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

September 15, 1993

MEMORANDUM FOR: Dennis Crutchfield, Associate Director
for Advanced Reactor and License Renewal
Office of Nuclear Reactor Regulation

FROM: Ashok C. Thadani, Director
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: REVISION 2 OF THE IMPLEMENTATION PLAN FOR THE REVIEW OF VENDOR TESTING PROGRAMS FOR THE AP600 AND SBWR

Enclosed is a revision of the subject plan. The revisions concern the manner in which the reviewers are to coordinate their efforts and reflect the discussions held at a meeting of the responsible parties in NRR and RES on July 7, 1993.

Reviewers of each test program, including reviewers of the relevant computer codes, are to form review groups under the leadership of the lead reviewer, prepare PERT charts showing the interface of their reviews with the test program and meet monthly to review the status of their work and to update the PERT chart. Guidance on the monitoring of the test program has been added to the plan to assist the review group in this aspect of its work.

Resources and schedules which were listed in the previous version have been omitted here; the resource requirements should be unchanged and the schedules which are now out-of-date are being replaced by the PERT charts. The charts will be continually updated and provided monthly to all interested parties.

Finally, it is important to note that more attention is given here to the reviewers of the relevant computer codes. This situation should develop further, in subsequent revisions, as the focus of this work moves from the experiment programs to the codes used in the design assessments, for in the end it will be these codes which must support the staff's safety determinations for the two designs.

Questions on this plan should be directed to Don McPherson, DSSA. He can be reached on 504-1246.

A C Thadani

Ashok C. Thadani, Director
Division of Systems Safety and Analysis
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc: See attached list

Enclosure 3

REVIEW PLAN FOR AP600 AND SBWR TESTING PROGRAMS
REVISION 2

INTRODUCTION

To support certification of the AP600 and the Simplified Boiling Water Reactor (SBWR) passive reactor designs, both Westinghouse and General Electric have developed testing and analysis programs. It is the responsibility of the Office of Nuclear Reactor Regulation (NRR) to evaluate the applicants' testing and analysis programs to ensure that the requirements of 10 CFR 52.47(b)(2) are met. Assistance from the Office of Nuclear Regulatory Research (RES) has been requested to support this effort.

In SECY-91-273, NRC described its approach for review of the design certification testing programs. Reference 1 describes NRC's program to evaluate, monitor and approve the vendor's testing program consistent with SECY-91-273. Both NRR and RES personnel will be needed to perform this evaluation. Reference 2 provides the overall coordination plan for implementing this program. The first revision of this Implementation Plan, Reference 3, defined the specific work efforts, estimated resources and a summary schedule, and incorporated the NRC confirmatory test program. **In this revision of the Plan, more details are provided concerning the organization and management of the work** including its integration into the activities of the vendors and the overall certification schedule.

For completeness, this revision includes, unchanged, the original descriptions of activities planned to reach a conclusion on the adequacy of the vendor's testing and analytical programs, the assignment of responsibility for each activity and a general outline of the DSER and FSER. However, the estimated resources have been omitted, and the schedule lists are being replaced by PERT charts which are to be updated monthly.

OVERALL RESPONSIBILITY

The purpose of this implementation plan is to describe in detail all activities necessary for NRR to make its safety determination that the vendor's testing program meets the requirements of 10 CFR 52.47(b)(2). Development of the DSER and FSER input is the responsibility of SRXB for the AP600, and SCSB for the SBWR. These inputs are to meet the dates established by ADAR (now **2/94 for AP600 DSER, 6/94 for SBWR DSER, 4/95 for AP600 FSER and 7/95 for SBWR FSER**) needed to support the issuance of the FDA. An outline for the SER inputs is provided (unchanged from the original version) in Enclosure 1. The DSER should use this outline to explain what will be documented in the FSER. Many of the activities described below are expected to produce detailed technical reports. As these reports are produced, copies shall be provided to DAR and SRXB or SCSB, as appropriate, for information. The assigned review branch is to provide SER inputs to SRXB or SCSB, as appropriate, consistent with the outline in Enclosure 1. These inputs should be prepared using WordPerfect 5.1, and copies of input shall be provided on floppy discs to SRXB or SCSB, as appropriate, one month prior to the DSER and FSER input dates (indicated by the PERT chart). SRXB or SCSB, as appropriate, shall provide the combined DSER and FSER inputs to ADAR.

In the performance of its responsibilities, the lead branch need not seek the concurrence of the support branches, unless the topic is in the area of expertise of the support branch, or there are other reasons for the lead branch to do so. However, the support branches should always be copied.

ORGANIZATION OF ACTIVITIES

Table 1 provides a summary of the implementation plan reproduced from Reference 3 with only minor modifications concerning support branches. It provides a matrix of those activities to be accomplished and the Branches involved.

FORMATION OF TEST PROGRAM REVIEW GROUPS

An important innovation in this revision to the plan is the formation of Test Program Review Groups (TPRG) for each of the vendor and NRC testing programs. For each line item of Table 1, the lead reviewer, support reviewer and associated code reviewer constitute the Review Group for that test program. The group has the responsibility, under the leadership of the lead reviewer, of coordinating all activities within this plan. Enclosure 2 is a listing of all test programs showing the reviewers and hence the Review Group responsible for each one.

HOW THE TEST PROGRAM REVIEW GROUPS ARE TO FUNCTION

In addition to the coordination of their review activities and preparation of the relevant reports, the group is to prepare a PERT chart* showing the significant activities of each branch and their relation to the vendor's testing/reporting activities. Enclosure 3 provides a sample to be used as guidance. The

*Lead reviewers should work with Ray Scholl of DSSA who will accept the input and prepare the PERT charts.

initiative for prepariang this chart will rest with the lead reviewer who should include on it each activity and event he believes important to the test program review, and for the management and control of that review. The submission of RAIs, the receipt of vendor responses, ACRS interaction points, and the staff approval of the test program are important events to be included.

Each group is to meet monthly to discuss the status of each reviewer's work, changes in review schedules, problems in obtaining information requested from vendors, areas in which required vendor testing beyond that planned is identified, and new work identified for the staff. Enclosure 4 is recommended as a typical agenda for the review group meetings. The group will mark up their PERT chart and submit it and a brief report on the significant items from their meeting to the overall coordinator, Don McPherson, on the first of each month, beginning October 1, 1993. After reviewing and coordinating these charts and reports, McPherson will provide a copy of the complete monthly package to RES, ADAR, and other interested parties. Subsequent revisions of this plan will contain PERT charts for all test programs.

Another important function of the review groups is to monitor selected experiments within the test program of their responsibility. The experiments to be monitored are to be selected on the basis of uncertainty in outcome, challenge to the safety systems, and diversity in the nature of the experiment. It is desirable that some of the more complex tests such as the integral tests be monitored by a group of 2 or 3 persons from the review group, subject to the agency's foreign travel restrictions. Guidance for Monitoring and Reporting on the Conduct of Thermal-Hydraulic Experiments - Enclosure 5 - should be adopted to the experiment in question and followed.

Each of the vendor testing programs is separately discussed below to indicate the work which is to be performed. The data and other information to be supplied ultimately by the vendors is described in Enclosure 6, which is being communicated to the vendors by ADAR.

AP600 Review Plan

CORE MAKEUP TANK (CMT) TESTS

The CMT tests are to evaluate the draining modes of the CMT, provide confirmation on the adequacy of the level instrumentation used in the CMT to initiate ADS, and provide data on specific thermal-hydraulic behavior in the CMT, such as condensation behavior and thermal stratification. These tests will be used by Westinghouse to verify their computer codes.

Overall review of the CMT tests is the responsibility of SRXB, however, significant assistance is needed from RPSB. The effort will include a review of the testing program, and testing matrix to ensure that the objectives will address the NRC's concerns related to the CMT, as addressed in SECY-91-273, and ensure that an appropriate range of conditions is examined. Further, a detailed review of the scaling chosen for the tests, and the instrumentation to be used will be performed to ensure that sufficient data is provided for code assessment. An audit of approximately 5 test plans will be performed to ensure that the testing is properly conducted, and some of these tests will be witnessed to confirm the tests are conducted consistent with the test plans.

Test data will be reviewed to confirm that expected phenomena were tested and that results confirm the behavior predicted by the AP600 safety analyses. The vendor code verification efforts will be reviewed to ascertain whether the code adequately predicted the observed phenomena. Tests will be selected for analysis by the staff to confirm the capability of the RELAP5/MOD3 code for use in audit analyses of the AP600 design.

SRXB will have lead responsibility for the review of the test program, matrices, and test plan reviews. RPSB will assist SRXB in its efforts and will provide comments to SRXB for inclusion in its assessment. RPSB will have primary review of the scaling analysis and instrumentation review and will forward its assessment to SRXB. SRXB will assess the data to ensure its adequacy, and will specifically address the adequacy of the vendors code verification results.

Verification of the staff's computer code will be performed by RPSB. RPSB shall inform SASC and SRXB of the tests selected for analysis. Results of the verification analysis shall be provided to SASG and SRXB to allow conclusions on code adequacy to be considered in assessing the results of audit analyses performed for the AP600 design. SRXB will compile DSER/FSER input for transmittal to ADAR.

AUTOMATIC DEPRESSURIZATION SYSTEM (ADS) TESTS

A critical component in the AP600 design is the ADS. These valves depressurize the reactor coolant system to allow gravity injection from the In-containment Refueling Water Storage Tank (IRWST) to provide long-term cooling. Full-scale tests of the ADS valves and the sparger in the IRWST are being performed in Casaccia, Italy. The Phase A tests to examine the sparger performance and IRWST loads are completed. Phase B tests are to evaluate full scale performance of the valves used in the first three ADS stages, and are to be done from Feb. to May 1994.

The staff has previously notified Westinghouse of the need to test the fourth stage ADS valve. While such tests will not be done as part of the Phase B ADS program, they will be done separately at a later date.

SRXB will have overall lead responsibility for review of these tests. SRXB will review the test program and audit selected test plans to ensure that the testing program adequately characterizes ADS valve performance. The data and the vendor's verification analyses will be reviewed to ensure that the code properly reflects the observed behavior. NRR/EMEB, with the advice of RES//EMEB will assist SRXB through review of the test program and data to assess ADS valve performance and reliability.

SCSB will perform a similar review to that planned by SRXB except its efforts will focus on the sparger behavior. SCSB shall provide results of its review to SRXB for inclusion in the DSER and FSER inputs.

PASSIVE CONTAINMENT COOLING SYSTEM (PCCS) TESTS

PRHR system testing has been completed by Westinghouse. The purpose of these tests was to evaluate the heat transfer behavior of the PRHR tubes, and to modify the correlations used to predict PRHR performance.

SRXB will have the lead for evaluating these tests. Since these tests have been completed, the effort will concentrate on examining whether or not the test program, testing matrix, and test facility design (scaling and instrumentation) were sufficient to characterize the behavior of the PRHR system. RPSB will evaluate the specifics of the test facility design and forward its evaluation to SRXB.

The test data, and the associated modeling of the PRHR by W, will be evaluated by SRXB to ensure that the PRHR system has been appropriately reflected in the AP600 safety analyses. RPSB will assess the capability of the RELAP5/MOD3 code to predict the test results. The results of its evaluation shall be forwarded to SASG and SRXB to assess audit calculations performed by the staff. Input to the DSER and FSER will be compiled by SRXB.

WIND TUNNEL TESTS

The AP600 containment is cooled by natural circulation around the outside of the containment shell. Westinghouse has performed a series of wind tunnel tests to examine the effect of wind direction and speed on the operation of the containment cooling air inlet design. The first two phases of this program have been completed; the third and fourth phases are scheduled to be completed by September 1993.

SCSB has the lead for evaluating these tests. SCSB will evaluate the test program, test matrix, facility design, and test results to confirm the adequacy of the air cooling inlet design. AEB will perform a detailed review of the test scaling and instrumentation and forward these results to SCSB. SCSB shall provide DSER and FSER input to SRXB for inclusion in the overall evaluation to be submitted to ADAR.

PASSIVE CONTAINMENT COOLING SYSTEM (PCCS) TESTS

The Westinghouse test program for the PCCS includes a series of separate effects tests at various scales to examine the heat transfer behavior on the interior of the containment, heat transfer on the containment exterior, and water distribution on the containment exterior. Simple geometry tests have been completed. A 1/8 scale facility has been constructed for tests of the entire PCCS and tests in this facility are scheduled for completion in September 1993. Tests on a full scale angular sector of the containment shell to study water distribution on the containment exterior were completed.

Overall review of the PCCS tests belongs to SCSB, however, significant assistance is needed from AEB. The effort will include a review of the testing program, and testing matrix to ensure that the objectives will fully evaluate the performance of the PCCS and ensure that an appropriate range of conditions are examined. Further, a detailed review of the scaling chosen for the tests, and the instrumentation to be used will be performed to ensure that sufficient data is provided for code assessment. An audit of approximately 5 test plans will be performed to ensure that the testing is properly conducted. Some tests will be witnessed to confirm the tests are conducted consistent with the test plans, and the data from one test will be locked up to permit a blind prediction by the vendor and by NRC.

Test data will be reviewed to confirm that expected phenomena were tested and that results confirm the behavior predicted by the AP600 safety analyses. The vendor code verification efforts will be reviewed to ascertain whether the code adequately predicted the observed phenomena.

SCSB will have lead responsibility for the review of the test program, matrices, and test plan reviews. AEB will have primary review of the scaling analysis and instrumentation review and will forward its assessment to SCSB. SCSB will assess the data to ensure its adequacy, and will specifically address the adequacy of the vendor's code verification results.

Verification of the staff's computer code will be performed by AEB. AEB shall inform SASG and SCSB of the tests selected for analysis. Results of the verification analysis shall be provided to SASG and SCSB to allow conclusions on code adequacy to be considered in assessing the results of audit analyses performed for the AP600 design. Both pre-test and post-test analyses will be performed.

Input for the DSER and FSER will be provided to SRXB for inclusion in the overall safety evaluation of the vendor's testing program.

CHECK VALVE TESTS

Check valves are key components in the AP600 safety system designs. These valves must open, and remain open, under relatively low pressure drops. Long-term exposure to reactor coolant conditions could affect the behavior of the valves. Preliminary hydraulic testing of the valves has been completed, but these tests were not performed on the "biased open" valves now planned for the AP600. Qualification testing of the valves is planned for completion by June 1994.

The Mechanical Engineering Branch (EMEB) is responsible for the review of these tests. A technical assistance contract is in place for the review of the testing program. NRR/EMEB, with the assistance of RES/EMEB, will review the test program, testing matrix, and testing plans, to ensure that the testing will be adequate for establishing valve performance and long-term operability of the valves after exposure to RCS environment. EMEB will also view selected tests, and will analyze the data obtained. SRXB will work with EMEB to evaluate the adequacy of the vendor's test plans to ensure that an appropriate range of conditions is included to adequately assess check valve performance. For the long-term performance test, the Materials and Chemical Engineering Branch (EMCB) will assist EMEB in assessing the capability of the vendor's test program to evaluate long-term check valve performance. EMEB will assist SRXB in assuring that the test results confirm the modeling assumptions use in the safety analysis. The DSER input should discuss the adequacy of the testing plans and program; FSER input should discuss the results of the testing and conclusions relative to valve performance. SRXB will compile the DSER and FSER input for transmittal to ADAR.

OREGON STATE UNIVERSITY (OSU) TESTS

Westinghouse is performing low-pressure, reduced-height integral system testing at OSU. The purpose of these tests is to demonstrate that gravity driven injection and natural convection provided adequate long-term cooling for the AP600 design. The data will be used to verify the computer codes used in the AP600 safety analysis. Matrix testing is to begin in October 1993.

Overall review of the OSU tests is the responsibility of SRXB, however, significant assistance is needed from RPSB. The effort will include a review of the testing program, and testing matrix to ensure that the objectives will address the NRC's concerns related to long-term cooling of the AP600 design and ensure that an appropriate range of conditions is examined. Further, a detailed review of the scaling chosen for the tests, and the instrumentation to be used will be performed to ensure that sufficient data are provided for code assessment. Vendor pre-test predictions will be reviewed to confirm that overall facility behavior is representative of the expected AP600 behavior.

Test data will be reviewed to confirm that expected phenomena were tested and that results confirm the behavior predicted by the AP600 safety analyses. The vendor post-test code verification efforts will be reviewed to ascertain whether the code adequately predicted the observed phenomena. Tests will be selected for analysis by the staff to confirm the capability of the RELAP5/MOD3 for use in audit analyses of the AP600 design.

SRXB will have lead responsibility for the review of the test program, matrices, and test plan reviews. RPSB will provide comments to SRXB for inclusion in its assessment and will have primary review of the scaling analysis and instrumentation review. SRXB will assess the data to ensure its adequacy, and will specifically address the adequacy of the vendor's code verification results.

Verification of the staff's computer code will be performed by both SASG and RPSB. RPSB and SASG shall inform SRXB of the tests selected for analysis. Results of the verification analysis shall be provided to SRXB to allow conclusions on code adequacy to be considered in assessing the results of audit analyses performed for the AP600 design.

SPES-2 TESTS

Full-height, high-pressure integral systems testing of the AP600 design is planned to be performed at the SPES-2 facility in Piacenza, Italy. This testing is to provide thermal-hydraulic data at high pressure to be used to verify the safety analysis computer codes. Matrix testing is expected to begin by October 1993 and end by March 1994. All post-test analyses are scheduled to be completed two months later, but details of the analysis plan have not been provided by Westinghouse at this time.

SRXB has lead responsibility for evaluation of the SPES-2 tests and preparation of DSER/FSER inputs. This review will be performed in the same manner as that described above for the OSU tests.

ROSA-V TESTS

The staff will perform confirmatory full-height, high-pressure integral systems testing of the AP600 design in the ROSA-V facility in Japan. The tentative schedule is to complete facility modifications by October 1993, initiate testing in December 1993, and complete testing by December 1994. An option is expected to allow for an additional year of testing at the facility.

Although these tests are confirmatory, and therefore not required to certify the AP600 design, the results of these tests will be used to verify the staff's RELAP5/MOD3 computer code. The staff will utilize this code to perform audit calculations of the AP600 design. DSER input is not required for this testing.

RPSB has the lead responsibility for these tests. RPSB will perform the scaling analyses, and develop the test plans and matrices. RPSB shall keep SRXB informed of its plans and will solicit SRXB comments on the proposed test plans and matrices. RPSB will station a resident engineer at the ROSA-V facility to provide oversight of the testing program. Data reports will be forwarded to SRXB for review. If any unusual behavior is identified during the tests, RPSB shall immediately inform SRXB and ADAR in order to allow these results to be considered in the staff's safety evaluation of the design.

Pre-test and post-test predictions will be performed by RPSB and SASG using the RELAP5/MOD3 code. These Branches shall coordinate their efforts to minimize duplication of effort. SRXB shall be kept informed of the results to allow conclusions on code adequacy to be considered in assessing audit results performed for the AP600 design.

University of California at Berkeley/ Massachusetts Institute of Technology (UCB/MIT) Correlations

The SBWR design utilizes isolation condensers for decay heat removal from the reactor coolant system and passive heat removal from the containment. A series of prototypical, single tube tests have been completed at UCB and MIT to evaluate the effect of non-condensible gases on tube-side heat transfer. The data were utilized to develop a heat transfer correlation which has been incorporated into the TRACG code.

SCSB has the lead for reviewing these tests. It will review the test conduct and instrumentation to ensure that an adequate range of initial conditions have been tested to cover possible SBWR conditions. SRXB will review the specific implementation of the correlation in the TRACG code. RPSB will also review the data to incorporate and test an appropriate correlation for use in the RELAP5/MOD3 code. Both SRXB and RPSB will provide summary DSER and FSER inputs to SCSB for incorporation into the safety evaluation.

GIRAFFE

General Electric (GE) performed the GIRAFFE tests in Japan to confirm the performance of the Passive Containment Cooling System (PCCS) and provide data for verification of the analytical models used for the SBWR safety analysis. These tests utilized a simulation of the SBWR containment to examine the overall PCCS performance, particularly the performance of the isolation condenser to purge non-condensible gases.

Overall review of this testing is the responsibility of SCSB. Assistance will be provided by SRXB, AEB, and RPSB. SCSB will review the test program and audit selected test plans to confirm the testing addressed staff concerns relative to the performance of the PCCS. This review should be used to identify additional testing needed from GE. AEB and RPSB shall review the scaling and instrumentation for the facility and forward a coordinated review evaluation to SCSB.

Data review will be performed by SCSB to assess the overall performance of the PCCS. SRXB will evaluate the vendor's predictions with the TRACG code as part of its overall evaluation of the code.

Post-test analyses of these tests using NRC codes will be performed by AEB, RPSB, and SASG. These branches shall inform

SCSB of the tests selected for analysis. Results of these evaluations shall be forwarded to SCSB to allow consideration of these results in assessing audit analyses performed for the SBWR.

PANTHERS

Full-scale testing of the isolation condensers is planned as part of the PANTHERS testing program at Piacenza, Italy. This testing will provide final confirmation of the performance of the isolation condenser including heat transfer and structural behavior. Testing is to be completed in March 1994 for the PCCS and late 1994 for the isolation condenser.

SCSB has the lead review for this effort, concentrating on the full scale performance of the PCCS. SRXB will assist SCSB by evaluating the isolation condenser tests. SCSB and SRXB will evaluate the test programs for the PCCS and isolation condenser, respectively. Audits of the testing plans will be performed and the tests will be viewed to ensure testing is conducted in accordance with the test plans.

RPSB and AEB will review the scaling and instrumentation used in these tests to ensure that adequate data is obtained. The results of its review shall be forwarded to SCSB for inclusion in the safety evaluation.

SRXB shall review GE's code predictions for these tests. This will be performed as part of the overall evaluation of the TRACG code. A summary of the review shall be provided to SCSB.

Pre- and post-test analyses using the staff's computer codes are planned by SASG, AEB, and RPSB. These branches shall inform SCSB of the tests selected for analysis. These results shall be provided to SCSB for assessing the adequacy of audit analyses performed for the SBWR.

PANDA

Testing at the PANDA facility at the Paul Scherrer Institute in Switzerland is being performed to investigated multidimensional behavior of the SBWR containment. The staff has concluded that these tests are necessary to support design certification. This test will include simulation of the major SBWR components, including the wetwell, drywell, isolation condenser, GDCS and the PCCS. The facility is 1/25-scale and full-height. The current schedule is for facility construction to be completed in November 1993, and testing initiated in October 1994. GE has stated that it will attempt to accelerate the schedule.

Overall coordination of this review shall be performed by SCSB. SCSB will review the test program to ensure that the tests fully examine the SBWR containment performance. AEB will evaluate the scaling rationale and instrumentation planned for the facility. The evaluation of the PANDA facility will be provided to SCSB for inclusion in the safety analysis. Audit of approximately 5 tests will be performed by SCSB.

SCSB will review the vendor's code predictions for the PANDA facility to ensure that the code adequately predicts SBWR containment behavior.

Pre- and post-test analysis will be performed by SASG, and AEB. SCSB will coordinated these analysis efforts to minimize duplication of effort. SCSB will be informed of the tests selected for analysis. Results of the predictions shall be forwarded to SCSB for review to allow consideration of the results in assessing the staff's audit analyses of the SBWR.

GRAVITY-DRIVEN COOLING SYSTEM (GDCS) INTEGRATED SYSTEM TEST (GIST)

Testing of the GDCS was completed at the GIST facility. This was an integratal test simulating major components of the SBWR, although based on an earlier configuration of the design. The purpose of the test was to provide thermal-hydraulic data for verification of the TRACG code.

SRXB has lead responsibility for evaluating these tests and RPSB for reviewing the scaling and instrumentation. Subsequent to the GIST testing, the GDCS was modified. Therefore, the evaluation shall specifically examine whether the tests were adequate for the current SBWR configuration. To date, the information provided have not been found adequate for code assessment of the GDCS behavior. DRIL has therefore performed an audit of the relavent information. The results of this audit and any subsequent review shall be forwarded to SRXB for further consideration. Ultimately the data sought are to be used by SCSB in its assessment of the TRACG code.

SRXB shall forward its evaluation of the GIST tests to SCSB for incorporation in the coordinated SER input to ADAP

SQUIB VALVE TESTING

The squib valves are important components in the SBWR, and are required to depressurize the SBWR to allow draining from the GDCS. Limited squib valve testing has been performed by GE, and the staff has recommended additional testing to ensure adequate valve reliability. GE has not yet informed the staff of any additional testing planned.

The Mechanical Engineering Branch (NRR/EMEB) with assistance of RES/EMEB, is responsible for the review of these tests. A technical assistance contract is in place for the review of the testing program. EMEB will review the test program and test results to ensure that the testing will be adequate for establishing reliable valve performance. EMEB will assist SRXB in assuring that the test results confirm the modeling assumptions used in the safety analysis. EMCB will also review the test data to assess squib valve performance from the aspect of valve degradation due to possible internal crevice corrosion. The DSER input should discuss the adequacy of the testing plans and program; FSER input should discuss the results of the testing and conclusions relative to valve performance.

SBWR SMALL SCALE LOOP

The staff is planning confirmatory, small scale integral systems testing of the SBWR. Purdue University has been selected to construct and operate a 1/4 height, 1/400 scale facility. Testing in this facility is expected to begin in late FY94.

Although these tests are confirmatory and therefore not required to certify the SBWR design, the results of these tests will be used to verify the staff's RELAP5/MOD3 computer code which will be used to perform audit calculations of the SBWR design. DSER input is not required for this testing.

RPSB has the lead responsibility for these tests. RPSB will perform the scaling analyses, and develop the test plans and matrices. RPSB shall keep SRXB and SCSB informed of its plans and will solicit their comments on the proposed test plans and matrices. Data reports will be forwarded to SRXB and SCSB for review. If any unusual behavior is identified during the tests, RPSB shall immediately inform SRXB, SCSB, and DAR to allow these results to be considered in the staff's safety evaluation of the design.

Pre-test and post-test predictions will be performed by RPSB and SASG using the RELAP5/MOD3 code. These Branches shall coordinate their efforts to minimize duplication of effort. SRXB shall be kept informed of the results to allow conclusions on code adequacy to be considered in assessing audit results performed for the AP600 design.

REFERENCES

1. Memorandum, T. E. Murley and E. S. Beckjord to J. M. Taylor, SUBJECT: Program for the Review of Vendor's Test Programs to Support Design Certification of Advanced Reactors, April 6, 1992.

2. Memorandum, T. E. Murley to E. S. Beckjord, SUBJECT: Coordination Plan for Passive Reactor Testing and Analysis, June 8, 1992.

3. Memorandum, A. C. Thadani to D. M. Crutchfield, SUBJECT: Revised Implementation Plan for the Review of Vendor Testing Programs for the AP600 and SBWR, February 17, 1993.

TABLE 1

OVERVIEW OF IMPLEMENTATION PLAN

	TEST PROGRAM & MATRIX	SCALING AND INSTRUMENTATION	TEST PLAN REVIEW	VENDOR PRE-TEST PREDICTION	NRC PRE-TEST PREDICTION	VIEW TEST	RESIDENT ENGINEER	VENDOR POST-TEST PREDICTION	DATA REVIEW	NRC POST-TEST PREDICTION
AP600										
CMT TESTS	SRXB/RPSB	RPSB/SRXB	SRXB/RPSB	NO	NO	SRXB	NO	SRXB	SRXB/RPSB	RPSB/SASG/SRXB
ADS TESTS	SRXB/SCSB	NO	SRXB/SCSB	NO	NO	SRXB/SCSB	NO	SRXB/SCSB	SRXB/SCSB	NO
PRHR TESTS	SRXB/RPSB	RPSB/SRXB	NO	NO	NO	NO	NO	SRXB	SRXB/RPSB	RPSB/SASG/SRXB
WIND TUNNEL TESTS	SCSB	AEB/SCSB	NO	NO	NO	NO	NO	NO	SCSB	NO
PCCS TESTS	SCSB	AEB/SCSB	SCSB	NO	NO	SCSB/AEB	NO	SCSB	SCSB/AEB	AEB/SASG/SCSB
CHECK VALVE TESTS	EMEB/EMCB	NO	EMEB/EMCB	NO	NO	EMEB	NO	SRXB	EMEB/EMCB	NO
OSU	SRXB/RPSB	RPSB/SRXB	SRXB/RPSB	SRXB	RPSB/SASG	SRXB/RPSB	NO	SRXB	SRXB/RPSB	RPSB/SASG
SPES	SRXB/RPSB	RPSB/SRXB	SRXB/RPSB	SRXB	RPSB/SASG	SRXB/RPSB	NO	SRXB	SRXB/RPSB	RPSB/SASG
ROSA	RPSB/SRXB	RPSB/SRXB	RPSB/SRXB	NO	RPSB/SASG	RPSB/SRXB	RPSB	NO	RPSB/SRXB	RPSB/SASG
SBWR										
UCB/MIT	SCSB SRXB/RPSB	RPSB	RPSB	NO	NO	NO	NO	SRXB	SCSB SRXB/RPSB	RPSB
GIRAFFE	SCSB SRXB/AEB RPSB	AEB RPSB/SCSB	SCSB SRXB/AEB RPSB	SCSB	AEB RPSB	SCSB SRXB/RPSB	NO	SCSB	SCSB SRXB/AEB RPSB	AEB RPSB/SASG
PANTHERS	SCSB SRXB	RPSB/SCSB	SCSB SRXB	NO	RPSB/SASG	SCSB SRXB	NO	SCSB	SCSB SRXB/RPSB	RPSB/SASG
PANDA	SCSB	AEB/SCSB/RPSB	SCSB	SCSB	AEB/SASG	SCSB/AEB/RPSB	NO	SCSB	SCSB/AEB	AEB/SASG/RPSB
GIST	SRXB	RPSB/SRXB	NO	NO	NO	NO	NO	SRXB	SRXB/RPSB	RPSB/SASG
SQUIB VALVES	EMEB	NO	EMEB	NO	NO	NO	NO	NO	EMEB/EMCB	NO
SBWR LOOP	RPSB/SRXB/SCSB	RPSB/SRXB/SCSB	RPSB/SRXB/SCSB	NO	RPSB/SASG	RPSB/SRXB/SCSB	NO	NO	RPSB/SRXB/SCSB	RPSB/SASG

NOTE: Where more than one branch has responsibilities, the lead branch is listed first

OUTLINE FOR SER INPUT

Executive Summary (SRXB for AP600 or SCSB for SBWR)

1. Introduction (SRXB for AP600 or SCSB for SBWR)

   This section should describe the general purpose of the evaluation. Specifically, it should provide a brief summary of the passive safety features used in the design, and how they are unique in comparison to currently operating plants. It should then discuss the requirements of 10 CFR 52.47(b)(2). It should be noted that validated computer codes are needed to predict the safety performance of the design and that the vendor has developed a testing program to gather the data necessary to confirm code adequacy. Finally, an outline of how the report is organized should be provided.

2. Issues of Concerns (SRXB for AP600 or SCSB for SBWR)

   In this section a summary of the important issues related to performance of the passive safety systems should be provided. This should highlight those issues which required testing and will lead into the subsequent sections of the report.

3. Overview of Vendor Testing Programs (responsible Branch)

   This section should describe, on a test program basis, the vendors testing program. The purpose of the tests should be described here. These should be directly related to the issues of concern.

4. Overview of NRC Activities (responsible Branch)

   On a test program basis, a description of the NRC activities should be provided in this section. An introductory paragraph should explain the "audit" nature of the review. This section should be very similar to the task descriptions presented in this plan.

5. Evaluation of Vendor Testing Programs (responsible Branch)

   Within this section, on a test program basis, the evaluation of the testing program should be provided. It should reflect an evaluation of how the issues of concerns were satisfied by the testing, and the evaluation of the test facility (e.g. results of scaling review if performed).

6. Code Validation (responsible branch)

   Within this section, a summary of the vendor's code validation program should be described along with the staff's conclusion on code adequacy. The basis for concluding that the code is adequate for supporting certification should be provided.

7. Compliance with 10 CFR 52.47(b)(2) (SRXB for AP600 or SCSB for SBWR).

   Each element of 10 CFR 52.47(b)(2) should be discussed separately. It is expected that this section will simply be a summary of the document and its conclusions.

NRC STAFF RESPONSIBILITIES FOR REVIEWING PASSIVE SAFETY SYSTEMS TEST FACILITIES FOR CODE ASSESSMENT
REVISED 2/1/94

AP600	Lead		Support	
Core Makeup Tank				
Testing 02/15/94-7/94	SRXB	A. Levin	RES/EMEB	G. Weidenhamer
			RPSB	F. Odar
			NRR/EMEB	D. Fischer
			SASG	W. Jensen
			HICB	H. Li
Automatic Depressurization System				
Testing 7/94 - 10/94 (hot shakedown/preop 4/94)	SRXB	A. Levin	SCSB	C. Hoxie
			RPSB	G. Rhee
			NRR/EMEB	D. Fischer& E. Sullivan
			RES/EMCB	G.Weidenhamer
Passive Reactor Heat Removal				
Testing Completed	SRXB	A. Levin	RPSB	F. Odar
			SASG	K. Campe
Wind Tunnel Tests				
Testing Completed	SCSB	C. Hoxie	AEB	A.Notafrancesco
			SASG	K. Campe
Passive Containment Coolant System Tests				
1/8th Scale HT Testing Completed	SCSB	C. Hoxie	AEB	A.Notafrancesco
			RES/SSEB	H. Graves
			SASG	K. Campe
			ECGB	S. Ali/S.Lee
Water Distribution Tests				
Weir Performance, Film thickness Testing Completed	SCSB	C. Hoxie	RES/SSEB	H. Graves
			SASG	K. Campe
			ECGB	S. Ali/S.Lee
Check Valve Tests In situ at Farley NPP, and/or Braidwood 4/94	EMEB	D. Fischer	EMCB	R. Hermann
			SRXB	A. Levin
			RES/EMEB	G.Weidenhamer
DNB TESTS Phase 2 2/94 - ?	SRXB	T. Attard		

AP600 CONT'D		LEAD		SUPPORT
Oregon State University - APEX Testing 6/94 - 2/95 (hot shakedown/preop - 4/94)	SRXB	A. Levin	RPSB SASG	H. Scott W. Jensen
SPES-2 (Integral Test Facility) 4 Cold Leg break tests 2/94 to 4/94	SRXB	A. Levin	RPSB SASG	J. Kelly W. Jensen
2 DVI break tests 5/94		"	"	
2 CMT/CL balance line break 6/94		"	"	
3 SGTR tests 7/94 to 9/93		"	"	
1 Steamline break 10-11/94		"	"	
ROSA-V (Integral Test Facility) Phase 1: 2/94 to 1/95	RPSB	G. Rhee	SRXB SASG	A. Levin J.Staudenmeier
RELAP 5	RPSB	D. Solberg	SASG	W. Jensen
CONTEMPT LT/28	SASG	K. Campe		
WGothic	SCSB	C. Hoxie	SASG AEB	K. Campe A.Notafrancesco
CONTAIN	AEB	A. Notafrancesco	SASG SCSB	K. Campe C. Hoxie
COMMIX	AEB	A. Notafrancesco	SASG	W. Jensen C. Hoxie
MELCOR	AEB	S. Basu	SASG SCSB	W. Jensen A. Drozd
TRAC-P	RPSB	F. Odar	SASG	J.Staudenmeier
W COBRA/TRAC	SRXB	F. Orr	SASG	J.Staudenmeier
NO TRUMP	SRXB	F. Orr	SASG	J.Staudenmeier
Coupled RELAP 5 & CONTAIN	RPSB	D. Solberg	SASG	W. Jensen
SCDAP/RELAP 5	AEB	Y. Chen	SASG	W. Jensen

SBWR	LEAD		SUPPORT	
UCB/MIT Completed	SCSB	R. Elliott	SRXB RPSB	A. Levin T. Lee
Giraffe Completed	SCSB	R. Elliott	SRXB AEB RPSB SASG	A. Levin A.Notafrancesco T. Lee W. Jensen
Panthers Passive Contain.Cool(PCCS) Tests 4/94-6/94	SCSB	R. Elliott	SRXB AEB ECGB SASG	A. Levin A.Notafrancesco S. Ali/S. Lee J.Staudenmeier
Isolation Condenser (IC) Tests late 1994 into 95	SRXB	A. Levin	SASG ECGB SCSB RPSB	J.Staudenmeier S. Hou R. Elliott T. Lee
Panda Hot shakedown mid-94 Matrix Tests late '94 - '96	SCSB	R. Elliott	AEB SRXB RPSB SASG	A.Notafrancesco A. Levin T. Lee K. Campe
GIST (Gravity Driven Containment System) Completed	SRXB	A. Levin	RPSB SASG	J. Han J.Staudenmeier
Squib Valves No defined schedule	BVEB	D. Fischer	BVCB RES/BVEB	R. Hermann G. Weidenhamer
Vacuum Breakers Testing begins 4/94 at SIET	BVEB	D. Fischer		
SBWR Loop (PUMA) Testing in 1995	RPSB	J. Han	SRXB SASG SCSB AEB	A. Levin J.Staudenmeier R. Elliott A.Notafrancesco

	Lead		Support	
TRACG.	SCSB	R. Elliott	SASG SRXB	J.Staudenmeier M. Razzaque
Coupled RELAP5 & CONTAIN	RPSB	D. Solberg	SASG	W. Jensen
CONTAIN	AEB	A. Notafrancesco	SCSB SASG	R. Elliott K. Campe
TRAC-BWR	SRXB	A. Rubin	SASG	J.Staudenmeier
MELCOR	AEB	S. Basu	SASG SCSB	W. Jensen A. Drozd
RAMONA	RPSB	F. Odar	SASG	J.Staudenmeier
RELAP5	RPSB	D. Solberg	SASG	W. Jensen
SCDAP/RELAP 5	AEB	Y. Chen	SASG	W. Jensen
CONTEMPT	SASG	K. Campe		

Enclosure 4

TYPICAL AGENDA FOR TEST PROGRAM REVIEW GROUPS

Layout schedule per example done for CMT test program (1st meeting)

Status of each reviewer's work

Status of RAIs, vendor's responses, and reviewer's conclusions

Problems and resolution

Additional work for staff

Additional work (analysis, test or questions) for vendor

Plan for monitoring tests

Schedule mark-up

On the first of each month, send schedule mark-up together with a short report on the points above to Don McPherson MS: 8E2, or E-Mail (GDM).

GUIDANCE TO NRC STAFF FOR MONITORING AND REPORTING ON THE CONDUCT OF THERMAL-HYDRAULIC EXPERIMENTS

In view of the large series of experimental programs underway, and the variety of NRC staff members responsible for reviewing them, the following guidance is prepared a) to assist staff members in the process of witnessing certain tests, and b) to provide a format for reporting their observations. Since it assumes the test(s) is being performed in an integral systems facility, it may be too elaborate for simpler, separate effects tests, but for those cases the guidance should be readily modified, keeping in mind that the reporting format should be followed so as to maintain a consistency in the visit reports.

Prior to the visit, the reviewer should become completely familiar with a description of the facility and its instrumentation, the test(s) to be performed, and any pretest predictions. He (she) should begin the visit about 2 days prior to the date of the test, preferably to observe a test "readiness review" (see below).

On site, the reviewer should carry out his review and subsequently report on the following areas:

Review
- Status of preparations with test engineer/supervisor [note how well preparations are proceeding, what problem areas, and test difficulties to watch for].

Instrumentation
- Have types and locations been chosen to support code needs?
- Has a list of instruments been prepared (and followed) which is considered essential to the running of the test?
- Has an error analysis been performed on the important instruments (including calibration, range, transient effects)?

Facility Tour
- Neatness, leaks, knowledge of operators of facility layout.
- Check location of a few instruments.

Preparation
- Are there written procedures, are they rehearsed?
- Is a readiness review performed? Describe.
- Safety considerations.
- Repairs and modifications completed?
- Check of instrumentation performance made?
- Are test termination criteria established to define when the test is completed?

Performance of Test
- Adequate number of operators? With duty assignments?
- Do they follow the procedures?
- Control room ambiance (professional? chaotic?)
- Instrumentation and controls carefully monitored?
- Data recording frequency.
- As problems arose, how were they resolved?
- Did the test proceed to its defined termination point?

Data Processing
- Assigned responsibilities for analysis.
- Follow-up data qualification.
- Planning in place for quick look and other reporting.

Was a post-test meeting held to review test success and the goodness of the data?

Any other general observations?

Are there any follow-up actions?

The report covering these points is to be provided to the lead reviewer and other members of the review group within one month of the visit and should be discussed at the next monthly meeting of the group.

Additional guidance directed at the quality of the test is provided in 10 CFR 50 Part 21 and ANSI/ASME NQA-1-1986, from which the pertinent information will be provided to the lead test reviewers.

Format and Content of Documentation for
Specified Experiments in Support of the
Advanced Light Water Reactor Safety Systems

Facility Description Document

The following should be provided, either as a single report or as a series.

Facility Dimensions

All sketches, drawings, operational procedures, material specifications, geometric information, and other information pertinent to the facility should be included such that an input model can be generated. A system schematic drawing should be provided to clearly show how the various components form the overall system. The facility should be described component by component. providing all necessary information to convey the component's function and operation as well as its geometry (areas, volumes, etc.). The drawings should include all dimensions, materials, and configurations of each part of the materials and configuration of each part of the facility. All important dimensions of the facility and test section should be given in a table. Pipe sizes and lengths should be included.

Characteristics of Active Components

Component operational data should include delay times, rates of change (valve movement), performance curves (pumps) and all other control and performance information necessary to fully describe the experiment. Hydraulic characteristics of valves and pumps should be included. Control systems associated with a component or group of components should be described to the level of detail necessary to convey their function and operation. Sufficient control system data should be included to allow duplication of the modeled control system. Trip points and setpoints should be clearly tabulated for control systems functions.

Facility Characterization

Hydraulic and geometric information necessary to determine loss coefficients and heat transfer coefficients should be included in the data package and referenced. Insulation of components and piping should be clearly identified and, where heaters were used to insulate a component (guard heaters), their control procedure for the experiment should by provided. If available, regionally quantified heat loss information should be provided. Insulation material properties and dimensions must be specified. Heat loss due to instrument cooling or uninsulated regions should be identified and quantified if possible. System coolant leakage estimates should be evaluated and included in the facility description package. Results from any startup and facility characterization tests should be described.

Instrumentation Description

--Describe types, numbers, and locations of instruments. The locations of instruments should be unambiguous.

--Describe the instrument accuracy and calibration procedures to NIST calibration standards.

--Describe signal processing and signal conditioning.

--Describe data acquisition system including recording equipment, response time and sampling time.

Facility Scaling

The objective of the scaling evaluation is to obtain the physical dimensions of the test facility that will preserve the phenomena and processes expected to be present in the full scale plant. Describe the facility scaling approach with the objectives to:

--Obtain the similarity groups which should be preserved between the test facility and the full scale prototype;

--Establish priorities for preserving the similarity groups;

--Assure that important processes have been identified and addressed in the above;

--Provide specifications for test facility design; and

--Quantify biases due to scaling distortions.

Quick Look Report

Quick Look Reports (QLR) should be provided for integral experiments if they are part of the vendor's planned reporting although the vendor may also find it useful to prepare them for certain separate effects tests. For integral tests it may be more convenient or appropriate to prepare a QLR to cover a test series e.g. small breaks or SGTR's, rather than each separate test. The objectives of QLRs should be to describe test objectives, how the tests proceeded, the degree to which objectives were met, show the most significant data plots (unqualified data are acceptable at this point) and their agreement with pretest predictions, and list important preliminary conclusions.

The WEC letter, reference ET-NRC-93-3946, NSRA-93-0305, Docket No. STN-52-003, Subject: General Outline for Quick Look Data Reports on AP600 Tests, signed by N. J. Liparulo, dated August 16, 1993, is consistent with the above description and would be quite acceptable to NRC.

Data Reports

The data report is designed to:

Transmit all data to the NRC.

Be a referable document.

The report should include:

Qualified Data Tape

All qualified data should be transmitted via either data tape or electronically if feasible. Non-functioning data channels should be identified. If certain channels are erratic, a note should be provided to indicate for which period the channels in question should be ignored.

Equipment Interaction Log

A listing of the equipment behavior for all hardware that was used in the experiment should be included. Thus, valve opening and closing, pump power downs or programmed changes in speed, core power ramps or power increases, equipment failures and any equipment interactions should be listed.

Data Microplots

Small figures showing the behavior of all the instrumentation channels should be transmitted. For certain specified parameters such as gamma-densitometer reading, both engineering and raw voltages plots are needed.

Data Uncertainty

Uncertainty of all data should be listed. If the only available uncertainties are the manufacturer's published uncertainties not including allowances for the signal processing equipment and recording equipment, then that should be stated. The best possible estimates of uncertainties are required for all key instrumentation.

Data Log

A log listing interpretations by the Vendor's Data Analysis Team should be included. The Data Log will give the results of the Data Analysis Team's data review. Observations concerning instrumentation zero shifts, noise, superimposed signals, time lags, channel interdependencies, miscalibrations, improper instrumentation hookups, bad channels, and the like from the Data Analysis Team should be entered in the Data Log and transmitted as an attachment to the Data Report.

Instrumentation List

All instrumentation used in the data report should be either referenced to an existing Instrumentation Description Report (containing instrumentation locations, specifications, hookup polarities, and label nomenclature) or described in the subject Instrumentation List such that all changes and modifications to earlier descriptions in the Instrumentation Description Report are clearly stated.

Data Formats

Data produced by experiments should be provided to the NRC staff in two ways. First, as part of the experimental data reports described above, with accompanying analyses and evaluation, in support of the verification and validation of the design and the analytical tools. Second, the qualified raw data should be provided either on magnetic media, or through direct interconnection with the NRC via modem or electronic data network.

The staff currently has the ability to read 3.5 inch floppy disks and 4 mm Digital Audio Tape (DAT). For small quantities of data, either the floppies or the electronic data network exchange method would be suitable. For large amounts of data, the DAT is preferred.

The data files for the tests should follow the following format, which has been used for data stored in the NRC data bank from test facilities sponsored by NRC and other thermal-hydraulic organizations.

The standard format for the data consists of 80 column card images in ASCII code. Cards will never cross record boundaries, and data for an individual measurement will not cross media boundaries, i.e., each floppy disk or DAT cassette is a "stand alone" record.

Each dataset for an experiment is described by two to 86 files of information. The first file is a directory file which describes the contents of the dataset. The remaining files are the data files. The following pages are a word-by-word description of the files.

The data are organized in the dataset in files by measurement type, so that all of the temperatures are in one file, the pressures in another, levels in a third, and so on. The individual measurements are named, within the files, with the name assigned by the data source, up to 16 characters long.

The keywords in the description are optional, with general keywords used to describe common items such as test start time, etc., and "Keyword" information, such as measurement uncertainty, applicable to specific measurements.

This format has proven to be very adaptable, and has caused virtually no problems in reformatting by previous data users.

Test Analysis Reports

An analysis report should be prepared following each test or a group of similar tests. This report should describe what happened, why it happened, and what phenomena of significance occurred. In addition, this report should contain comparisons of code calculations with the data. The analysis report should include plots of key parameters as a function of time, describe the behavior of the key parameters, and provide an analysis of major experimental results.

The Test Analysis Report is designed to:

--Provide the exact initial and boundary conditions for each experiment;

--Provide figures showing the key parameters and instrumentation that describe the experiment transient behavior;

--Provide an interpretation of the important events that occur during the transient including the basis for the interpretation; and

--Be a referable document.

The report should include:

Test Description

A description of the test matrix and objectives for each test including how a test series relates to other test series in the same facility. For separate effects and component test facilities, the rationale for selection of parametric variations and boundary conditions should be described to show that the testing encompasses the range of conditions expected to occur in the full scale plant.

Experimental Configuration

A description of special hardware changes, hardware configurations or installations. All configurational changes, details on initial conditions and test boundary conditions should be specified. All the instrumentation used should be either referenced to an existing Instrumentation Description Report (containing instrumentation locations, specifications, hookup polarities, and label nomenclature) or describe in the Test Analysis Report such that all changes and modification to earlier descriptions in the Instrumentation Description Report are clearly stated.

Test Procedure

The way the experiments were conducted should be described. For example, when valves opened, what caused the valves to open, when pumps turned on or off, etc. The test conditions should be described in as much detail as possible.

Description of Experiments

The transients should be described, transient chronologies should be prepared, major events should be identified, and analysis performed to explain unexpected results. The key instrumentation channels should be described, including their uncertainty.

Conclusions and Observations

Identify whether the experiment met the stated objectives, list unexpected results, and present the explanation of all major events.

Code Qualification Report

Introduction

The introduction should include a detailed discussion of the assessment study background, scope and objectives, and should present the assessment methodology used for the study.

Facility and Test Description

A brief discussion should be provided of the experimental facility including its geometric layout, instrumentation, operation procedures, and other information, as required for understanding the code analyses. Reference may be make to the detailed facility description and test results reports. The experiments to be calculated should be discussed including important thermal hydraulic information, initial and boundary conditions, and operational information pertinent to the calculation. Measurement uncertainty must also be discussed.

Code Input Model Description

The code input mode should be discussed in detail including nodalization diagram, nodalization rationale, assumptions, boundary and initial conditions and operational conditions for the calculation. The nodalization description should be related to the full scale plant model. Discuss modifications to the input model (nodalization, boundary, initial and/or operational conditions resulting from sensitivity studies (if conducted). Provide an input model listing in both hard copy and on data tape.

Results

Results of the calculation that lead to major conclusions should be clearly presented and discussed. Applicable key assessment parameters should be discussed. The rationale for performing any sensitivity studies should be discussed along with the methodology used to perform them. Modifications to base case conditions and the resulting effect should be fully described and qualified. The discussion should include:

--A comparison between the code prediction and the experiments with regard to the important physical phenomena that occurred during the experiments. Identify and explain the causes of discrepancies between the code and data, i.e. discuss the deficiency in the code or the inaccuracy of the experimental measurements. Assess whether the timing of events agrees with the experimental data.

--Assess whether the calculated results are self consistent and present a cohesive set of information that is technically rational and acceptable. Explain any unexpected or at first glance strange results calculated by the code, particularly when experimental measurements are not available to give credence to the calculated results. Determine whether calculated results are due to compensating errors. Discuss how important the code deficiency is to the overall results (parameters of interest) or explain why it may not be important for the particular scenario.

--Provide guidelines for performing similar analyses.

Code Comparison Calculations

Background

Assessing the safety of a nuclear installation requires the use of a number of highly specialized tools: computer codes, experimental facilities and their instrumentation, special measurement techniques, methods for testing materials and components and so on. A highly effective way of increasing confidence in the validity and accuracy of such tools is provided by code comparison exercises in which calculations produced by a computer code is gauged against agreed standards. For example, predictions of different computer codes for a given physical problem may be compared with each other and with the results of a carefully controlled experimental study which also could be a real plant transient.

These exercises are performed as "open" or as "blind" problems. In an open problem the results of an experiment are available to analysts before it is evaluated. In a blind problem the results of the experiment are not made known to the analysts until after delivery of the calculated results. Depending on the kind of experiment and its objectives, certain boundary and initial conditions of the experiment may be communicated to the analysts before they start the exercise. For all exercises, the analysts are provided with a complete description of the experimental facility as discussed below.

Experimental Description Document

Once the particular experiment has been selected for the exercise, a detailed description of the experiment is necessary.

The experimental description document which is prepared for this purpose should include:

-- A description of the experimental facility, including engineering drawings providing exact facility configurations (no assumptions on what is important). These drawings should include all dimensions, materials, and configurations of each part of the facility. The drawings should be of sufficient detail to allow detailed analytical models to be developed. Unambiguous descriptions of instrumental locations should be provided. All important dimensions of the facility and the test sections should be given in a table.

-- Results to be calculated. The points at which parameter values are to be calculated should be specified. If these include points where experimental data are not available, this should be pointed out and the reason explained. The type of experimental measurements to which calculated results will be compared should be described.

-- Experimental data to be available after the experiment is completed, including expected error bands as a function of time. This may help analysts' selection of calculational nodes, considering which data will be available for post-test analysis.

-- Initial and boundary conditions. For a blind exercise, initial conditions should be provided after the experiment is performed. The analyst should be able to use preliminary expected initial values to formulate a simulation model and check it out. The analysis would then be performed using the measured initial conditions from the actual experiment with very little change to the previous checked-out simulation model. For an open exercise, all the measured parameters are specified and communicated to the analysts. If specifically recommended boundary conditions are given, a justification for using them should be provided.

Calculation Comparison Report

Reporting the results of the comparison exercise results requires sufficient information to allow evaluation of the analytical models used, to provide guidance for future code development efforts, and to contribute to better understanding of phenomena. The following should, therefore, be included in the comparison report:

Facility Description

The experimental facility should be discussed briefly. The description should indicate the position and error bands of experimental measurements, major components and positions for which calculations have been requested. Calculated results should refer to these descriptions.

Computer Codes

-- Computer codes and versions should be clearly identified. Code descriptions should contain relevant information on the analytical models available, including appropriate equations and assumptions used in the derivation.

-- Changes made to the computer code to perform the exercise that are not documented in the referenced code description should be described along with reasons for the changes.

Simulation Model

-- A description of the code application model used including nodalization, time step control, empirical program options selected, and other options.

-- Assumptions used in the calculation to simulate the experimental facility (physical properties).

-- Specified initial and boundary conditions and assumed initial and boundary conditions used in the calculation.

Calculations Performed

-- Computer used and running time to perform the calculation.

-- Results for all points and parameters specified in the problem specifications should be plotted and given in tables using metric system units (SI Units).

-- Calculated results should be discussed briefly including interesting and unexpected results.

-- Results should be plotted to further explain specific phenomena revealed during the calculation.

Comparison of Calculated Results and Experimental Data

Plots of calculated results and corresponding experimental data with error bands should be shown. It may be necessary to present more than one plot per calculated position because of overlapping results or the need to use an expanded scale in one area.

Additionally, the comparison report should include information on deviations between planned conditions of the experiment and conditions actually achieved.

Explanation of Results

The experimental results should be discussed. Any deviations from expected results should be explained if possible. This aids in assessing the difference between computed results and experimental

Post-exercise Analysis

Post-exercise analysis is important. Analysts should run sensitivity studies to determine which inputs to their codes require closest scrutiny. Various options or models should be tried to see how they affect the results. Nodalization should be scrutinized to see if it was adequate for the problem. Areas which may require additional study include, for example, time step convergence, Nodalization or variation of code options.

Each analyst should include the results of any post-test analysis as an appendix to the final comparison report, where they add additional pertinent information to previous results. Particular attention should be paid to explaining why substantial deviations occurred between calculated best estimate results and actual data. If a predictive evaluation model calculation is to be reported (in addition to a best estimate calculation), anomalous behavior of the evaluation model compared to the data or to the best estimate calculation should be explained. The differences between best-estimate and evaluation model applications of the codes involved should be tabulated.

Comparison Calculations to be Performed

The staff has determined that the vendors should calculate the following experiments "blind", as described in the Enclosure above. This list is not final, and is expected to be revised as the staff reviews the test programs and the computer codes used by the vendors.

AP600

SBWR

Attachment

cc: J. Taylor
J. Sniezek
M. Taylor
E. Beckjord
T. Speis
J. Wiggins
B. Boger
B. Sheron
T. Murley
F. Miraglia
W. Russell
R. Borchardt
J. Norberg
L. Shotkin
F. Eltawila
J. Strosnider
T. King
N. Lauben
C. Tinkler
D. Bessette
F. Hasselberg
T. Kenyon
I. Catton
J. Larkins
P. Boehnert
G. Weidenhamer
F. Odar
D. Fischer
H. Li
G. Rhee
E. Sullivan
A. Notafrancesco
J. O'Brien
S. Ali
S. Lee
H. Scott
T. Lee
S. Hou
R. Caruso
R. Jones
M. Rubin
A. Levin
R. Barrett
J. Kudrick
C. Hoxie
R. Elliott
J. Han
M. Malloy
F. Orr
M. Razzaque
J. Wermiel
G. Bagchi