NRC CONFIRMATORY TESTING PROGRAM FOR SBWR

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PRESENTED AT

21ST WATER REACTOR SAFETY INFORMATION MEETING

OCTOBER 27, 1993
BETHESDA, MARYLAND

PRESENTATION OUTLINE

- BACKGROUND
- OBJECTIVE
- WORK SCOPE
- PURDUE TEST FACILITY FOR SBWR
- TEST MATRIX
- MILESTONES AND SCHEDULE

BACKGROUND

- GE HAS SUBMITTED SBWR FOR DESIGN CERTIFICATION (FINAL DESIGN APPROVAL OF SBWR - 5/96, FSER TO PM - 7/95)

- SBWR IS A NATURAL CIRCULATION REACTOR

- SBWR HAS UNIQUE SAFETY SYSTEMS NOT IN OPERATING BWRS:

  1. GDCS = GRAVITY-DRIVEN COOLING SYSTEM

  2. PCCS = PASSIVE CONTAINMENT COOLING SYSTEM

- IN ADDITION, SBWR ALSO HAS ICS (= ISOLATION CONDENSER SYSTEM), SIMILAR IN FUNCTION TO SOME OF OLDER BWRs

- GE HAS THREE INTEGRAL TESTING PROGRAMS:

  1. GIST ON SHORT-TERM GDCS PERFORMANCE (< 20 MIN. AFTER LOCA INITIATION)

  2. GIRAFFE ON LONG-TERM PERFORMANCE OF PCCS AND GDCS (> 1 HOUR AFTER LOCA INITIATION)

  3. PANDA ON LONG-TERM PERFORMANCE OF PCCS, GDCS, AND ICS (> 1 HOUR AFTER LOCA INITIATION)

- TO CONFIRM GE TEST RESULTS AND TO BROADEN DATA BASE FOR CODE ASSESSMENT, AN NRC-SPONSORED CONFIRMATORY TESTING PROGRAM FOR SBWR WAS ESTABLISHED.

OBJECTIVE OF THE NRC CONFIRMATORY TESTING PROGRAM FOR SBWR

TO PROVIDE FOR SBWR CODE ASSESSMENT THE CONFIRMATORY INTEGRAL DATA FOR A BROAD SPECTRUM OF LOCAs AND TRANSIENTS CONCURRENT WITH SINGLE OR MULTIPLE COMPONENT FAILURE:

1. PERFORMANCE OF GDCS AND PCCS (INCLUDING INTERACTIONS WITH NON-SAFETY SYSTEMS)

2. T/H RESPONSE OF VESSEL AND CONTAINMENT UNDER LOCAs AND TRANSIENTS

WORK SCOPE

FOUR ELEMENTS OF THE NRC CONFIRMATORY TESTING PROGRAM:

1. DESIGN AND CONSTRUCT A WELL-SCALED INTEGRAL TEST FACILITY, WHICH HAS ALL OF THE KEY COMPONENTS AND SYSTEMS REQUIRED FOR INVESTIGATING INTEGRAL PERFORMANCE OF GDCS AND PCCS.
   (PURDUE UNIVERSITY)

2. PROVIDE TWO PRE-CONSTRUCTION PREDICTIONS USING RELAP5/CONTAIN (FOR MAIN STEAM LINE BREAK AND BOTTOM DRAIN LINE BREAK) AND COMPARE THE RESULTS WITH SIMILAR SBWR CALCULATIONS. PROPOSE DESIGN IMPROVEMENTS, IF COMPARISON IS NOT ACCEPTABLE.
   (BNL)

3. PROVIDE CONFIRMATORY DATA FOR CODE ASSESSMENT.
   (PURDUE UNIVERSITY)

4. ASSESS THE RELAP5/CONTAIN CODE WITH DATA FROM THE PURDUE FACILITY
   (BNL)

IN ADDITION, BNL WILL ASSESS THE EXISTING LOCA DATA BASE FOR SBWR APPLICATION. (THE PURDUE FACILITY AND GE'S FACILITIES SUCH AS GIST, GIRAFFE, AND PANDA ARE LOW-PRESSURE FACILITIES, WHICH CANNOT HANDLE BLOWDOWN FROM SBWR OPERATING PRESSURE.)

PURDUE TEST FACILITY FOR SBWR

- 1/4 OF THE SBWR HEIGHT
  (FOR COMPARISON, GIST = 1,
  GIRAFFE = 1, PANDA = 1)

- 1/400 OF THE SBWR VOLUME
  (GIST = 1/508, GIRAFFE = 1/400,
  PANDA = 1/25)

- ASPECT RATIO (DIAMETER SCALE/HEIGHT SCALE)
  OF 1/2.5 (SBWR = 1, GIST = 1/22.5,
  GIRAFFE = 1/20, PANDA = 1/5)

- LOW-PRESSURE (APPROX. 150 PSIA)
  (SAME AS GIST, GIRAFFE, PANDA)

- WATER, STEAM, NON-CONDENSIBLE
  (SAME AS GIST, GIRAFFE, PANDA)

- ALL OF KEY COMPONENTS AND SYSTEMS:
  VESSEL, UPPER AND LOWER DRYWELLS, SUPPRESSION
  POOL, GDCS, PCCS, ICS, DRYWELL AND SUPPRESSION
  POOL SPRAYS, PIPING AND VALVES, AND
  INSTRUMENTATION.

- BOTH SHORT-TERM AND LONG-TERM CORE AND
  CONTAINMENT COOLING WILL BE COVERED
  TO OVERLAP GIST/GIRAFFE/PANDA DATA
  (GIST COVERED SHORT-TERM COOLING ONLY,
  GIRAFFE AND PANDA COVER LONG-TERM COOLING ONLY)

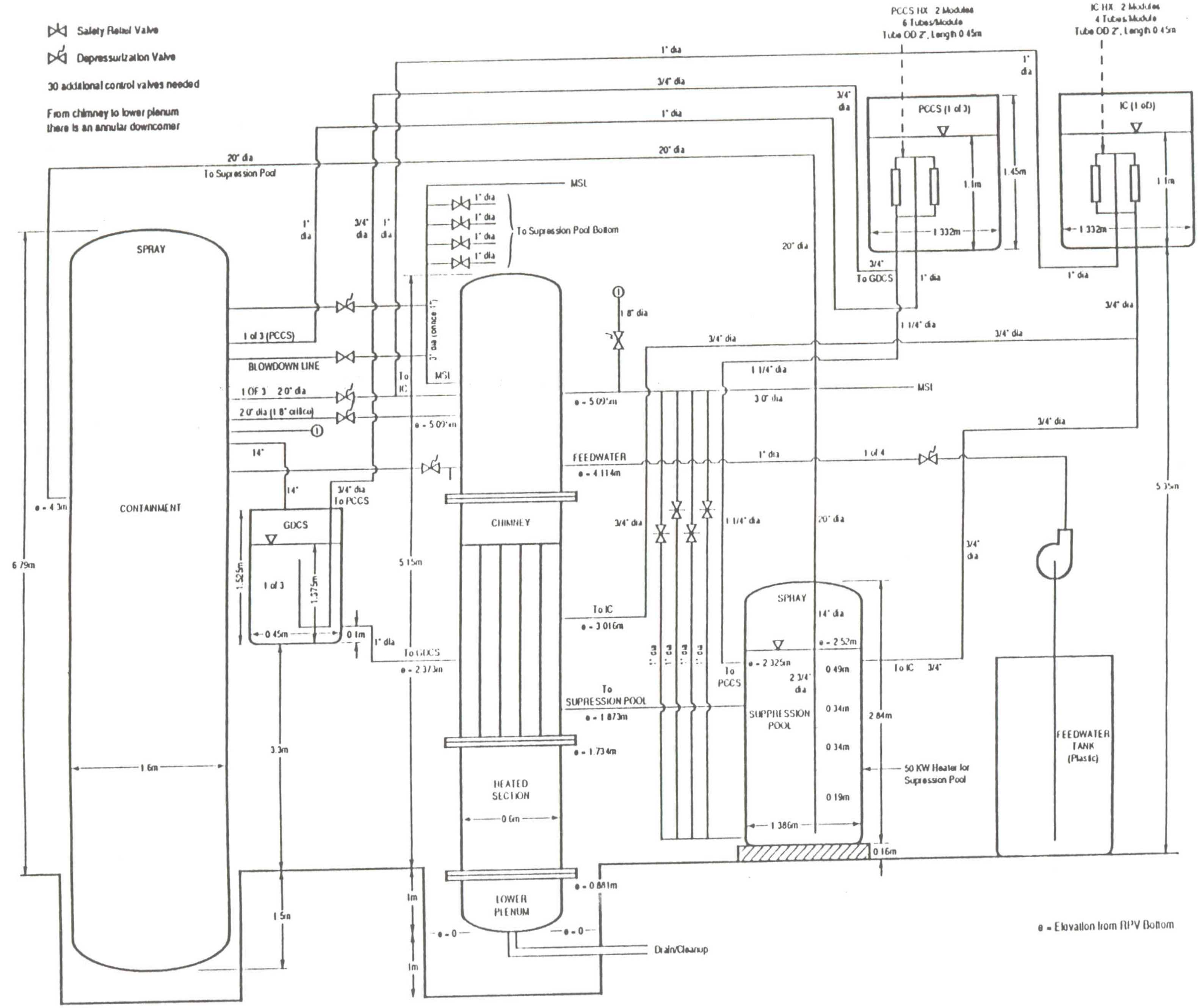

Figure 1. Elevation Drawing of Proposed Integral Facility for SBWR

Table 1. Phase 1 of the test matrix - Base case and GE counterpart tests

Test	Event	Operational Components: PCCS	ICS	GDCS Lines	DPV	VB	EQUAL	DWS	WWS
1 (Base)	MSLB	3	3	6	6	3	3	0	0
2*	MSLB (GIST B01)	0	0	4	6	3	3	0	0
3	MSLB	3	3	4	6	3	3	0	0
4 (Base)	BDLB	3	3	6	6	3	3	0	0
5*	BDLB (GIST A07)	0	0	4	6	3	3	0	0
6	BDLB	3	3	4	6	3	3	0	0
7 (Base)	GDLB	3	3	5	3	3	0	0	0
8*	GDLB (GIST C01A)	0	0	4	6	3	3	0	0
9	GDLB	3	3	4	6	3	3	0	0
10 (Base)	LOFW	3	3	6	6	3	3	0	0
11*	LOFW (GIST D03A)	0	0	4	6	3	3	0	0
12 (Base)	FWLB	3	3	6	6	3	3	0	0
13*	FWLB	0	0	4	6	3	3	0	0
14	MSLB(GIRAFFE/PANDA)								
15	BDLB(GIRAFFE)								
16	GDLB(GIRAFFE/PANDA)								
17	ICRLB(PANDA)								

*Test will be terminated when a temperature or pressure setpoint is reached to prevent damage.
VB = vacuum breaker between drywell and wetwell, EQUAL = equalization line connecting suppression pool to the vessel (e.g., 3 means all three equalization lines will open if actuated automatically or manually), DWS = drywell spray, WWS = wetwell spray, MSLB = main steam line break, BDLB = bottom drain line break, GDLB = GDCS line break, LOFW = loss of feedwater, FWLB = feedwater line break, ICRLB = isolation condenser condensate return line break. No information is currently available regarding the number of operational components in the GIRAFFE and PANDA tests.

Table 2. Phase 2 of the test matrix - sensitivity study and beyond DBA tests

Test	Event	PCCS	ICS	GDCS Lines	DPV	VB	EQUAL	DWS	WWS
		Operational Component							
18	BDLB	3	3	6	5	3	3	0	0
19	BDLB	3	3	5	6	3	3	0	0
20	BDLB	3	3	6	6	3	2	0	0
21	BDLB (1 VB failed in open position)	3	3	6	6	2	3	0	0
22	BDLB (1 VB failed in closed position)	3	3	6	6	2	3	0	0
23	BDLB (all 3 VBs failed in open position)	3	3	6	6	0	3	0	0
24	Blackout	2	3	4	6	3	3	0	0

In addition to the above tests, the following tests will be selected:

1. Several additional tests with multiple component failure.

2. A few tests to assess the impact of non-safety systems upon GDCS and PCCS (e.g., control rod drive flow or RWCU/SDCS flow on GDCS performance, drywell spray on PCCS and GDCS performance, wetwell spray on suppression pool flow to the vessel via equalization line).

3. A few tests at different break sizes (e.g., 50% of BDLB).

4. A few tests to assess natural circulation flow characterization by measuring core flow as a function of power, downcomer water level, and vessel pressure (including the determination of any flow oscillation or instability).

5. Several sensitivity tests by varying core power or other PIRT-identified important parameters.

6. A few helium tests to investigate the presence of hydrogen on PCCS performance.

7. A few repeatability tests.

MILESTONES AND SCHEDULE

- A 3-YEAR CONTRACT WAS AWARDED TO PURDUE UNIVERSITY ON JULY 26, 1993

- FIRST NRC/PURDUE MEETING ON AUGUST 17, 1993, AT PURDUE UNIVERSITY

- NRC/PURDUE/GE MEETING ON OCTOBER 1, 1993, AT PURDUE UNIVERSITY

- SECOND NRC/PURDUE MEETING IN DECEMBER 1993 AT NRC

MILESTONES AND SCHEDULE (CONT'D)

TASK	COMPLETION DATE	MILESTONE
1	12/93	PRELIMINARY FACILITY DESIGN INCLUDING INSTRUMENTATION
	-	PHENOMENA IDENTIFICATION AND RANKING (BNL INPUT)
	-	SCALING RATIONALE
	-	TEST MATRIX (NRC INPUT)
	-	INTERIM REPORT
2	2/94	DETAILED FACILITY DESIGN INCLUDING INSTRUMENTATION
	-	FINAL DESIGN REPORT
3	12/94	FACILITY CONSTRUCTION
4	3/95	FACILITY CHARACTERIZATION AND ACCEPTANCE TESTING
5		PERFORMING TESTS
	4/95	QUICK LOOK DATA REPORT: TESTS 1 - 3
	5/95	QL REPORT: TESTS 4 - 7
	7/95	QL REPORT: TESTS 8 - 17
	8/95	DATA REPORT EVERY 3 MONTHS (TESTS: 18 - 48)
6	7/96	FINAL NURER/CR DATA REPORT

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NRC CONFIRMATORY TESTING PROGRAM FOR SBWR

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Abstract

The objective of the NRC Confirmatory Testing Program for SBWR is to provide integral data for code assessment, which reasonably reproduce the important phenomena and processes expected in the SBWR under various loss-of-coolant accident (LOCA) and transient conditions. To achieve this objective, the Program consists of four coupled elements: (1) to design and construct an integral, carefully-scaled SBWR test facility at Purdue University, (2) to provide pre-construction RELAP5/CONTAIN predictions of the facility design, (3) to provide confirmatory data for code assessment, and (4) to assess the RELAP5/CONTAIN code with data. A description of the "preliminary design" of the Purdue test facility and test matrix is presented. The facility is scheduled to be built by December 1994. Approximately 50 tests will be performed from April 1995 through April 1996 and documented by interim data reports. A final and complete data report is scheduled to be published by July 31, 1996.

1. Introduction

General Electric Company (GE) has submitted for design certification an advanced boiling water reactor (BWR) called the Simplified BWR (SBWR)[1]. The SBWR design is largely based on the proven BWR technology of many years of operating experience. However, there are some differences. First, unlike most of the operating BWRs, SBWR is a natural circulation reactor with core flow driven by the hydrostatic head difference between the downcomer and the core. There is a long chimney region above the core to enhance the natural circulation flow in the SBWR vessel; there are no jet pumps in the vessel downcomer region nor the recirculation pumps outside the vessel. Second and more importantly, the SBWR uses passive (not pump-driven), safety systems to provide emergency core and containment cooling. These passive systems rely on gravity-driven stored energy (e.g., a water tank at higher elevation than the core), natural convection, and condensation to provide driving forces to maintain their operation without the use of any pumps or AC power. In addition to the passive systems, the SBWR also has pump-driven, non-safety systems that are normally operating and can be used as the first line of defense to prevent and mitigate accidents.

There are three passive safety systems in the SBWR that provide emergency core and containment cooling: (1) the low-pressure Gravity-Driven Cooling System (GDCS) for providing emergency cooling and makeup water to the reactor vessel, (2) the low-pressure Passive Containment Cooling System (PCCS) for maintaining containment cooling and integrity, and (3) the high-pressure Isolation Condenser System (ICS) that is capable of maintaining core cooling for non-LOCA transients with scram. Both the GDCS and PCCS are unique to the SBWR and do not exist in any of the operating BWRs, while the ICS is similar to those on some of the earlier BWRs but with a different condenser design. Since the GDCS is a low-pressure system, it can be initiated "only" after the vessel is almost depressurized by the automatic depressurization system (ADS), which is actuated when the vessel water level drops to 3.6 m (i.e., 11.8 ft) above the top of active fuel during a LOCA or transient (normal vessel water level at full power operation is at 18.26 m above the core). Note that the GDCS and ADS comprise the SBWR emergency core cooling systems (ECCS)[1].

Because of the unique features in these passive safety systems of the SBWR, GE has established testing programs[2] to demonstrate their performance and to provide a data base for assessing analytical tools, in compliance with the requirements of 10 CFR 52.47 for design certification[3]. The GE testing programs include three integral test facilities - namely, GIST[2,4], GIRAFFE[2], and PANDA[5], which are used to assess the performance of the GDCS (GIST), PCCS (GIRAFFE and PANDA), and ICS at low pressure (PANDA). GE also has a separate-effect PANTHERS facility[6] investigating the performance of full-pressure, prototypical condensers of the ICS and PCCS. In addition, tests were conducted to assess the performance of prototypical depressurization valves (DPVs)[2], which are part of the ADS and are also installed on the GDCS injection lines and the suppression pool equalization lines connected to the vessel[1].

To provide data for code assessment and to confirm GE test results for the SBWR including the GDCS and PCCS performance, the NRC has established a Confirmatory Testing Program for SBWR.

2. Objective

The objective of the NRC Confirmatory Testing Program for SBWR is to provide integral data for code assessment, which reproduce the important phenomena and processes as expected in the SBWR under various loss-of-coolant accident (LOCA) and transient conditions. These data will significantly broaden the current SBWR data base (to be discussed later in this paper). The data will be used to confirm GE test results for the SBWR.

3. Program Elements

The NRC Confirmatory Testing Program consists of four coupled elements being performed jointly at Purdue University and Brookhaven National Laboratory (BNL):

(1) To design and construct at Purdue University[7] a carefully-scaled integral SBWR test facility, which has all of the key components and

systems required for investigating integral performance of GDCS and PCCS (Purdue University).

(2) To provide two pre-construction predictions using RELAP5/CONTAIN[8-10] for a main steam line break and a bottom drain line break. The results will be compared with similar calculations for the SBWR. Propose design improvements to the Purdue test facility, if comparison is not acceptable (BNL).

(3) To provide confirmatory data for code assessment (Purdue University).

(4) To assess the RELAP5/CONTAIN code with data from the Purdue test facility (BNL).

The first element above includes a detailed scaling analysis being performed by Purdue and a Phenomena Identification and Ranking Table (PIRT) being performed by BNL and Purdue. The purpose of the scaling analysis, PIRT, and comparison of RELAP5/CONTAIN calculations (stated in the second element above) is to ensure that the test facility as designed can reasonably reproduce the important phenomena and processes (e.g., core coolant makeup by GDCS, containment cooling by PCCS, etc.) expected to occur in the SBWR. As a result, the data from the Purdue test facility should be valid for code assessment.

Although only two RELAP5/CONTAIN calculations of the Purdue facility are currently planned before facility construction, additional calculations of the facility and comparisons with the similar SBWR calculations will be made afterward.

4. <u>Preliminary Design of the Purdue Test Facility for SBWR</u>

The Purdue test facility for SBWR will have all of the key components and systems required for investigating the integral performance of GDCS and PCCS. The facility consists of a vessel with electrically-heated fuel rods, an upper drywell and a lower drywell, suppression pool (namely, wetwell), safety systems including GDCS, PCCS, and ICS, non-safety systems (including drywell spray, wetwell spray, and pump-driven water injection to the vessel), and connecting pipes and valves. Sufficient instrumentation will be provided to collect data for code assessment. Non-safety systems are included in the facility so that possible interactions with the safety systems such as GDCS and PCCS can be investigated. Figure 1 shows a simplified drawing of the preliminary design of the Purdue test facility including a vessel, upper and lower drywells, suppression pool, three GDCS pools (only one is shown), three PCCS condensers and three ICS condensers (only one each is shown). Not shown in Fig. 1 are the non-safety systems mentioned earlier and a feedwater tank. In comparison, GIST did not have PCCS and ICS, and GIRAFFE was not equipped with concurrent operation of ICS and PCCS. Non-safety systems such as drywell spray and wetwell spray are not present in GIST, GIRAFFE, and PANDA.

Since the SBWR does not have high-pressure safety systems to provide emergency coolant injection to the vessel and both GDCS and PCCS are designed to operate at low pressure, a "low-pressure" test facility is deemed technically adequate as a cost-effective design for providing integral data for code assessment. The Purdue test facility is a low-pressure facility with its vessel designed for 150 psia and containment components designed for about 90 psia. It is worth noting that all of the GE integral facilities including GIST, GIRAFFE, and PANDA are also low-pressure facilities.

Based on a detailed scaling analysis performed by Purdue, the height scale of the Purdue facility is selected to be 1/4 of the SBWR height, and the volume scale is 1/400 of the SBWR volume. This leads to an area scale of 1/100 of the SBWR flow area. In comparison, GIST, GIRAFFE, and PANDA are full-height facilities. GIST has a volume scale of 1/508 of an earlier SBWR design; GIRAFFE has a volume scale of 1/400 of an earlier SBWR design; PANDA has a volume scale of 1/25 of the current SBWR design. The volume scale of Purdue facility is the same as GIRAFFE, but smaller than PANDA.

However, the Purdue facility has an aspect ratio (AR) of 2.5 (defined here as = height scale/diameter scale = 0.25/0.1), which is closer to the SBWR (AR = 1) than GIST (AR = 22.5), GIRAFFE (AR = 20), and even PANDA (AR = 5). The Purdue facility has a favorable aspect ratio for investigating multi-dimensional phenomena in the vessel and containment.

5. Preliminary Test Matrix

The preliminary test matrix consists of a total of approximately 50 tests divided in Phases 1 and 2, which cover a broad spectrum of LOCAs and transients. For each LOCA or transient test, there can be a single failure of a component (e.g., a GDCS injection line that is connected to the vessel, a PCCS unit, etc.), or multiple component failure, or no component failure (for base cases only).

Phase 1

Phase 1 of the preliminary test matrix is listed in Table 1. It consists of 17 tests - 5 base case tests (Tests 1, 4, 7, 10, and 12), 8 GE counterpart tests (Tests 2, 5, 8, 11, and 14 - 17), and 4 complementary tests (Tests 3, 6, 9, and 13). Four types of LOCAs and a transient will be investigated: bottom drain line break (BDLB), main steam line break (MSLB), GDCS line break (GDLB), feedwater line break (FWLB), and loss of feedwater (LOFW).

The five base case tests are the tests in which all of the listed components that are supposed to be operational are operational. The components listed in Table 1 include PCCS (a total of 3 in SBWR), ICS (a total of 3 in SBWR), DPV (a total of 6), VB (vacuum breaker between the upper drywell and gas space of the suppression pool, a total of 3), and EQUAL (equalization line between the suppression pool and the vessel, a total of 3), DWS (drywell spray, 0 means that it is not operational), and WWS (wetwell spray, 0 means not operational).

The eight GE counterpart tests have similar test conditions, to the extent feasible, as the integral tests in GIST, GIRAFFE, and PANDA. The four complementary tests complement the base case tests and GE counterpart tests.

For instance, Test 3 has the same break size and location as Test 1 (a base case test for MSLB) and Test 2 (a counterpart test to GIST Test B01) but with different operational components. Test 3 has less operational components than Test 1 but more than Test 2. Note that the number of operational PCCS or ICS in Test 2 is zero due to the lack of PCCS or ICS in GIST. To assess the impact of PCCS and ICS on the GDCS performance, Test 3 has three PCCS units and three ICS units operational in addition to what are available in Test 2.

It should be pointed out that Tests 12 and 13 for FWLB have no counterpart tests in GIST, GIRAFFE, and PANDA. The numbers of operational components for Tests 14 - 17 are left in blank for current lack of information. In addition to those 17 tests listed in Table 1, a few repeatability tests may also be needed as part of the Phase 1 tests.

Phase 2

Table 2 lists Phase 2 of the preliminary test matrix that includes sensitivity study tests and beyond DBA (design-basis accidents) tests. Table 2 should consist of Tests 18 - 50, but only Tests 18 - 24 are listed. Tests 25 - 50 are yet to be selected to accommodate the future NRC needs. Tests 18 - 22 are for BDLB concurrent with a single component failure. Test 18 has a single DPV failure (i.e., not open). Test 19 has a single failure of a GDCS injection line (i.e., a valve on the line not open on demand). Test 20 has a single failure of an equalization line (i.e., a valve on the line not open on demand). Test 21 has a vacuum breaker failed in open position. Test 22 has a vacuum breaker failed in closed position. The purpose of Tests 18 - 22 is to assess the impact of a single component failure on GDCS and PCCS performance. Test 23 has multiple component failure - all three vacuum breakers failed in open position. Test 24 is a station blackout test (namely, loss of all AC power) concurrent with a PCCS unit not available for operation.

It should be pointed out that most of the tests in Phase 1 and Phase 2 will begin when the vessel is depressurized to about 150 psia and continue to cover the short-term cooling involving initial injection of GDCS water to the vessel and the long-term cooling. The tests will last long to capture the important phenomena and processes expected to occur during the long-term cooling, which include continuous replenishment of GDCS pools by PCCS condensate, PCCS purging of drywell noncondensibles to the suppression pool, possible suppression pool water injection to the vessel via equalization lines, etc. In comparison, GIST tests only covered the short-term cooling and ended at less than 30 minutes after an accident or transient initiation; as a result, the long-term cooling was not investigated in GIST. GIRAFFE and PANDA tests begin at about 1 hour after LOCA initiation, and consequently the short-term cooling is not covered.

6. Schedule

The Purdue test facility for SBWR is scheduled to be built by the end of 1994. It will become fully operational and begin to produce data around April 1995. A total of approximately 50 tests will be performed from April 1995 through April 1996 with interim data reports published. A final and complete data report will be published by July 31, 1996. Meanwhile, assessment of the RELAP5/CONTAIN code will be performed against the data.

7. Conclusions

The NRC Confirmatory Testing Program for SBWR will provide integral data for code assessment and for confirming GE test results. A total of approximately 50 tests, which cover a broad spectrum of LOCAs and transients, will be performed at the Purdue test facility from April 1995 through April 1996. The data from these tests are expected to reasonably reproduce important phenomena and processes expected in the SBWR and will significantly broaden the current SBWR data base for code assessment.

8. Acknowledgement

The authors wish to thank their NRC colleagues (including Alan Levin, Robert Jones, Robert Elliott, Joseph Staudenmeier, and Allen Notafrancesco) for helping develop the test matrix.

9. References

1. GE Nuclear Energy, "SBWR Standard Safety Analysis Report," 25A5113 Rev. A, August 1992.

2. A. S. Rao, "SBWR Design and Testing Program," presented to the ACRS Thermal Hydraulic Phenomena Subcommittee on April 23, 1993.

3. U. S. Government, "Code of Federal Regulations," 10 Parts 51 to 99, Revised as of January 1, 1993, U. S. Government Printing Office, 1993.

4. P. F. Billig, "Simplified Boiling Water Reactor (SBWR) Program Gravity-Driven Cooling System (GDCS) Integrated System Test - Final Report," GEFR-00850, October 1989.

5. J. R. Fitch, "ALPHA Test Program," presented to the ACRS Thermal Hydraulic Phenomena Subcommittee on April 23, 1992.

6. P. F. Billig, "PANTHERS - IC/PCCS Heat Exchanger Test Program," presented to the ACRS Thermal Hydraulic Subcommittee on April 23, 1992.

7. U. S. Nuclear Regulatory Commission, Contract No. NRC-04-93-049, awarded on July 26, 1993 to Purdue University.

8. NUREG/CR-5535 (Draft), "RELAP5/MOD3 Code Manual," Vols 1-5.

9. NUREG/CR-5026, "User's Manual for CONTAIN 1.1: "A Computer Code for Severe Nuclear Reactor Accident Containment Analysis," November 1989.

10. NUREG/CR-5715, "Reference Manual for the CONTAIN 1.1 Code for Containment Severe Accident Analysis," July 1991.

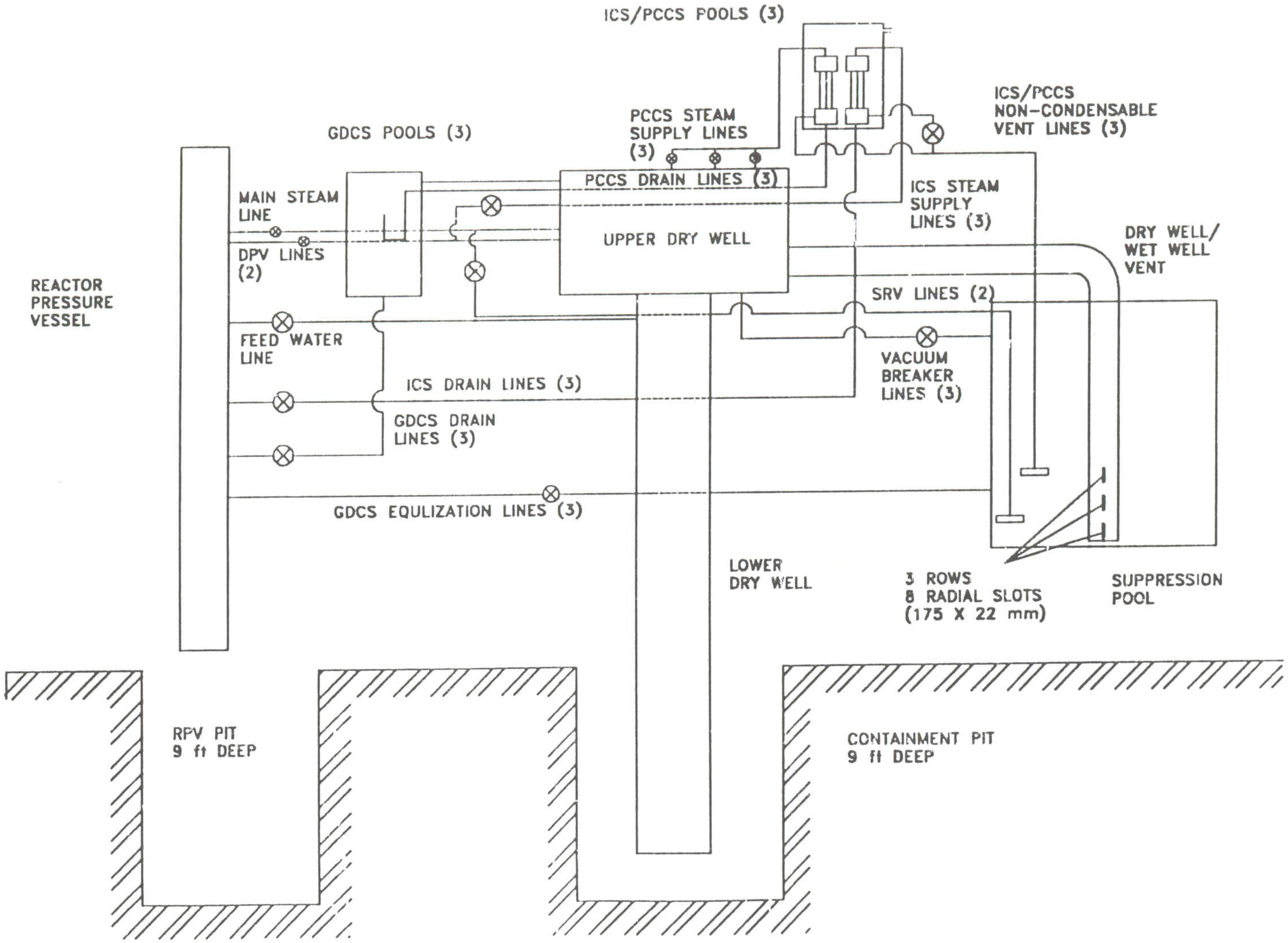

Fig. 1. A simplified drawing of the Purdue test facility for SBWR.

Table 1. Phase 1 of the test matrix - Base case and GE counterpart tests

Test	Event	Operational Components PCCS	ICS	GDCS Lines	DPV	VB	EQUAL	DWS	WWS
1 (Base)	MSLB	3	3	6	6	3	3	0	0
2*	MSLB (GIST B01)	0	0	4	6	3	3	0	0
3	MSLB	3	3	4	6	3	3	0	0
4 (Base)	BDLB	3	3	6	6	3	3	0	0
5*	BDLB (GIST A07)	0	0	4	6	3	3	0	0
6	BDLB	3	3	4	6	3	3	0	0
7 (Base)	GDLB	3	3	5	3	3	0	0	0
8*	GDLB (GIST C01A)	0	0	4	6	3	3	0	0
9	GDLB	3	3	4	6	3	3	0	0
10 (Base)	LOFW	3	3	6	6	3	3	0	0
11*	LOFW (GIST D03A)	0	0	4	6	3	3	0	0
12 (Base)	FWLB	3	3	6	6	3	3	0	0
13*	FWLB	0	0	4	6	3	3	0	0
14	MSLB(GIRAFFE/PANDA)								
15	BDLB(GIRAFFE)								
16	GDLB(GIRAFFE/PANDA)								
17	ICRLB(PANDA)								

*Test will be terminated when a temperature or pressure setpoint is reached to prevent damage.
VB = vacuum breaker between drywell and wetwell, EQUAL = equalization line connecting suppression pool to the vessel (e.g., 3 means all three equalization lines will open if actuated automatically or manually), DWS = drywell spray, WWS = wetwell spray, MSLB = main steam line break, BDLB = bottom drain line break, GDLB = GDCS line break, LOFW = loss of feedwater, FWLB = feedwater line break, ICRLB = isolation condenser condensate return line break. No information is currently available regarding the number of operational components in the GIRAFFE and PANDA tests.

Table 2. Phase 2 of the test matrix - sensitivity study and beyond DBA tests

Test	Event	Operational Component PCCS	ICS	GDCS Lines	DPV	VB	EQUAL	DWS	WWS
18	BDLB	3	3	6	5	3	3	0	0
19	BDLB	3	3	5	6	3	3	0	0
20	BDLB	3	3	6	6	3	2	0	0
21	BDLB (1 VB failed in open position)	3	3	6	6	2	3	0	0
22	BDLB (1 VB failed in closed position)	3	3	6	6	2	3	0	0
23	BDLB (all 3 VBs failed in open position)	3	3	6	6	0	3	0	0
24	Blackout	2	3	4	6	3	3	0	0

In addition to the above tests, the following tests will be selected:

1. Several additional tests with multiple component failure.

2. A few tests to assess the impact of non-safety systems upon GDCS and PCCS (e.g., control rod drive flow or RWCU/SDCS flow on GDCS performance, drywell spray on PCCS and GDCS performance, wetwell spray on suppression pool flow to the vessel via equalization line).

3. A few tests at different break sizes (e.g., 50% of BDLB).

4. A few tests to assess natural circulation flow characterization by measuring core flow as a function of power, downcomer water level, and vessel pressure (including the determination of any flow oscillation or instability).

5. Several sensitivity tests by varying core power or other PIRT-identified important parameters.

6. A few helium tests to investigate the presence of hydrogen on PCCS performance.

7. A few repeatability tests.

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TWENTY-FIRST WATER REACTOR SAFETY INFORMATION MEETING

at the
Bethesda Marriott Hotel
5151 Pooks Hill Road
Bethesda, Maryland

October 25-27, 1993

This is the **Preliminary Agenda** for the 21st WRSM. The final program will be handed out at the meeting. Please note the details as described below and in the enclosed Meeting Information flyer. A registration card is also enclosed.

LOCATION:	Bethesda Marriott Hotel
REGISTRATION FEE:	3-days $130.00 (All inclusive) 1-day $50.00
PAYMENT:	Reservations and payment required by October 8, 1993 **Note: Payment required in U.S. currency, U.S. Traveler's Check, or check ($) drawn against U.S. Bank payable to *A.U.I.***
REGISTRATION:	Sunday, October 24, 5 to 7 p.m. in Salon A Monday through Wednesday, 8 a.m. in Salon A Avoid long registration lines -- return your registration card and payment to the address shown below by **October 8, 1993.**
TRANSPORTATION:	Medical Center Metro Station on Red Line Complimentary shuttle service to/from Marriott Hotel Telephone 897-9400 to request pickup at Metro
RECEPTION / MIXER:	Monday, October 25, 6:30 to 8:00 p.m. in Congressional Ballroom
LUNCH:	12:00 to 1:30 p.m. in Congressional Ballroom

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