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Attention: Theodore E. Quay, Director
Standardization Project Directorate

Subject: SBWR, GIRAFFE SYSTEMS INTERACTION TEST CHANGES

Reference: Phonecon, GE/NRC, GIRAFFE SYSTEMS INTERACTION TEST, May 15, 1995

During the Referenced telephone call changes were agreed to, in principal, for the GIRAFFE Systems Interaction Tests, pending agreement with Toshiba. Toshiba has agreed to the changes. The attachment to this letter is markups of subsection A.3.1.7, GIRAFFE/SIT (Systems Interaction Test) and Tables A.3-21 and A.3-23 of the SBWR Test and Analysis Program Description, NED-32391 Revision B, which describe the changes agreed to.

If you have any questions regarding the changes, please call J. D. (Jack) Duncan of our staff on (408) 925-6947.

Sincerely,

J D Duncan, acting for

James E. Quinn, Projects Manager
LMR and SBWR Programs

Attachment: Markups of Subsection A.3.1.7 and Tables A.3-21 and A.3-23 of NED-32391 Revision B.

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nitrogen used in Test H1 is replaced with helium to obtain a one-to-one comparison of PCC system performance in the presence of lighter-than-steam and heavier-than-steam noncondensibles. Tests H3 and H4 are dependent upon the assumption of 100% metal water reaction to generate hydrogen over a one hour period. Due to the continuous purging of gases from the drywell to the wetwell during the time of hydrogen generation, the equilibrium concentration of hydrogen in the drywell is substantially less than would occur if all of the hydrogen were generated instantaneously. The 20% helium partial pressure initial condition for Test H3 is based on this equilibrium value. Thus, Test H3 does not utilize a helium mass equivalent to hydrogen from a 100% metal water reaction in a SBWR, but about a fifth of that value.

A.3.1.6.5 TRACG Analysis Plans

All tests in the GIRAFFE/Helium H-series will have TRACG analysis performed on a blind post test basis. Although the tests will be performed prior to TRACG analysis, the analyst will have no knowledge of the test results while the analysis is being performed. Tests T1 and T2 will have TRACG analysis performed on a post-test basis.

A.3.1.7 GIRAFFE/SIT (Systems Interaction Test)

A.3.1.7.1 Test Description

Overview

The GIRAFFE/SIT (System Interaction Tests) will be performed by the Toshiba Corporation at their Nuclear Engineering Laboratory in Kawasaki City, Japan. Test data will be obtained for TRACG qualification during the late blowdown/early GDCS phase of liquid line breaks.

The facility configuration is discussed in Subsection A.3.1.6.1 and is shown schematically in Figure A.3-18, with the addition of a second heat exchanger so that both the PCC and IC can be in operation simultaneously. The configuration of the IC is similar to the PCC unit shown in Figure A.3-19.

The GIRAFFE/SIT tests will be performed in accordance with Japanese Quality Assurance Standard JEAG-4101, 1990 (Reference 58). Review of this standard against the requirements of ANSI/ASME NQA-1 has shown that the essential elements of NQA-1 are met by this standard. Therefore, results from the GIRAFFE/SIT test program are appropriate for use as design basis data.

Instrumentation

Instrumentation utilized in the GIRAFFE/SIT test program is similar to that used in earlier GIRAFFE tests. (See Subsection A.3.1.6.1.)

Method

GIRAFFE/SIT testing follows a methodology very similar to that used in PANDA and GIRAFFE/Helium. Once the initial conditions for a given test have been established, all control (except for the decay of RPV power and possibly the microheater power) will be terminated. The GIRAFFE RPV and containment will be allowed to function without operator intervention,

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mirroring the SSAR assumptions for the SBWR. Details will be identified in the Test Plan and Procedure for these tests.

A.3.1.7.2 Test Objectives

In the initial GE evaluation, no need for these tests was identified. However on page 16 of the TAPD Draft Safety Evaluation Report (DSER) the NRC staff notes, "While GE considers MSLBs to be the limiting accident in terms of containment performance, both GDCS line breaks and bottom drain line (BDL) breaks are more limiting in terms of reactor vessel response, especially minimum water level. The staff has, therefore concluded that additional integral systems tests are required as part of the design certification test program for the SBWR. The tests should be performed in an appropriately scaled facility that (a) represents the current design of the SBWR; (b) has the capability of simulating a range of design basis events, including GDCS line breaks and BDL breaks; and (c) has sufficient power and pressure capability to represent these events prior to the initiation of GDCS injection." The GIRAFFE facility meets these criteria.

Based on the above, the test objective of the GIRAFFE/SIT Test Program is:

Provide a data base to confirm the adequacy of TRACG to predict the SBWR ECCS performance during the late blowdown/early GDCS phase of a LOCA, with specific focus on potential systems interaction effects. *(Integral Systems Tests)*

A.3.1.7.3 Test Matrix and Data Analysis

A series of four transient systems tests is planned to provide an integral systems database for potential systems interaction effects in the late blowdown/early GDCS period. All four tests are liquid breaks: two GDCS line breaks and two bottom drain line breaks. Tests will be performed with and without the IC and PCC in operation, and two different single failures are considered. The test matrix defining the four tests is given in Table A.3-21. Preliminary initial conditions for the base case, Test GS1, are given in Table A.3-22.

The initial conditions for all tests approximate SBWR conditions 10 minutes post-LOCA, based on the breaks and equipment operations listed in Table A.3-21. All tests will run for approximately two hours. Containment related parameters will be taken from the appropriate SBWR TRACG LOCA case at the time RPV pressure is 1.034 mPa (150 psia).

The RPV collapsed water level at the start of the test will be determined by using the TRACG GIRAFFE model. Since GIRAFFE is not an exact "scale model" of the SBWR, it will not be practical to have the water/steam distribution in GIRAFFE be the same as in SBWR. For example, the GIRAFFE RPV lower plenum is shorter than the SBWR lower plenum. Additionally, the GIRAFFE RPV material is thinner, and begins the LOCA simulation at a lower temperature than the SBWR. As a result, a smaller amount of energy is transferred to the RPV lower plenum fluid in GIRAFFE. Methods to better simulate this energy addition are being investigated, and may effect the final definition of the initial RPV water level.

Additional details on the initial conditions for the other GIRAFFE/SIT tests will be included in the Test Plan and Procedure.

The following provides the purpose and additional information on each GIRAFFE/SIT test:

- Test GS1 is the base case test, a GDCS line break, with DPV failure as the single failure and neither the PCCS, nor the IC, in operation. This test has initial conditions similar to GIST Test C01A, and may be compared with GIST C01A to evaluate the effects of configuration distortions in GIST and potential GDCS containment system performance interactions.

- Test GS2 is ~~a bottom drain line break, otherwise similar to Test GS1~~. Test GS2 results will be compared to those of Test GS1 ~~to determine the effects of break location on minimum water level. Test GS2 will also be compared to GIST Test A01 in the same manner as Tests GS1 and C01A~~.

- Test GS3 is ~~also~~ a bottom drain line break with DPV failure, ~~but~~ for this test both the PCCS and IC will be functioning. Data from test GS3 will be ~~compared directly with Test GS2~~ for identification of potential systems interactions associated with the IC and PCC.

- Test GS4 is a GDCS line break, with the single failure being a GDCS valve failure in one of the other GDCS injection lines. ~~As in Test GS3~~, both the PCC and IC will be in operation. This condition is expected to provide the slowest rate of recovery of water level. Data from test GS4 can be compared to test GS1 to identify potential interactions with the IC and PCC even though the single failures are different.

GIRAFFE/SIT Tests GS1 though GS4 provide a data base for TRACG qualification that meets the GIRAFFE/SIT test objective.

A.3.1.7.4 Justification of Test Conditions

Choice of the Base Case Test

Test GS1, the base case test for this series, had conditions defined that resulted in the lowest predicted chimney water level, considering the various break locations, sizes, and single failure combinations. Additionally, the commonality of conditions between this case and that of GIST Test C01A allows a comparison between the GIST and GIRAFFE simulations. The differences between the GIST and GIRAFFE test configurations allow an assessment of the effect of containment on GDCS performance.

Other Tests

The other test cases were defined with the objective of identifying systems interactions, should they occur. Since the primary focus of this testing is GDCS performance, the RPV water level is the figure of merit in these investigations. TRACG predictions for several break locations, single failures, and IC/PCC operation combinations were performed. The additional tests were chosen based on these results, which are presented in Table A.3-23.

A.3.1.7.5 TRACG Analysis Plan

All four transient tests in the GIRAFFE/SIT series will have TRACG analysis performed on a blind post test basis. Although the tests will be performed prior to the TRACG analysis, the analyst will have no knowledge of the test results while the analysis is being performed.

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Exceptions will be information needed to conduct the analysis such as actual initial conditions, decay power and microheater power during the test. The assessment of TRACG's adequacy will be based on the ability to predict chimney and downcomer water level.

A.3.1.8 Other Analyses Planned

The previous sections have discussed the major SBWR-unique test programs and defined the test conditions to be analyzed with TRACG.

This section will give a brief overview of these tests and the anticipated corresponding TRACG analyses.

A.3.1.8.1 1/6 Scale Boron Mixing Test

GE-NE has performed a set of boron mixing injection tests for BWR/5 and BWR/6 geometries. These tests were reported in Reference 28. The tests were performed in a 1/6 scale three-dimensional model of a 218 in. reactor pressure vessel, and used the High Pressure Core Spray (HPCS) spargers as the primary injection location of the simulated boron solution. Using scaled boron injection rates of either 400 or 86 gpm, with and without HPCS flow, the parametric effects on mixing were examined in the upper plenum and core bypass regions. Two alternate injection locations were also examined.

Standby Liquid Control injection locations are different in the SBWR from previous product lines, due primarily to the natural circulation recirculation feature of the SBWR. The SBWR utilizes direct injection into the core region through the shroud at 16 locations.

A series of TRACG predictions of the BWR/5-6 data is planned. Specific test cases to be analyzed have not yet been identified. Primary data comparisons will be made against data for the *mixing coefficient*, which is defined as the concentration of injected solution at the measured location divided by the concentration that would be present if the injected solution were uniformly mixed with the entire vessel inventory. Comparisons will be made at several locations.

A.3.1.8.2 CRIEPI Natural Circulation Thermal-hydraulic Test Facility

The CRIEPI test facility is a parallel channel test facility intended to study the stability characteristics of a natural circulation loop during startup conditions. The two parallel channels are 1.79m high and are equipped with heaters with a maximum power input of 64 kW each. At the channel exit, there is an adiabatic chimney which is 5.7m high. The loop has a separator, a condenser and a subcooler which are used to return the condensed steam to the downcomer. A preheater with a capacity of 150 kW controls the inlet temperature to the channels. Tests have been run at low pressure to simulate low pressure loop startup. Oscillations have been observed under some conditions and a stability map has been created for the test loop.

Table A.3-20 GIRAFFE/Helium Test T2 Initial Conditions

Parameter	Value	Tolerance
RPV Pressure (kPa)	267	±6 kPa
Initial Heater Power (kW)	41+heat loss compensation	±1 Kw
RPV Collapsed Water Level (m)*	13.2	±0.150 m
Drywell Pressure (kPa)	266	±4 kPa
Drywell Nitrogen Pressure (kPa)	38	±4 kPa
Wetwell Pressure (kPa)	266	±4 kPa
Wetwell Nitrogen Pressure (kPa)	212	±4 kPa
GDCS Gas Space Pressure (kPa)	266	±4 kPa
GDCS Nitrogen Pressure (kPa)	246	±4 kPa
Suppression Pool Temperature (K)	352	±2 K
PCC Pool Temperature (K)	373	±2 K
GDCS Pool Temperature (K)	333	±2 K
GDCS Pool Level (m)	†	
Suppression Pool Level* (m)	3.2	±0.075 m
PCC Collapsed Water Level *(m)	23.2	±0.075 m
PCC Vent Line Submergence (m)	0.90	±0.075 m

* Referenced to the TAF.

† GDCS pool level should be positioned in hydrostatic equilibrium with the RPV level (including an appropriate adjustment for temperature difference.

Table A.3-21 GIRAFFE/SIT Test Matrix

Test	Break	Single Failure	IC/PCCS on?
GS1	GDL	DPV	No
~~GS2~~	~~BDL~~	~~DPV~~	~~No~~
GS2	GDL	DPV	Yes
GS3	BDL	DPV	Yes
GS4	GDL	GDCS	Yes

GDL = Gravity Drain Line
BDL = Bottom Drain Line
DPV = Depressurization Valve
GDCS = GDCS Injection Valve

Table A.3-22 Test GS1 Initial Conditions

Parameter	Value	Tolerance
RPV Pressure (kPa)	1034	20
RPV Collapsed Water Level (m)*	-2.34	0.15
Initial Heater Power (kW)	68+ heat loss compensation	1
Drywell Total Pressure (kPa)	289	4
Drywell Steam Partial Pressure (kPa)	178	4
Wetwell Total Pressure (kPa)	254	4
Suppression Pool Temperature (K)	333	2
PCC Pool Temperature (K)	373	2
GDCS Pool Temperature (K)	319	2
GDCS Pool Level (m)*	16.2	0.075

* Referenced to Top of Active Fuel (TAF).

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Table A.3-23 Basis for GIRAFFE/SIT Test Conditions

Objective	Option			Test ID
	Break	Failure	IC/PCC Operation	
Worst Break/Single Failure Combination	GDL	DPV	No	GS1
Benefit of IC/PCC	~~BDL~~ GDL and ~~BDL~~ GDL	DPV DPV	~~Yes~~ NO ~~No~~ Yes	GS1 GS2
Slow Water Level Recovery	GDL	GDCS	Yes	GS4
Fast Water Level Recovery	~~BDL~~ BDL	~~DPV~~ DPV	~~No~~ Yes	~~GS2~~ GS3
~~Case representing a different break than worst break~~	~~BDL~~	~~DPV~~	~~No~~	~~GS2~~
Case showing GDCS void quenching and break flow depressurizing drywell	~~BDL~~ GDL	~~DPV~~ DPV	~~No~~ No	~~GS2~~ GS1