTHIC and experimental results, what criteria were applied in selecting the terms "acceptable", "proper", etc?

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2509	NRR/SCSB	21.	RAI-OI		07/19/96	Action W	Action W	NSD-NRC-96-4751	

Gov

(PCS-GSR-004) EXPERIMENTAL COMPARISONS (GENERAL)
The comparisons offered do show approximate agreement, as expected since the basic Nusselt number formulations employed are standard. However, the report says little as to what inferences may be drawn as to the adequacy of the heat transfer modeling for AP600 analysis. In particular, there is no attempt to apply the results to draw quantitative inferences concerning the conservatism and/or the uncertainties that must be allowed for when applying these correlations to AP600 analysis.

The following specific points are noted:

- Based upon the results presented, there appears to be no basis for claiming conservatism in these correlations; predicted to experimental (P/E) values greater than unity are at least as common as values less than unity.
- Results are consistent with the correlations' being best-estimate (BE) correlations. However, BE analysis is generally acceptable in this context only if it is accompanied by an assessment of the uncertainties.
- All the experimental tests considered involve an approximation to channel geometry but some are characterized by L/D values too small to permit full flow development in the channel.
- In the experiments, the channels (or pipe) are symmetrically heated, while the AP600 channel heating is very asymmetric. Heat transfer coefficients for asymmetrically heated channel surfaces may not be the same as for symmetrically heated channel surfaces.
- Not one of the 23 experiments, for which results are summarized, provides experimental support for the belief that entrance effects significantly enhance local Nu values. In all cases in which significant enhancement was predicted, the prediction is in error. Continued use of the entrance effect enhancement in WGOTHIC analysis requires a considerably stronger defense than any given to date.
- Although the cases analyzed are stated to correspond to assisted mixed convection, there is no consideration as to whether the mixed convection formulation used gives any improvement over what would be obtained assuming either natural or forced convection by itself. It would be instructive to include Nu numbers for both natural and forced convection calculated individually. This would permit conclusions to be drawn as to which process dominates; whether the mixed result is differing significantly from Max(Nufree,Nuforc); and whether the mixed formulation is offering any improvement over Max(Nufree,Nuforc).

480.363 WEC should attempt to apply the results to draw quantitative inferences concerning the conservatism and/or the uncertainties that must be allowed for when applying these correlations to AP600 analysis.

480.364 Based upon the results presented, there is no basis for claiming conservatism in these correlations. Results are consistent with the correlations' being best-estimate (BE) correlations. However, BE analysis is acceptable in this context only if it is accompanied by an assessment of the uncertainties. How will WEC address uncertainties for the AP600 analyses?

480.365 All the experimental tests considered involve an approximation to channel geometry, although some results were obtained for L/D values too low to provide fully-developed channel flow. Will WEC use the comparisons to claim validation for heat transfer modeling in the channel, on the shell interior surface, or both? Justification is required for whatever applications are intended.

480.366 The experiments all involve symmetrically-heated channels (or pipes), while heating of the AP600 channel is quite asymmetric. How large an uncertainty does the asymmetry of the AP600 channel heating introduce into the analysis, when the only validation data are for a symmetrically heated channel?

480.367 The WEC model for entrance effects predicts enhanced heat transfer close to the entrance for a number of the experiments. In every instance, this prediction is in error: not one of the 23 experiments for which results are summarized provides experimental support for the belief that entrance effects significantly enhance local Nu values. How does WEC reconcile this result with the continued use of the entrance effect model in WGOTHIC?

480.368 Does the mixed convection formulation give any improvement over what would be obtained assuming either natural or forced convection by itself? It would be instructive to include Nu numbers for both natural and forced convection calculated individually.

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2510	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

Gvr

(PCS-GSR-006)
The following questions are based on "Experimental Basis for the Mass Transfer Correlations Selected for Modeling Condensation and Evaporation on the AP600 Containment Vessel," PCS-GSR-006, Westinghouse Electric Corp., October 1994.

This document discusses the correlations used for Nusselt numbers and briefly summarizes the heat/mass transfer analogy used to define the Sherwood (Sh) number and the mass transfer coefficient. Comparisons between the code and experimental results are expressed in terms of the ratio of predicted to experimental values of Sh for three different sets of experimental data: the University of Wisconsin Condensation Tests, the Gilliland and Sherwood Evaporation Tests, and the Westinghouse STC Flat Plate Evaporation Tests. Values reported are averages over the test surface. There is no attempt to present comparisons in terms of local values as was done for Nu.

UNIVERSITY OF WISCONSIN (UW) CONDENSATION TESTS

In the tests for which comparisons are given, the experiments involved measuring condensation rates for a steam/air mixture flowing through a channel with a cooled surface in an apparatus that could be tilted in order to study the effect of inclination angle upon condensation rates. When the test section was inclined, the text seems to imply that the steam/air source was at the low end (implying opposed mixed convection); however, published descriptions (see for example, I. K. Huhtiniemi and M. L. Corradini, "Condensation in the Presence of Noncondensible Gases," Nuclear Engineering and Design 141 (1993) 429-446.) of the experiments indicate that the steam air mixture enters at the high end (implying assisted mixed convection).

When the inclination angle is low, it is not clear that either the "assisted" or the "opposed" mixed convection treatment is appropriate.

Results are presented for 59 tests. The average P/E value is 0.968 with SD = 0.203. P/E values are plotted against inclination angle over the range 0-90o, against Red over the range 7x103-2.5x104, and against steam mole fractions (0.12-0.65). Results suggest a tendency for P/E to increase slightly with increasing angle, with increasing Red, and with decreasing steam mole fraction. These trends are weak but, just by visually inspecting the data, they appear to be statistically significant, at least marginally (no statistical significance tests are given in the Huhtiniemi and Corradini paper). These trends suggest a potential for nonconservatism in modeling the exterior channel which, relative to these tests, would be characterized by high inclination angle, high Red, and low steam mole fraction for most of the surface.

480.369 The text implies that the steam-air mixture enters at the low end of the apparatus while it is believed that it enters at the high end. WEC needs to check this and revise the text as appropriate.

480.370 Are the "assisted" versus "opposed" mixed convection classifications appropriate at low inclination angles? What was assumed in analyzing the low-angle experiments?

480.371 The P/E ratios appear to increase with increasing inclination angle, with increasing Red, and with decreasing steam mole fraction; do these trends indicate that there is a potential for nonconservatism in modeling the PCS channel?

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2511	NRR/SCSB	21.	RAI-OI		07/30/96	Closed	~~Action W~~ CLOSED		

Gvr

(PCS-GSR-006) GILLILAND AND SHERWOOD EVAPORATION TESTS
These involved study of evaporation of downward-flowing liquid films on the inside of a vertical tube 1.17 m high and 0.0267 m ID. Liquid and air were at approximately the same temperature (i.e., the tests were approximately isothermal). Temperatures were relatively low, 25-56 oC and vapor mole fractions were therefore low. Under these conditions, buoyancy effects were presumably minimal. Reynolds numbers were 2x103 to 2.5x104, with values under 104 in the majority of cases.

A total of 71 tests were analyzed. The mean P/E value was 0.925 with SD = 0.072. A plot of P/E against Red revealed no evidence of any trend.

~~(No specific question)~~

Closed - No specific question. SHOULD NOT BE IN THIS DATA BASE! — NOT AN RAI

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2512	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W	

(PCS-GSR-006)WESTINGHOUSE STC FLAT PLATE EVAPORATION TESTS
The test section was a vertical heated and wetted flat steel plate 6 feet long. An acrylic cover provided a channel for forced air flow. Reynolds numbers ranged from 2x104 to 1.2x105 (presumably these are based upon a channel hydraulic diameter although this is not stated). The average P/E value for the 23 tests considered was 0.936 with SD = 0.139. A plot of P/E against Reynolds number showed no evidence of any trend.

480.372 Is the Reynolds number range calculated based on the channel hydraulic diameter? If not, how were the Reynolds numbers obtained?

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2513	NRR/SCSB	21.	RAI-OI		07/19/96	Action W	Action W	NSD-NRC-96-4751

(PCS-GSR-006) OBSERVATIONS
The basic observations on these results are similar to those for the heat transfer correlations. The results clearly show that the correlations give Sh of the right order of magnitude and are defensible as best estimate values but not unconditionally conservative values. No "bridge" between these results and quantitative implications for AP600 analysis is provided: i.e., no effort is made to evaluate a quantitative uncertainty for the correlations when applied to the AP600 or to quantitatively assess implications for the accuracy and/or conservatism of WGOTHIC results for the AP600.

The UW condensation tests exhibit some weak trends that, if extrapolated to AP600 conditions, suggest that the treatment of evaporation from the shell exterior could be somewhat nonconservative. The other test series considered exhibited no such trends, however. It is not clear whether a more detailed review of the test series and/or of the WGOTHIC analyses would lead to a better understanding of these differences and whether they are of any concern for AP600 analysis.

480.373 WEC should attempt to apply the results to draw quantitative inferences concerning the conservatism and/or the uncertainties that must be allowed for when applying these correlations to AP600 analysis.

480.374 Based upon the results presented, there is little basis for claiming conservatism in these correlations. Results are consistent with the correlations' being best-estimate (BE) correlations. However, BE analysis is acceptable in this context only if it is accompanied by an assessment of the uncertainties, which has not been provided. How will WEC address uncertainties for the AP600 analyses?

480.375 P/E ratios for the UW condensation tests exhibit some weak trends suggesting that the treatment of evaporation from the shell exterior in the AP600 could be somewhat nonconservative. However, no systematic trends in P/E ratios were evident in the other two test series. A more detailed review of these test series and/or of the WGOTHIC analyses needs to be performed by WEC to provide a better understanding of this issue and how it impacts the AP600 analyses.

The correlations discussed here for heat and mass transfer are used for the channel and the interior surface of the containment shell, but they are not used for the internal heat sinks. The Uchida correlation is used for the internal heat sinks. While general experience is that Uchida is expected to be conservative, the implications of its use for the specific scenarios of interest to the AP600 have not been assessed. Clarification is also needed as to whether WGOTHIC takes credit for superheat in applying Uchida. Taking credit for superheat has been the subject of some debate in the past. If credit is taken for superheat, it is less clear that Uchida will necessarily yield conservative results.

480.376 What are the implications of the use of the Uchida correlation for heat sinks inside the containment?

480.377 Does WGOTHIC take credit for superheat in applying Uchida?

Closed - Response provided via Westinghouse letter NSD-NRC-96-4751, dated 6/20/96.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2514	NRR/SCSB	21.	RAI-OI		07/19/96	Action W	Action W	?SD-NRC-96-4649

The following questions are based on the WEC March 29-30, 1995 ACRS Presentation on Scaling.

480.378 Provide the basis for the "well mixed" assumption including a discussion of the apparent inconsistency of this assumption based on data and calculation (in terms of the Froude number).

480.379 Where does the "U" in the correlations come from when the main steam line break (MSLB) is being analyzed? How were equations derived, what assumption were used?

480.380 The Large-Scale Test air-annulus was scaled by matching Reynolds (Re) numbers. This tends to result in higher heat transfer and more vigorous in-containment convection than might be expected in the AP600. It would seem that scaling to the following form would be more appropriate:

integral (q dA / v)

What are the ramifications?

480.381 What is the impact of the pre-heating of the dome on the external surface film cooling? There appear to be inconsistencies between the models used and test observations. How is the film scaled to be sure that the correlations used are valid over the proper parameter ranges? What are the parameters?

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2875	NRR/SCSB	21.	RAI-OI		05/13/96	Closed	Action N	NSD-NRC-96-4649

480.382 Provide a comparison of the expected surface temperature range for the AP600 (both LOCA and MSLB) and compare this range to the test range (110 F to 180 F). Provide this comparison for the time period around the peak pressure as well as for the long term, about 24 hours. Do the tests cover the expected AP600 conditions and support the use of 20 degrees for "Theta"? What would be the impact of using 28 degrees for "Theta"?

Reference:
1. "A Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System," PCS-GSR-003, July 1994.

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2876	NRR/SCSB	21.	RAI-OI		05/13/96	Closed	Action N	NSD-NRC-96-4649

480.383 Provide a comparison of the water temperature (assumed for design basis accident (DBA) evaluations) for the AP600 PCS to the water temperature in the wetting tests. Provide justification that the temperature, and therefore the thermodynamic properties used in the Zuber-Staub model, is appropriately covered by the wetting tests to validate use of the model.

Reference:
1. "A Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System," PCS-GSR-003, July 1994.

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2877	NRR/SCSB	21.	RAI-OI		05/13/96	Closed	Action XN	NSD-NRC-96-4649	

480.384 Provide a table similar to Table 3 in Ref. 1 that includes the following data for each test: (1) the PCS water temperature, (2) the PCS water flow rate, (3) the surface heat flux (q") and (4) the temperature (T) used to evaluate the liquid film properties. These data are required to calculated the predicted coverage. If   is not always considered to be 20 degrees, include the value used for each case in the table and justify it's selection. Since the PCS water flow rate may not be constant, how is the value obtained for the comparisons? How are q" and T determined for the comparisons? What is the range of q" (from the heat flux thermocouple pairs) in each test? What is the range of the surface temperatures in the each test?

Reference:
1. "A Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System," PCS-GSR-003, July 1994.

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2878	NRR/SCSB	21.	RAI-OI		05/13/96	Closed	Action XN	NSD-NRC-96-4649	

480.385 Compare the q" and T values from the above response to the q" and T values expected in the AP600 (for both LOCA and MSLB) to demonstrate that the test data encompasses the AP600. While the test matrix indicates only a single comparison, in an AP600 analysis there are multiple axial and radial regions modeled, each with it's own set of properties. Provide this data for each region for the time period around the peak pressure as well as for the long term, about 24 hours.

Reference:
1. "A Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System," PCS-GSR-003, July 1994.

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2879	NRR/SCSB	21.	RAI-OI		05/13/96	Closed	Action XN	NSD-NRC-96-4649	

480.386 Since the Zuber-Staub model requires as input the expected q" and T (the liquid film temperature at which the properties are evaluated), and since q" and T are both transient parameters, how is the water coverage that is used in the AP600 DBA calculated? It seems that the model requires knowledge of the results before the calculation is performed.

Reference:
1. "A Method for Determining Film Flow Coverage for the AP600 Passive Containment Cooling System," PCS-GSR-003, July 1994.

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2880	NRR/SCSB	21.	RAI-OI		05/13/96	Closed	Action XN	NSD-NRC-96-4649	

480.387 In Ref. 2, it is indicated that the stability parameter, referred to as Rref, when set to a specific value, conservatively predicts results from the 1/8th scale Large Scale Tests (LST) and full scale Water Distribution Tests (WDT). With the exception of one test, this is true. Will a new value of Rref be determined to bound all the test data as part of the revised DBA approach to develop a bounding evaluation model? If the test ranges do not adequately cover the AP600 (in terms of q" and T), can a value of Rref be determined for use in a bounding evaluation model?

Reference:
2. "Supplemental Information on AP600 Film Flow Coverage Methodology," NTD-NRC-94-4286, August 31, 1994.

Closed - Response provided by NSD-NRC-96-4696.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2881	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		

480.388 In Ref. 2, it is indicated that the weathered surface exhibited marginally better wetting characteristics than the unweathered surface. If during the life of the plant, the shell exterior is returned to a pre-weathered condition, what is the impact of larger values of   (30 to 58 degrees)? Quantify "marginally." Should the DBA evaluation model Rref include consideration of an unweathered surface to assure bounding analyses?

Reference:
2. "Supplemental Information on AP600 Film Flow Coverage Methodology," NTD-NRC-94-4286, August 31, 1994.

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
2882	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		
	Gm			480.389 Ref. 3 provides the results of calculations with WGOTHIC to 13 LST tests (212.1A, -B, -C, 214.1A, -B, 216.1A, -B, 219.1A, -B, -C, 222.1, 222.4A , and -B) and the blind test, Test 220.1. For each test, provide a table similar to that requested above which includes the parameters used to determine the water coverage (q", T. , Rref, PCS flow rate, PCS water temperature, etc.). Data needs to be provided for each wetted area. At what time in the transient are these data selected and how is the data used to obtain the water coverage used for each test prediction. Were the water coverage data calculated before the tests were run based on the planned (expected) stripping specified in the test matrix? Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.					
2883	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		
	Gm			480.390 No discussions are provided in Ref. 3 to address differences between the test results and WGOTHIC results. For example, test 212.1 shows WGOTHIC predicting an increasing pressure while the test data appears fairly constant; and test 214.1 pressure predictions are less than the measured value. To what extent are differences attributed to the water coverage model? Discuss other problem with either the test data or the WGOTHIC analyses that explain the differences between the data and the analyses. Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.					
2884	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		
	Gm			480.391 In Ref. 3, the results of the blind test are provided. The distributed parameter model under predicts the early pressure response. To what extent are differences attributed to the water coverage model? To what extent are differences attributed to not knowing the test boundary condition for the inlet steam? Since the blind test required that the test actual be run and resulting data be used to establish boundary conditions for the analysis, justify it's use as a blind test in the validation and verification of WGOTHIC. What would be the consequence of not having a blind test as part of the WGOTHIC validation and verification? Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.					
2885	NRR/SCSB	21.	RAI-OI		06/03/96	Action W	Action W		
	Gm			480.392 If Ref. 3, air pressure ratios for test 212.1A, -B, and -C, 216.1A and -B, 219.1A, -B, and -C, and 221.1 are compared (test to predicted). For test 219.1B and -C, helium pressure ratios are also compared. These data are plotted as fixed points without uncertainty. Provide the uncertainty bands for the measured values. For the measured values, uncertainties relate to, in part, the uncertainty in pressure and temperature measurements of the captured gas samples, and taking multiple samples, as well as other uncertainties in analyzing the gas samples. For the predicted values, provide a discussion of how the plotted points are determined. If uncertainty is included in this determination (for example extrapolation of a test measurement for comparison) then include the appropriate uncertainty band on the predicted values as well. Once uncertainty is included, would any conclusions regarding non-condensible distributions, mixing or stratification be altered? Explain. Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.					

AP600 Open Item Tracking System Database: Executive Summary

Date: 09/11/96

Selection: [DSER Section] like '21*' And [NRC Branch] like 'NRR/SCSB' Sorted by NRC Branch

Item No.	Branch	DSER Section/ Question	Type	Title/Description Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. / Ltr Date
2886	NRR/SCSB	21.	RAI-OI	480.393 The modeling of the LST, particular the dome region, has changed from that presented in a meeting on November 15, 1994 and referred to as the "Subdivided WGOTHIC Model" to the distributed parameter model presented in Ref. 3 (Figure 5-34). Is appears that no changes have been made in the lumped parameter model, this should be verified. Justify the model presented in Ref. 3 and what impact, if any, the modeling of the dome region has on the WGOTHIC results as compared to the old model. How are user inputs determined to account for the actual geometry? The model description should be expanded to include a pictorial representation of the "climes" and discuss how the "climes" are modeled: wet and dry strips, number of "climes" in a stack, recommended user input parameters, etc. Also discuss how volume, mass, area and momentum are properly accounted for in the model. The discussion should also address modelling of the AP600 and any additional requirements on user input. Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995. Closed - Response provided by NSD-NRC-96-4696.	05/13/96	Closed	Action	NSD-NRC-96-4649
2887	NRR/SCSB	21.	RAI-OI	480.394 For the blind test, two analyses are presented. One for the distributed parameter model and one for the lumped parameter model. Explain the difference between the two results for the initial pressure response. Why does the lumped parameter model perform better than the distributed parameter model during the early part of the analyses? Why do both analyses underpredict the initial pressure rise? Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.	06/03/96	Action W	Action W	
2888	NRR/SCSB	21.	RAI-OI	480.395 On page 9-1 of Ref. 3, the text refers to Section 9.4. This should be Section 9.6. Figure 9-1 on page 9-10 is cut off and the x-axis is missing. Provided the full figure. Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.	06/03/96	Action W	Action W	
2889	NRR/SCSB	21.	RAI-OI	480.396 Reference 3 of Ref. 3 is the March 29-30, 1995 ACRS meeting of the thermalhydraulic phenomena subcommittee. To the extent that the information presented at this meeting is being used to support the PIRT, as noted on page 1-2 of Ref. 3, provide a written discussion and include copies of the relevant presentation material. In part, it appears that the material provided to the ACRS supports the PIRT in Table 7-3 on page 7-7 of Ref. 3 which differs from Table 2-1 on page 2-10 of WCAP-14190. Reference: 3. "WGOTHIC Code Description and Validation," WCAP-14382, May 1995.	06/03/96	Action W	Action W	

AP600 Open Item Tracking System Database: Executive Summary

Date: 10/1/96

Selection: [DSER Section] like '14*' And [NRC Branch] like 'NRR/HQMB' Sorted by Item #

Item No.	Branch	DSER Section/ Question	Type	Title/Description / Status Detail	Last Mod Date	(W) Status	NRC Status	Letter No. /	Ltr Date
1234	nrr/hqmb	14.2.1-1	DSER-OI	Westinghouse should acceptably address the issues identified in Q260.23, and identify items (discussed in Section 14.2.1 of this report) that are not addressed by the initial test program, and justify their exclusions. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1235	nrr/hqmb	14.2.2-1	DSER-OI	In Section 14.2.2 of the SSAR, Westinghouse should replace the phrase "NRC staff personnel from the Office of Inspection and Enforcement" with "NRC inspection personnel." Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1236	nrr/hqmb	14.2.2-2	DSER-OI	Westinghouse should add to the SSAR the identified COL Action Items. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1237	nrr/hqmb	14.2.2.1-1	DSER-OI	Westinghouse should include in the SSAR a description of the organizational units and any augmented organizations or other personnel that will manage, supervise, or execute any phase of the ITP in a manner consistent with the guidance in Section 14.2.2 of RG 1.70. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1238	nrr/hqmb	14.2.2.2-1	DSER-OI	Westinghouse should add COL Action Item 14.2.2.2-1 to the SSAR. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1239	nrr/hqmb	14.2.8-1	DSER-OI	Westinghouse should modify preoperational test abstract 14.2.8.1.80 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68, Appendix A, Items 1.a.(2)(d) and 1.h.(2). Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1240	nrr/hqmb	14.2.8-2	DSER-OI	Westinghouse should modify preoperational test abstract 14.2.8.1.85 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.79 and RG 1.68, Appendix A, Item 1.h.(1). Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1241	nrr/hqmb	14.2.8-3	DSER-OI	Westinghouse should modify preoperational test abstract 14.2.8.1.87 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.139 and RG 1.68, Appendix A, Items 1.d.(5), 1.d.(8), and 1.h. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		
1242	nrr/hqmb	14.2.8-4	DSER-OI	Westinghouse should modify preoperational test abstract 14.2.8.1.94 in Appendix 1A of the SSAR to include the applicability of this testing to subsequent AP600 plants, or to provide appropriate justification for this exception to RG 1.68.2, as well as RP C.3 and C.4. Closed - Response provided via Westinghouse letter NSD-NRC-96-4800, dated August 13, 1996.	8/13/96	Closed	Action N		

 Total Records: 82