Enclosure 2

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for the ESBWR Wetwell-Drywell Vacuum Breakers,"

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Public Version

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LEAKAGE DETECTION INSTRUMENTATION CONFIRMATORY TEST FOR THE ESBWR WETWELL-DRYWELL VACUUM BREAKERS

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1.0 SCOPE

The wetwell-to-drywell vacuum breaker (VB) leakage detection instrumentation confirmatory test is designed to validate the VB isolation valve (VBIV) instrumentation design effectiveness for the scope of bounding drywell (DW) and wetwell (WW) accident conditions. The results of the test are used to adjust the VBIV control algorithm and to establish the VBIV control setpoint value.

2.0 TEST PARAMETERS

2.1 SUMMARY

The leakage detection instrumentation confirmatory test is based on the conditions predicted to occur during design basis Loss of Coolant Accident (LOCA) events. The design basis of the vacuum breaker isolation function is to detect vacuum breaker leakage that would lead to hot steam leaking from the DW into the WW.

The leak tight integrity of the wetwell-to-drywell VBs is necessary during the design basis accident response to support containment heat removal through the passive containment cooling system (PCCS). VB seat integrity is part of maintaining the drywell-to-wetwell pressure differential that drives PCCS flow. To prevent PCCS function from being significantly impaired by VB leakage, the leak detection instrumentation subsystem monitors the temperature differential across each VB and will initiate a VBIV isolation signal for a leaking VB. Because a perfect seal cannot always be achieved, technical specifications allow an acceptable leakage value. The vacuum breaker isolation function must not cause isolation of an acceptable vacuum breaker.

After the initial 72 hours of the accident response, the PCCS augmentation fans are available for inducing a relatively larger volumetric rate of drywell steam condensation return flow. This mechanically induced condenser flow reduces overall containment total pressure. In addition, cooled noncondensable gases in the PCCS flow are discharged into the WW, so the VB bypass leakage from DW to WW after the initial 72 hours is not a concern. This limits the duration required for testing.

Tests 1 through 12 outlined on the Test Matrix (Table 4-1) are based on Technical Specifications Surveillance Requirement (TSSR) limits for leak detection. Tests 13 through 16 represent gradually degrading leak conditions. The following sections describe the test parameter ranges, which are selected to provide reasonable bounding values for the results of the spectrum of analyzed LOCA events.

2.2 TEMPERATURE DIFFERENTIAL (ΔT)

Test Range: [[

]]

2.3 DRYWELL PRESSURE

Test Range: [[

]].

2.4 WETWELL PRESSURE DIFFERENTIAL

Test Range: [[

]]

2.5 TEST ENVIRONMENT

DW Test Environment: Saturated Steam

The simulated DW temperature is controlled at the saturation temperature corresponding to the test system pressure, based on the expected nominal operating temperature for normal power generation and the peak temperature of the accident analyses.

WW Test Environment: Nitrogen with 100% Relative Humidity

The WW environment represented in the test is the design basis LOCA environment. The liquid volume is heated to represent the LOCA post-blowdown condition. The simulated WW gas volume is nitrogen purged with less than or equal to 4% oxygen; based on the inerted containment design. The temperature and pressure established for each test are as described in Table 4-1.

2.6 LEAK AREA (EQUIVALENT A/√k)

Test Leak Area: A/√k = 0.3, 0.4, 0.6 and 1.0

The first leak area value above is based on the containment leak limit for an individual VB. The third test leak area value represents the analytical leak area limit to initiate closure of an individual VBIV. The second and fourth test leak area values are used only to demonstrate consistent detection response around the analytical limit.

2.7 VACUUM BREAKER FAILURE MODE

[[

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2.8 VACUUM BREAKER DETECTION INSTRUMENT TEST SPECIMEN

[[

]]

3.0 TEST ACCEPTANCE CRITERIA

[[

a.

b.

c.

]]

4.0 TEST DESCRIPTION

4.1 TEST FACILITY AND SETUP

4.1.1 Quality Requirements

The testing is performed under an approved quality assurance program and using approved procedures or specifications that satisfy the requirements of Title 10CFR, Part 50, Appendix B.

The test facility and setup will meet the requirements of NIST Handbook 150, and of ANSI/ISO/IEC 17025-2005, "General Requirements for the Competence of Testing and Calibration Laboratories."

The test procedure will meet the requirements of ASME Code NQA-1, 1983 Edition, Subpart 2.1, "Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants." The wetwell-to-drywell VB is assigned Cleanliness Class – B.

4.1.2 Test Configuration

Each specimen is mounted in a test configuration as follows (see Figure 4-1):

a. [[

b.

c.

d.

e.]]

4.1.3 Test Equipment

The calibrated test equipment required for the confirmatory test is as follows:

a. Multipoint temperature/pressure recorder;

b. High-precision pressure sensors or transducers, one each for test setup VB inlet and outlet;

c. High-precision low differential pressure transmitter, temperature compensated;

d. High-precision RTD temperature probes; and,

e. Precision-machined test flow orifices.

4.2 CONFIRMATORY TEST

4.2.1 Orifice Calibration

The orifices used for the series of tests described below are calibrated by means of flow loop, pressure decay or other appropriate test method to verify the specified Equivalent A/√k value of each test orifice.

4.2.2 Prerequisite Conditions

The following conditions are established for each test cycle listed on Table 4-1:

a. [[.

b.

c.

d.

e.

]]

4.2.3 Test Cycle

[[

a.

b.

c.

a.

b.

c.

d.

]]

4.3 DATA ANALYSIS

The data generated by the tests are evaluated by comparison of drywell temperature, extension pipe internal temperature and wetwell temperature around the extension pipe exterior.

[[

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Further data analysis is applied as necessary to improve the control response of the algorithm.

[[ ]]

[[ ]]

[[ ]]

Figure 4-1 – VB Leakage Detection Test Facility (Conceptual)