



GE Nuclear Energy

General Electric Company
175 Carlin Avenue, San Jose, CA 95128

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

Attention: Robert C. Pierson, Director
Standardization and Non-Power Reactor Project Directorate

Subject: Information Requested during the December 17, 1992 Meeting on
the SBWR Testing Program

Dear Mr. Pierson:

During the subject meeting, the Staff asked GE to provide additional information concerning the GIRAFFE, PANTHERS, PANDA, and MIT/UCB testing programs. The enclosed information follows the format suggested by the Staff during the meeting. This information will clarify the on-going and completed tests that have been discussed over the past months. GE suggests that a meeting be held in San Jose on January 28, 1993, to discuss the content of the enclosure.

Sincerely,

P.P. Stancavage, Acting Manager
Safety & Licensing
M/C 444, (408) 925-6948

Enclosure

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SBWR Test Programs

University Condensation Tests

1. **Purpose:**

The MIT and UCB test programs were initiated in order to develop a heat transfer correlation for steam condensation that can be used in the TRACG analysis of the SBWR IC and PCCS condensers. The effective heat transfer in the condensers is dependent on both shear enhancement and noncondensable gas effects. Previously published studies in this area have considered the effects of noncondensable gases, but they have mainly dealt with external surfaces and report only average heat transfer coefficients. The present studies provide the local heat transfer coefficient for steam condensation inside of tubes. The noncondensables considered are air and helium representing, respectively, nitrogen and hydrogen in the SBWR containment. A correlation based on the completed test data has been incorporated in TRACG. Additional tests to be conducted this year will provide confirmation of previous results.

2. **Scaling Analysis:**

All tests used essentially full length tubes. The Reference 1 experiments used a 1" diameter tube. All others have used 2" diameter tubes, which are prototypical of SBWR condenser tubes. Additional details are given in Reference 2.

3. **Test Instrumentation:**

This is discussed in References 1 through 4.

4. **Test Matrix:**

Details are given in References 2 through 5.

5. **Test Schedule:**

Testing in support of the SSAR are complete. Additional confirmatory testing is scheduled for completion by September 1993.

6. **Post-test Analysis:**

References 1 through 6 provide the post test analysis of data used in the SSAR analysis. An additional test report documenting the ongoing testing will be provided in November 1993.

7. **NRC Site Visit:**

It is recommended that the NRC staff visit to the two test sites be the week of March 22, 1993 for the University of Calif. at Berkeley and the week of April 19, 1993 for MIT.

SBWR Test Programs

University Condensation Tests (cont.)

References:

1. Karen Vierow and Virgil Schrock, "Condensation in a Natural Circulation Loop with Noncondensable Gases, Parts I and II", Proceedings of the International Conference on Multiphase Flows, Tsukuba, Japan, September 1991.
2. Karen Vierow, "Behavior of Steam-Air Systems Condensing in Cocurrent Vertical Downflow", M.S. Thesis, U.C. Berkeley Dept. of Nuclear Engineering, August 1990.
3. Mansoor Siddique, "The Effects of Noncondensable Gases on Steam Condensation under Forced Convection Conditions", Doctor of Philosophy Dissertation, Massachusetts Institute of Technology, January 1992.
4. Daniel Ogg, "Vertical Downflow Condensation Heat Transfer in Gas-Steam Mixtures", M.S. Thesis, U.C. Berkeley Dept. of Nuclear Engineering, December 1991.
5. M. Golay, "Steam Condensation Measurements at MIT", provided by J. Baechler to the U.S. NRC.
6. J. Kuhn, V.E. Schrock, P.F. Paterson, "Status of UCB Condensation Experiment", provided by J. Baechler to the U.S. NRC.

SBWR Test Programs

GIRAFFE

1. **Purpose:**
The objectives of the GIRAFFE testing program are to provide separate effects and integral test data for qualification of TRACG, the computer code which will be used for analysis of the SBWR containment. The separate effects tests address the issues of steam condensation heat transfer rates from a steam-nitrogen mixture under steady-state conditions, and of venting of noncondensable gases from scaled-down passive containment heat exchangers (PCC's) to the suppression pool. The integral tests demonstrate the concept of the PCC System and provide data for a variety of LOCA simulations, against which analytical models for the containment may be qualified.
2. **Scaling Analysis:**
Details are provided in References 1, 2 and 3.
3. **Test Instrumentation:**
A description is given in References 1, 2 and 3.
4. **Test Matrix:**
Data from the separate effects condensation tests were obtained at a total pressure of 0.3 MPa, for steam flow rates of 0.01 to 0.04 kg/s and nitrogen partial pressures of 0.0 to 0.03 MPa. The initial conditions for the noncondensable venting and long-term integral tests corresponded to those at one hour after LOCA occurrence. For the venting study, the nitrogen vent line of the scaled-down heat exchanger was submerged by 0.40m, 0.65m, and 0.90m. The main steam line break, GDCS line break and bottom drain line break LOCAs were simulated during the long-term system response tests.

Additional details are given in References 1, 2 and 3.
5. **Test Schedule:**
Testing has been completed.

SBWR Test Programs

GIRAFFE (cont)

6. **Post-test Analysis:**

A complete qualification of the TRACG computer code is given in Reference 6. Additional analyses are presented in References 1, 4 and 5. In May, 1993, a report presenting the results of testing completed in late 1992, specifically the Gravity-Driven Cooling System and Bottom Drain line break integral tests, will be supplied to the NRC.

7. **NRC Site Visit:**

A recommendation regarding the date for a site visit will be made by the end of this month. GE needs to confirm availability with Toshiba.

References:

1. "Joint Study Report, Feature Technology of Simplified BWR (Phase-1)", Final Report, 1990.
2. Nagasaka, H., K. Yamada, M. Katoh, S. Yokobori, "Heat Removal Tests of Isolation Condenser Applied as a Passive Containment Cooling System", from transactions of *International Conference on Nuclear Engineering - 1*, Tokyo, Japan, Nov., 1992, pp. 257-263.
3. Yokobori, S., H. Nagasaka, T. Tobimatsu, "System Response Test of Isolation Condenser Applied as a Passive Containment Cooling System", from transactions of *International Conference on Nuclear Engineering - 1*, Tokyo, Japan, Nov., 1992, pp. 265-271.
4. Oikawa, H., K. Arai, H. Nagasaka, "Optimization Study on SBWR Isolation Condenser Heat Removal Performance", from transactions of *International Conference on Nuclear Engineering - 1*, Tokyo, Japan, Nov., 1992, pp. 273-279.
5. Arai, K., H. Nagasaka, "Analytical Study on Drywell Cooler Heat Removal Performance as a Passive Containment Cooling System", from transactions of *International Conference on Nuclear Engineering - 1*, Tokyo, Japan, Nov., 1992, pp. 281-287.
6. Andersen, J. G. M., et. al, "TRACG02 Qualification Licensing Topical Report", (scheduled publication in February, 1993).

SBWR Test Programs

PANTHERS TEST

1. **Purpose:**
The major objective of these tests is to confirm, for the Passive Containment Cooling (PCC) condenser, the thermal-hydraulic performance for the SBWR service conditions. See reference document Par. 3.2 for more details.
2. **Scaling Analysis:**
This is a test of full-scale prototype of the condenser, therefore no scaling analysis is necessary.
3. **Test Instrumentation:**
See reference document, Par. 4.1.4.
4. **Test Matrix:**
See reference document, Par. 5.2 and Appendix A.
5. **Test Schedule:**
The test schedule is currently under revision, and the new schedule will be available by the end of this month. The PCC shakedown testing will occur during the second half of this year. Matrix testing will start approximately one month later.
6. **Post-test Analysis:**
A report describing PCC confirmatory test results will be completed during the first quarter of 1994.
7. **NRC Site Visit:**
It is recommended that the NRC visits to the PANTHERS test site be:
(1) during the May/June 1993 time frame for review of the test matrix and
(2) approximately November/December 1993 to witness the PCC tests.

Reference:

"Isolation Condenser & Passive Containment Condenser Test Requirements",
GE NE Document No. 23A6999, Rev. 1, 11/12/91.

SBWR Test Programs

PANDA TESTS

1. **Purpose:**
The overall objectives of these tests are to demonstrate that the containment long term cooling performance is the same in a large scale system as previously demonstrated at a smaller scale (GIRAFFE) and that with non-uniform drywell conditions, no significant adverse effects are introduced on the performance of the Passive Containment Cooling System (PCCS).
2. **Scaling Analysis:**
See reference document.
3. **Test Instrumentation:**
See attached material taken from Draft TM-42-18, ALPHA-213.
4. **Test Matrix:**
Two main steamline (MSL) break tests will be performed. The first test will duplicate the initial conditions of the GIRAFFE MSL break test with uniform drywell conditions and the second will be the same except with non-uniform conditions in the drywell.
5. **Test Schedule:**
The testing will be performed in the first half of 1994.
6. **Post-test Analysis:**
A test report is expected to be available by mid-1994.
7. **NRC Site Visit:**
It is recommended that the next NRC visit to the PANDA test site be during the May/June 1993 period to review test procedures and planned data analysis.

Reference:

Coddington, P., "ALPHA - The Long Term Passive Decay heat Removal and Aerosol Retention Programme" (previously given to NRC).