AMERICAN ENVIRONMENTS COMPANY INC.
17 COMMERCIAL BLVD., MEDFORD, N.Y. 11763 • (516) 736-5883

QUALIFICATION TEST PROCEDURE

ON

VALVE AND ACTUATOR

FOR

VALTEK INCORPORATED

SPRINGSVILLE, UTAH

NUMBER	REVISION	BY	DATE
STP-33186-1		AMERICAN ENVIRONMENTS COMPANY	07/18/86
STP-33186-1	"A"	AMERICAN ENVIRONMENTS COMPANY	09/09/86

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CLIENT APPROVAL BY: Craig Haroldsen

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REVISION RECORD

DATE	REVISION NUMBER	PAGE NUMBER	PARAGRAPH NUMBER	CHANGES OR ADDITIONS	APPROVED BY
07/18/86	N/C	-	-	-	
09/09/86	A	All	All	Entire Procedure Revised Per Bechtel/Valtek and AECO Meeting of 09/09/86	

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ADMINISTRATIVE DATA

DATE: 18 July 1986

PURPOSE OF TEST:	To determine the effects of Environmental Qualification Testing on the Butterfly valve's physical ability to maintain shut-off within specified limits for expected normal and accident operating (Environmental and Seismic) conditions.
MANUFACTURER:	Valtek Incorporated P.O. Box 2200 Springsville, Utah 84663
MANUFACTURER TYPE	Purge Containment Isolation Valve Part Number 34753/2-48
DRAWINGS SPECIFICATIONS OR EXHIBITS:	1) IEEE 323-1974 2) IEEE-627-1980 3) NUREG-0588, Revision 1 4) Bechtel Specification Number 4Z439ZS1007, Revision 8 (Paragraphs 3.5 and 3.6) 5) Bechtel Specification Number 4A479ES1019, Revision 1 6) Bechtel Specification Number 4A479ES1018, Revision 2 7) IEEE-344-1975
QUANTITY OF ITEMS TO BE TESTED:	One (1) unit (Valve assembly with the seat material) Two (2) Additional seat rings
DISPOSITION OF TEST SPECIMEN:	To be returned to client.
TEST TO BE CONDUCTED BY:	AMERICAN ENVIRONMENTS COMPANY, INC. 17 Commercial Blvd. Medford, N.Y. 11763
ABSTRACT:	It is the function of American Environments Company, Inc., as an impartial testing agency in performing these tests, to subject the test specimen to qualification testing as outlined in the detailed test procedure to meet the requirements of Bechtel specifications.

TEST APPARATUS

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1.0 DESCRIPTION OF TEST APPARATUS

1.1 Environmental Chamber, Model No. -80/175C, Serial No. 6944, manufactured by Tenney Engineering Inc.

1.2 Sweep/Function Generator, Model No. 3025, Serial No. 22-04292, manufactured by B & K Precision, Inc.

1.3 Pressure Transducer, Model P2-1251, Serial No. 52536, manufactured by Wianko.

1.4 Flowmeter, Model No. F1100, Serial No. K-144, manufactured by Gilmont Instruments, Inc.

1.5 Spray Nozzles, Model No. 3/8 G15, manufactured by Spraying Systems.

1.6 Digital Temperature Indicator, Model No. 707, Serial No. 1237440H614, manufactured by Hades Manufacturing Corp.

1.7 Steam Boiler, Model No. 3LSG, Serial No. 6720043, manufactured by Orr and Sembower.

1.8 Pressure Vessel, Model No. 0-150, Serial No. 4159, manufactured by B & G Machine.

1.9 Chart Recorder, Model No. 260, Serial No. 05530, manufactured by Gould Instruments.

1.10 Pressure Regulator, Model No. 44-1012-24, Serial No. L19767, manufactured by Smith's Regulators.

1.11 Pressure Gauge, Model No. 0-60, Serial No. 5-2871, manufactured by Seegers Standards. Equipment Range: 0 to 60 psig, Equipment Accuracy: +/- 0.5%.

1.12 Compressor, Model No. 459863, Serial No. 158, manufactured by Scales Air Compressor.

1.13 Pressure Gauge, Model No. 0-160, Serial No. 975, manufactured by Enerpac Corporation.

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1.0 DESCRIPTION OF TEST APPARATUS (Continued)

1.14 Event Counter, Model No. 6Y-32363-400RMF, Serial No. 266, manufactured by Durant Manufacturing Co.

1.15 DC Power Supply, Model No. HB-8M, Serial No. C-32857, manufactured by Kepco Corporation.

1.16 Stopwatch, Model No. 0-60-1/10, Serial No. K-145, manufactured by Aristo-Apollo.

1.17 pH/Temperature Meter, Model No. 102B, Serial No. 1541, manufactured by Ecologic Instruments.

1.18 Triple Beam Balance, Model No. 700, Serial No. 146, manufactured by O'Haus Scale, Inc.

1.19 Digital Multimeter, Model No. 179A, Serial No. 141300, manufactured by Keithley Instruments, Inc.

1.20 Flowmeter, Model No. F-1300, manufactured by Gilmont Instruments, Inc. Equipment Range: 200 to 12,000 cc/min (air), Equipment Accuracy: +/- 2% or +/- 1 division, whichever is greater.

1.21 Load Cell, Model No. FTA7, Serial No. K-163, manufactured by Schaevitz Corporation.

1.22 Flowmeter, Model No. F-1100, Serial No. A-5621, manufactured by Gilmont Instruments, Inc. Equipment Range: 0 to 280 cc/min (air), Equipment Accuracy: +/-2% or +/- 1 division, whichever is greater.

Note: The above equipment, or equivalent, is to be used in the performance of this test. Equipment calibration takes place on a continuous basis and shall be current for the equipment used at the time of test performance. In-house quality control and calibration procedures conform to the intent of 10 CFR 50 Appendix B, Mil-STD-45662 and provides for traceability to the National Bureau of Standards.

2.0 DESCRIPTION OF TEST SPECIMEN

1) Purge Containment Isolation Valve Assembly, with Vespel SP-1 (DuPont Trademark) polyimide seat ring. 18 inch ANSI 150 Class Valdisk, similar to Serial No. 34753/2-48. Serial No. to be recorded prior to initiation of testing.

2) Two additional seat rings, identical to the one installed in the valve assembly. These two seat rings will be subjected to accelerated thermal aging and radiation exposure to simulate 2.63 and 4 years normal life (see sections 3.4.1 and 3.4.3) and to accident radiation dosage (see section 3.4.6). The purpose for including these seat rings in the test is to provide back-up seats with which to continue the test in the event the original seat ring fails during the test.

Prior to the initiation of the test program the valve will be functionally tested, by Valtek personnel, in accordance with the following:

The valve is designed to meet a Shell Hydrostatic Test at 450 psig and a Valve Closure Test (Disk Test) at 75 psig per Valtek Procedure SPP No.'s 498 and 4008. The Valve Closure Test shall be repeated with each of the two additional seat rings that are included in the test. The results of these tests shall be recorded and referenced in the Qualification Test Report.

3.0 METHOD OF TEST

Testing shall be accomplished in accordance with the following procedures; except that the material being tested alone shall be pre-conditioned (thermally aged and irradiated) in the same manner as the primary specimen.

NOTE: The Margin of Safety requirements, specified by IEEE-323-1974, have been taken into consideration in this procedure.

3.1 TEST SEQUENCE

Testing shall be performed in the following sequence:

3.1.1 Pre-test Inspection and Baseline Functional Tests
3.1.2 Thermal Aging of Assembly
3.1.3 Functional Test
3.1.4 Mechanical Wear
3.1.5 Functional Test
3.1.6 Radiation (Normal Dose + 2 hour Accident dose + margin)

3.1 TEST SEQUENCE (Continued)

3.1.7 Functional Test
3.1.8 Seismic Loads
3.1.9 Functional Test
3.1.10 LOCA Simulation
3.1.11 Functional Test
3.1.12 Radiation (Remaining Accident Dose + Margin)
3.1.13 Functional Test

NOTE: If at any time during the test the seat ring fails to pass the functional test (section 3.3.2) Valtek and Bechtel shall be immediately notified. See sections 3.3.2 and 3.4.5.1(4) note 2.

3.2 TEST SET-UP

The valve assembly shall be installed in the Test Fixture and connected as shown in Figure 1, Appendix A. Testing shall be performed on the valve and additional seat rings described in paragraph 2.0. All test set ups shall simulate typical in-service installation and orientation. All testing outlined herein shall be performed with the valve assembly mounted in the vertical position.

3.3 PRE AND POST QUALIFICATION TESTS

3.3.1 Visual Inspections

Prior to and following each test outlined herein, the valve and additional seat rings shall be visually inspected in order to determine any physical damage which may have occurred.

3.3.2 Functional Tests

As specified, the specimen shall be functionally tested in order to determine its' ability to maintain seat leak within the specified limit.

The valve shall be installed in the functional set-up shown in Figure 1. The valve shall be energized to the open position utilizing a supply voltage of 130 volts (DC) and an actuator pneumatic pressure of between 70 and 125 psig.

After opening the valve the DC voltage shall be reduced to 0 in order to close the valve. Seat leakage shall be measured as outlined below:

Step 1) The containment (inlet) port of the valve shall be pressurized to 54 psig (48.4 + 10%) utilizing air, filtered to 10 microns, as a test media.

3.3 PRE AND POST QUALIFICATION TESTS (Continued)

3.3.2 Functional Tests (Continued)

Step 2) After pressurization, the system shall be isolated by closing a hand valve, located upstream from the valve.

Step 3) Following a five (5) minute stabilization period, any leakage, as evidenced by a decay in inlet pressure shall be noted.

Step 4) In the event of pressure decay in Step 3, the leakage rate shall be measured utilizing a flowmeter located downstream from the valve.

The maximum allowable leakage shall not exceed the following:

New Valve: 34 Std. cc/min with air at 54 psig

End of Life: 1) 1330 Std. cc/min with air at 54 psig, or
2) 4.5 cc/min water. (LOCA testing only)

If the measured seat leakage exceeds 10% of the allowable value (i.e., 133 cc/min air or 0.45 cc/min water) before the start of LOCA test, Valtek and Bechtel shall be immediately notified

During the LOCA test the seat leakage test shall be performed as follows:

During the performance of the initial transient of LOCA testing the specimen shall be visually monitored for gross leakage.

During the remaining portions of LOCA testing all fluid condensate exiting from the specimen outlet port shall be collected and the leakage rate (if any) measured and noted.

3.4 QUALIFICATION TEST METHODS

3.4.1 Accelerated Thermal Aging

The valve assembly and the two additional seat rings shall be installed in an environmental chamber capable of simulating the required elevated thermal condition. The two additional seat rings shall be appropriately placed in the chamber so as to receive the same thermal effects as the valve. The valve shall be opened by energizing the actuator.

3.4 QUALIFICATION TEST METHODS (Continued)

3.4.1 Accelerated Thermal Aging

Following installation, the chamber temperature shall be raised to 205 degrees F. at a rate of less than 2 degrees F. per minute. The valve shall be stabilized at the 205 degree F. condition for a period of two (2) hours. At the conclusion of the two (2) hour stabilization period, the Accelerated Thermal Aging Test shall be inititated.

The valve shall be maintained at the 205 degree F. condition for a period of 191 hours to simulate five (5) years at 120 degrees F. One of the two additional seat rings shall be maintained at the 205 degree F. condition for a period of only 100* hours to simulate 2.63 years at 120 degrees F. The other of the two additional seat rings shall be maintained at the 205 degree F. condition for a period of only 152.3 hours (138.39 hours + 10% margin) to simulate four (4) years at 120 degrees F.

The Accelerated Thermal Agirg Test parameters were determined utilizing Arhenius methodology, assuming a qualified life of five (5) years for the valve assembly, a normal operating temperature of 120 degrees F. and an Activation Energy of 1.20. Utilizing this data, a test time of 7.21 days, at a test temperature of 205 degrees F. was determined. Adding the 10% margin required by IEEE-323-1974, results in the total test duration of 7.93 days or 191 hours.

The activation energy of the polyimide seat material is 1.57 (See Appendix B for reference material). The use of the activation evergy of 1.20 in the Thermal Aging calculation is determined to be conservative.

At the conclusion of the Accelerated Thermal Aging Test, the conditions within the environmental chamber shall be adjusted to room ambient and a Post Test Inspection and Functional Test performed in accordance with paragraph 3.3 herein.

*100 hour minimum test time in accordance with paragraph 6.3.3 of IEEE-323-1974 (Required test time for 2.63 equivalent life is 90.99 hours, adding 10% margin results in 2.63 years).

3.4.2 Mechanical Wear

The specimen shall be subjected to Mechanical Wear testing after completion of thermal aging. The specimen shall be operated from the full open to the full closed and return to the full open position a total of 413 times. The mechanical wear cycles shall be performed at the rate of one (1) complete cycle per minute.

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3.4 QUALIFICATION TEST METHODS (Continued)

3.4.2 Mechanical Wear (Continued)

Specimen operation shall be performed utilizing a supply voltage of 130 volts (DC) and an air pressure of between 70 and 125 psig, supplied to the actuator pneumatic port.

The Mechanical Wear Test parameters were determined based on an average of 75 complete cycles performed per year for a period of five (5) years, resulting in a requirement of 375 complete cycles. By adding the 10% margin required by IEEE-323-1974 a total of of 413 cycles is obtained.

At the conclusion of the Mechanical Wear Test, a Post Test Inspection and Functional Test shall be performed in accordance with paragraph 3.3 herein.

3.4.3 Radiation (Normal Dosage + 2 Hours Accident Dosage)

The complete valve and flange, without the actuator and removable flange (See Figure 1, Appendix A) and additional seat rings shall be installed in the Radiation Cell. The test specimen shall then be exposed to 8.8 megarads of Gamma Radiation, at a dose rate of 0.5 to 1.0 megarads per hour. The irradation shall be performed utilizing Cobalt 60 as a source. The radiation shall be directed at the in-containment side of the valve with the valve in the open position.

At the conclusion of the Normal + 2 Hour Accident Dosage Radiation Test, a Post Test Inspection and Functional Test shall be performed in accordance with paragraph 3.3 herein.

3.4.4 Static Seismic Loading

The test specimen, installed in the test fixture in the open position, shall be subjected to a Static Seismic Loading Test. Static load test shall meet the requirements of paragraph 3.4 of Specification 4A479ES1019, Revision 1. One load, the resultant of three static loads (5.0 g x 966 pounds = 4830 pounds each), shall be applied through the center of gravity of the valve topworks. The force applied shall be the resultant of the two (2) horizontal and the vertical forces as shown in the following calculation:

1) Horizontal Resultant is equivalent to SQRT ((4830 squared) + (4830 squared)) = 6830.7.

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3.4 QUALIFICATION TEST METHODS (Continued)

3.4.4 Static Seismic Loading (Continued)

2) The overall resultant is equivalent to SQRT ((6830.7 squared) + (4830 squared)) = 8365.8 pounds.

The overall resultant force shall make an angle of 45 degrees with respect to one of the horizontal axes in the horizontal plane and also an angle of 35.3 degrees in the vertical plane with respect to the horizontal plane.

The system shall be held pressurized to 54 psig during the test. (The side load attachment points shall be provided by Valtek Corporation prior to the initiation of testing.)

The load shall be applied for a minimum duration of three (3) minutes. During the application of the load the specimen shall be cycled from the fully opened to the fully closed and return to the fully open condition a total of three (3) times.

The valve shall be held closed for a minimum of ten (10) seconds before it is open again and then held open for a minimum of ten (10) seconds before closing. The valve shall be closed for the fourth time and the seat leakage test performed in accordance with paragraph 3.3.2 herein, with the loads still applied.

At the end of seat leakage testing, the valve shall be returned to its fully open position. The static loads are then removed. Specimen operation shall be performed utilizing a supply voltage of 130 volts (DC) and an actuator pneumatic pressure of 70 to 125 psig. Any binding and/or spurious operation during the application of the seismic load shall be noted.

Following completion of the Static Seismic Loading Test, a Post Test Inspection and Functional Test shall be performed in accordance with paragraph 3.3 herein.

3.4.5 Loss of Cooling Accident (LOCA) Simulation

3.4.5.1 Performance of Transients

The test specimen shall be installed in the test fixture as shown in Figure 1, Appendix A. Following installation the specimen shall be functionally tested utilizing a supply voltage of 130 volts (DC) and an actuator pneumatic pressure of 70 to 125 psig.

Following completion of the Functional Test the specimen shall be placed in the open condition and steam supplied to the inlet port. To ensure a live steam condition throughout the test, a bleed valve shall be located at the specimen inlet port pipe section.

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3.4 QUALIFICATION TEST METHODS (Continued)

3.4.5.1 Performance of Transients (Continued)

The temperature at the inlet port shall be adjusted to 120 degrees F. (+15/-0 F.). The specimen shall then be subjected to LOCA Simulation testing, outlined as follows (See Figure 2, Appendix A):

	Elapsed Time
(1) - The 120 degree F. (+15/-0 F.) thermal condition shall be maintained for a minimum period of two (2) hours.	0 sec.
(2) - At the conclusion of the two (2) hour period, the specimen shall be functionally tested utilizing a supply voltage of 130 volts (DC) and an actuator pneumatic pressure of 70 to 125 psig. Following completion of the Functional Test the valve shall be placed in the open condition.	0 sec.
(3) - The first transient shall be initiated by raising the chamber temperature to 338 degrees F. (323 + 15), while simultaneously raising the pressure to 100 psig utilizing saturated steam. This transition shall be accomplished in a period of approximately ten (10) seconds. When the chamber pressure reaches a condition of approximately 5 psig (225 degrees F.), the valve shall be closed utilizing a supply voltage of 130 volts (DC) and an actuator pneumatic pressure of 70 to 125 psig.	10 sec.
After closure the specimen outlet port shall be visually monitored for gross leakage.	
(4) - The 338 (323 + 15) degree F., 100 psig condition shall be maintained for a minimum period of 90 seconds.	100 sec.

NOTES:

1) At the conclusion of the first transient the specimen shall be maintained in the closed position and the conditions within the chamber adjusted to room ambient. Seat leakage measurement shall be repeated at room ambient after the first transient at differential pressures as specified in paragraph 3.4.5.2 herein. In order to satisfy the Margin of Safety Requirements of IEEE-323-1974, a second transient shall be performed.

3.4 QUALIFICATION TEST METHODS (Continued)

3.4.5.1 Performance of Transients (Continued)

NOTES:

2) In case of high leakage (greater than 10% allowable leakage) anytime during the LOCA simulation, Bechtel and Valtek shall be informed immediately in writing (preferably by Telex). Bechtel/Valtek will assess the leakage and decide the necessary action. At no time shall the test be disrupted unless written instruction from Bechtel/Valtek has been provided or uncontrolled events occurred as determined by the laboratory test engineer.

3) The valve shall be maintained in the closed condition throughout the remainder of the test program.

Prior to initiating the second transient, the temperature within the chamber shall be adjusted to 120 degrees F. (+15/-0 F.) utilizing steam.

During this test, all fluid condensate exiting from the specimen outlet port shall be collected and the leakage rate (if any) shall be measured and noted throughout the twenty-four (24) hour test.

	Elapsed Time
(5) - The 120 degree F. (+15/-0 F.) thermal condition shall be maintained for a minimum period of two (2) hours.	0 sec.
(6) - With the valve in the closed position, the second transient shall be initiated by raising the chamber temperature to 338 (323 + 15) degrees F. while simultaneously raising the pressure to 100 psig utilizing saturated steam. This transition shall be performed in a period of approximately ten (10) seconds.	10 sec.
(7) - The 338 (323 + 15) degree F., 100 psig condition shall be maintained for a minimum period of 90 seconds. At the conclusion of the 90 second period, a Chemical Spray shall be introduced into the chamber as follows:	100 sec.

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3.4 QUALIFICATION TEST METHODS (Continued)

3.4.5.1 Performance of Transients (Continued)

	Elapsed Time
(7) - 1) 1.5% by weight boric acid 2) 98.5% by weight potable water 3) The solution shall be adjusted to a ph of 10.5, at room temperature, utilizing sodium hydroxide as a buffer. The spray shall be applied, in the downward direction, at a rate of approximately 0.7 gpm/sq. foot of specimen projected horizontal cross sectional area. Prior to initiating the injection of Chemical Spray, the solution shall be maintained at a temperature of 120 degrees F. After initiation of spray the solution temperature shall be uncontrolled. Periodically the pH of the spray shall be measured and, if required, adjusted to maintain a minimum pH of 7.5.	
(8) - The conditions within the chamber shall be adjusted to 295 (280 + 15) degrees F. at a pressure of 48 psig. This transition shall be performed in a period of approximately 400 seconds.	500 sec.
(9) - The 295 degree F. (280 + 15), 48 psig condition shall be maintained for a minimum period of 4500 seconds.	5000 sec.
(10)- The conditions within the chamber shall be adjusted to 200 (185 + 15) degrees F. at a pressure of 0 psig. This transition shall be performed in a period of approximately 22.6 hours.	1 day

NOTES:

1) At this point of the transient, the chemical spray shall be halted. The specimen and the pipe sections shall be installed in a second environmental chamber. In order to obtain a high humidity condition, a small amount of water shall be introduced into the containment side pipe section (See Appendix C of IEEE-323-1974 for justification of humidity control).

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3.4 QUALIFICATION TEST METHODS (Continued)

3.4.5.1 Performance of Transients (Continued)

NOTES:

2) Prior to the continuance of LOCA testing into the second chamber, seat leakage measurement shall be performed at differential pressures specified in paragraph 3.4.5.2 herein and test results shall be noted.

3) Test results from 3.4.5(10) Note 2 above and the leakage measured through the condensate collection in the second transient of the LOCA Test shall be transmitted in writing immediately for assessment by Bechtel Energy Corporation and Valtek Incorporated.

	Elapsed Time
(11)- The temperature within the chamber shall be reduced gradually to 190 (175 + 15) degrees F. This transition shall be performed over a period of approximately 10 days with the relative humidity maintained at 97 to 100% throughout the remainder of the Test.	11 days
(12)- The temperature within the chamber shall be reduced gradually to 135 (120 + 15) degrees F. This transition shall be performed over a period of approximately 22 days.	33 days

3.4.5.2 Leakage at Differential Pressures

At the conclusion of the thirty-three (33) day period the specimen shall be removed from the chamber and visually inspected in accordance with paragraph 3.3.1 herein. In addition the leakage test portion of the functional test outlined in paragraph 3.3.2 shall be performed, except that the leakage test shall be performed at 1, 2, 5, 10, 20, 30, 45 and 54 psig.

NOTE: No attempt shall be made at opening the valve. The valve shall remain in the closed condition with provisions be provided to ensure that the valve remains closed throughout the remainder of the Test.

3.4.6 Radiation (Accident Dosage)

The complete valve and flange, without the actuator and removable flange (See Figure 1, Appendix A) and the two (2) additional seats shall be installed in the Radiation Cell.

3.4 QUALIFICATION TEST METHODS (Continued)

3.4.6 Radiation (Accident Dosage Continued)

The test specimen shall then be exposed to 124 megarads of Gamma Radiation, at a dose rate of 0.5 to 1.0 megarads per hour. The irradation shall be performed utilizing Cobalt 60 as a source. The radiation shall be directed at the in-containment side of the valve only.

At the conclusion of the Accident Dosage Radiation Test, the specimen shall be visually inspected in accordance with paragraph 3.3.1 herein.

Following the Visual Inspection, Seat leakage testing shall be performed in accordance with paragraph 3.3.2 herein except that the leakage test shall be performed at differential pressures in accordance with paragraph 3.4.5.2 herein.

NOTE: No attempt shall be made at opening the valve until this last test sequence is completed.

4.0 PERFORMANCE TEST (FOR INFORMATION ONLY)

The results of this Performance Test are not to be considered as part of the Qualification Test Program.

After completion of the environmental and seismic test and all necessary data has been recorded, performance functional operation shall be performed to gather additional information. The valve shall be cycled once from the closed position to the open position then closed and seat leakage measured and noted, at differential pressures, in accordance with section 3.4.5.2.

5.0 TEST RESULTS

The observed test results and test data shall be included in a final detailed Test Report.

6.0 TEST REPORT

1) A Summary report including all seat leakage data shall be submitted within seven days after completion of tests to Bechtel Energy Corporation and Valtek Incorporated.

2) The final test report shall be submitted to Valtek Corporation and shall include photographs, a list of equipment used, calibration due dates, test results and all observations made.

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APPENDIX A

FIGURES

FOR

VALTEK INCORPORATED

VALVE AND ACTUATOR

American Environments Company, Inc.

FIGURE 1

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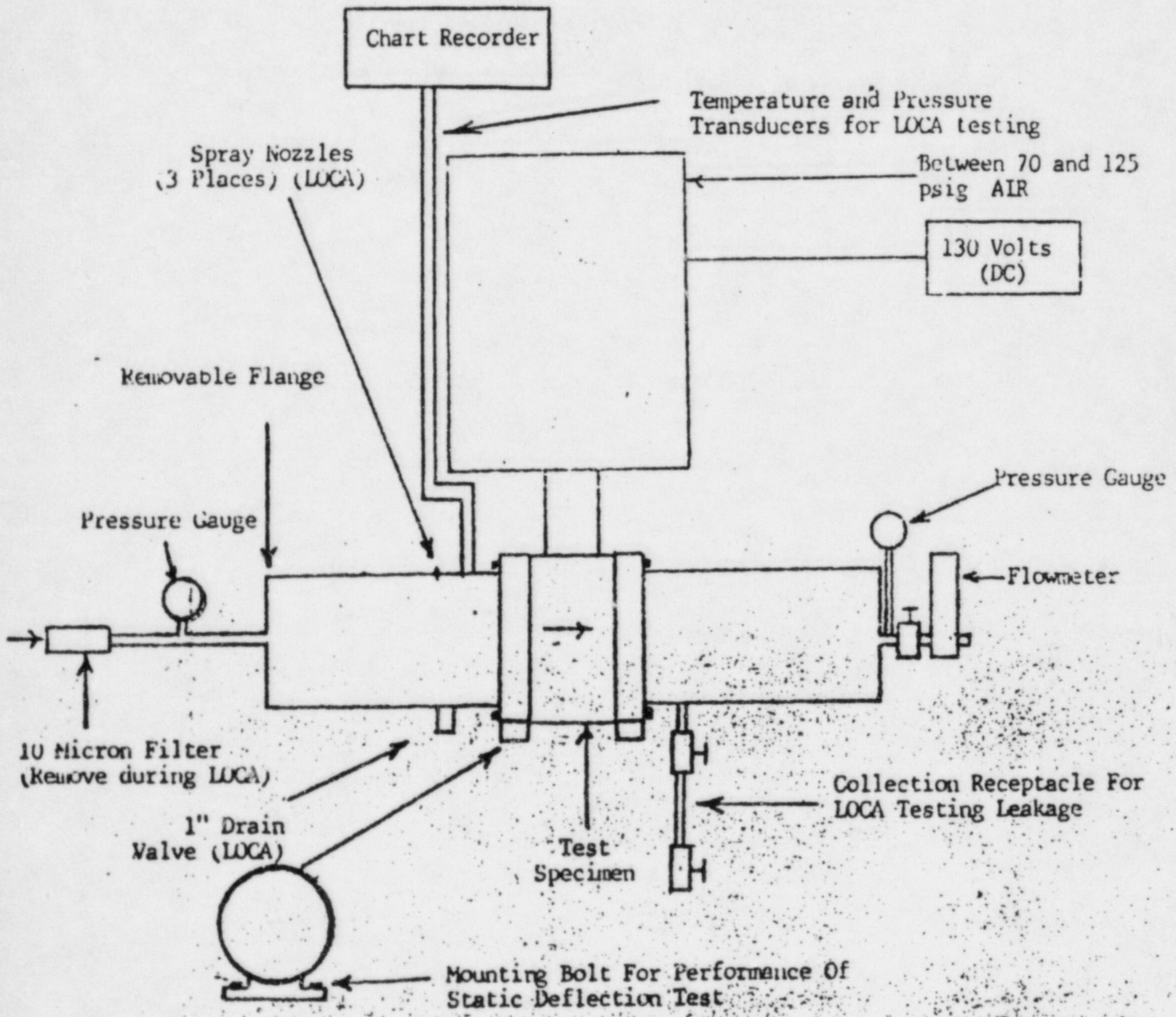

FIGURE 2

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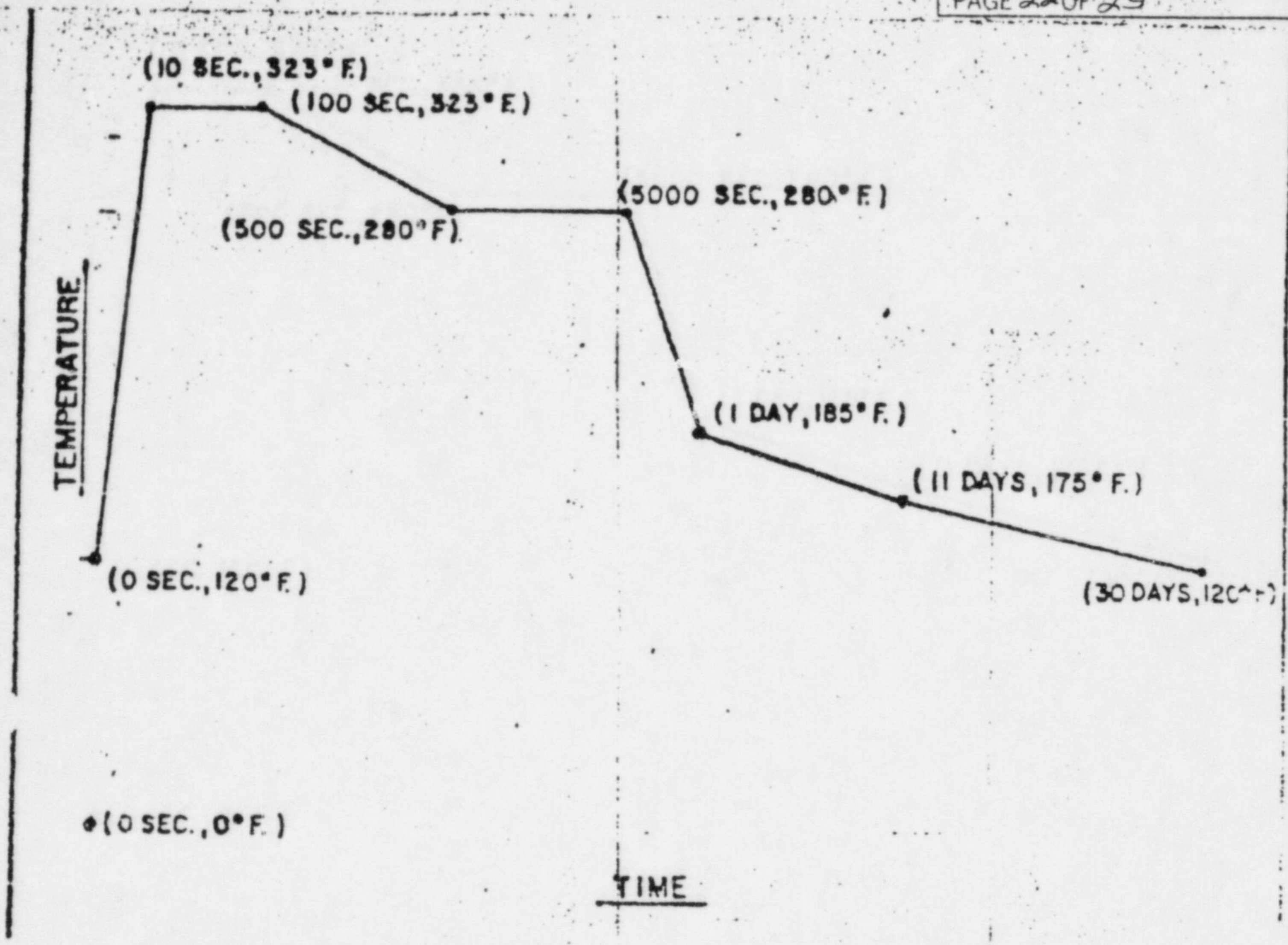

FIGURE 2

Initial 100 seconds to be performed twice.

IEEE-323-1974 Temperature and Pressure margins shall be included.

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APPENDIX B

THERMAL AGING TEST INFORMATION

FOR

VALTEK INCORPORATED

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A Review of Equipment Aging Theory and Technology

EPRI

EPRI NP-1558
Project 890-1
Final Report
September 1980

Keywords:
Aging
Equipment Qualification
Environmental Qualification
Electrical Equipment
Nuclear Safety

Prepared by
Franklin Research Center
Philadelphia, Pennsylvania

ELECTRIC POWER RESEARCH INSTITUTE

American Environments Company, Inc.

THERMAL AGING TEST INFORMATION

Activation Energies

Material/ Component/Device	Activation Energy (eV)	Citation	Remarks
Polypropylene, isotactic	1.13	973	t_{10} induction periods. See Note 14.
Polyalkene – polyvinylidene fluoride, irradiated insulation, 20 gauge wire.	1.10	461	MIL-W-81044/9. Mean time to failure. See Notes 9 and 14.
Printed circuit board material (1/32 in.), NEMA G-10 and FR-4	1.05	717	50% retention of electrical strength. See Note 14.
Printed circuit board material (1/32 in.) NEMA G-10 and FR-4	1.49	717	50% retention of flexural strength. See Note 14.
Polyimide, aromatic, TFE-banded and coated insulation, 20 gauge wire.	1.57	461	Meantime to failure. See Notes 9 and 14.
Polymethylmethacrylate	0.54	890	
Polytetrafluoroethelene	0.43	890	
Polytetrafluoroethylene	3.29	537	10% weight loss in vacuum. See Note 14.
Polythermaleze, heavy, insulation and 3M 241 epoxy encapsulant on solenoid coil.	0.95	320	Average coil life. See Notes 12 and 14.
Polythermaleze insulation and Acme 4027-A epoxy encapsulant on solenoid coil.	0.92	320	Average coil life. See Notes 12 and 14.
Polythermaleze insulation on magnet wire.	1.00	610	See Notes 1 and 11
Polythermaleze insulation on magnet wire.	0.96	610	See Notes 2 and 11.
Polythermaleze insulation on magnet wire.	1.56	610	See Notes 3 and 11.
Polythermaleze insulation on magnet wire.	1.00	610	See Notes 4 and 11.
Polythermaleze insulation on magnet wire.	0.98	610	See Notes 5 and 11.
Polythermaleze insulation on magnet wire.	0.75	610	See Notes 6 and 11.

Attachment 3

FSAR Question 1

Paragraph 3.7.1.1 on page 3.7-1 states that none of the points on the STP design response spectra fall below 10 percent of the design response spectra. It is not clear whether the spectra being compared to are those of Regulatory Guide 1.60. It also seems that the wording in this paragraph should be corrected to read, "None of the points falls more than 10 percent below the design response spectrum."

Response to FSAR Question 1

Paragraph 3.7.1.1 of the current FSAR does not discuss STP design spectra/RG 1.60 spectra comparison. Section 3.7.1.2 correctly states that the STP time histories conform to the SRP guidelines on enveloping RG 1.60 spectra, i.e., do not fall below the RG spectra by more than 10% and not more than 5 points.

FSAR Question 2

Paragraph 3.7.1.3 on page 3.7-3 states that a damping value of 10% was used in the qualification of safety-related cable trays in some cases. No evidence is given that this damping value was supported by test data, as is required by Regulatory Guide 1.61..

Response to FSAR Question 2

Paragraph 3.7.1.3 of the current FSAR does not discuss cable tray damping. Section 3.7.3A.15 states the basis for selection of damping and references figure 3.7-55 which gives the correlation curve obtained from tests.

A detailed discussion of the cable tray testing program was submitted to the NRC in response to a NRC Structural Engineering Branch (SEB) audit concern. For additional information, see the response to action item 13 contained in the HL&P letter to the NRC, ST-HL-AE-1250, dated May 16, 1985.

FSAR Question 3

Paragraph 3.7.2.43, page 3.7-13, indicates that a program named LUSH was used to perform all soil structure interaction (SSI) analysis. Explain how this program was verified to give correct solutions in the assessment of SSI effects.

Response to FSAR Question 3

LUSH is a computer program for complex response analysis of soil-structure systems using finite element techniques. The original version of the program was developed by Lysmer et al. of the Department of Civil Engineering at the University of California, Berkeley. The verification and documentation of the original program are described in Lysmer et al. (1974). The program was subsequently modified and verified by Woodward Clyde Consultants (WCC) who performed the original SSI analyses for STP. The modifications and verifications were documented in WCC Computer Program Documentation File - Verification and Documentation of WCC * LUSH 4 dated June 2, 1975.

Verification runs made to verify Program WCC * LUSH 4 included (1) one-dimensional ground response analysis to compare with closed-form solutions provided by Computer Program SHAKE (Schnabel, Lysmer, and Seed, 1972) and (2) two-dimensional soil-structure interaction analysis to compare with the solutions obtained by the original program LUSH.

References

Schnabel, P. B., Lysmer, J. and Seed, H. B. (1972) "SHAKE - A Computer Program for Earthquake Response Analysis of Horizontally Layered Sites", Earthquake Engineering Research Center, University of California, Berkeley, Report No. EERC 72-12, December.

Lysmer, J. Udaka, T., Seed, H. B. and Hwang, R. (1974) "LUSH - A Computer Program for Complex Response Analysis of Soil-Structure Systems", Earthquake Engineering Research Center, University of California, Berkeley, Report No. EERC 74-4, April.

FSAR Question 4

Paragraph 3.7.2.7 on page 3.7-15 states that modal combinations were ignored in the response spectrum analysis of the condensate storage tank. This seems to be indicative of an incomplete analysis. This statement should be clarified to assure that an acceptable analysis has been performed on the tank.

Response to FSAR Question 4

Paragraph 3.7.2.7 of the current FSAR does not discuss the condensate storage tank (CST). The auxiliary feedwater storage tank (new designation of CST) was analyzed by the response spectrum method using a multi-mass model which takes the effect of all significant modes into account.

FSAR Question 5

Paragraph 3.7.3.5 on page 3.7-24 and paragraph 3.10.2.2.2.2 on page 3.10-7 state that static seismic accelerations are increased by 50% (or amplified by 1.5) for multidegree-of-freedom systems which may be in the resonance region of the response spectra. This increase in the seismic acceleration in an equivalent static analysis is intended to account for multi-modal participation in the structural response. Regulatory Guide 1.100, Position C.1, permits the use of an amplification factor of 1.5 for frame-type structures but requires justification for factors used for other structures. Amplifying static seismic acceleration by 50%, therefore, is not acceptable for all multidegree-of-freedom structures unless justification is provided.

Response to FSAR Question 5

Paragraphs 3.7.3.5 and 3.10.2.2.2.2 of the current FSAR do not address the equivalent static load method of analysis. This is addressed in paragraphs 3.7.3A.5 and 3.7.3A.1.2.

The equivalent static load method of analysis described in paragraph 3.7.3A.1.2 is not used for large bore safety-related piping systems. Analysis of small diameter vents and drains which are decoupled from the main line, may be performed using the equivalent static load method. A constant acceleration of 1.5 times the acceleration at the vent or drain connection to the main pipe is used to calculate seismic loads in such cases. This is to account for amplification of response due to the main pipe. This is justified since these are short cantilevered pipe configurations with only one or two isolation valves and this method is used only when the frequency of the vent or drain line is more than 20 cps, which is in the rigid range for STP.

FSAR Question 6

In paragraph 3.9.3.2.1.3 on page 3.9-44, the condition that sine-beat response spectra envelop floor response spectra in the region of significant response is listed as a sufficient condition to justify the use of sine-beat testing. According to the requirements of IEEE Std. 344-1975, this condition alone is not sufficient to justify single-frequency testing. Multi-frequency testing is required to properly simulate the simultaneous response for all modes of multidegree-of-freedom systems, per IEEE Std. 344-1975.

Response to FSAR Question 6

Valve motor operators and electro-mechanical appurtenances were seismically tested using single axis sine beat techniques. Single axis testing is justified because these components are line mounted and seismic input has been strongly filtered.

Seismic testing performed on pump motors is multi-frequency, multi-axis because input motion for pump assemblies is not typically strongly filtered. When performing seismic testing on pump motors, the TRS are generated such that the RRS are enveloped.

Single frequency testing performed in accordance with IEEE 344-1975 is restricted to line mounted equipment.

FSAR Question 7

Paragraph 3.9.3.2.1.3 on page 3.9-44 states that seismic qualification on pump motors and valve operators can be accomplished by analysis alone, but does not emphasize that this qualification approach should only be used when the equipment operability can be suitably demonstrated by analysis alone. Tables 3.9-10 and 3.9-11 indicate that almost all safety-related Seismic Category I equipment was qualified by analysis alone. Was equipment operability properly demonstrated in the qualification of all this equipment?

Response to FSAR Question 7 (NSSS)

Analysis is utilized by Westinghouse for the seismic qualification of equipment when one of the following conditions is met:

a. The equipment is too large or the external loads, connecting elements or appurtenances cannot be simulated with a shaker table test.

b. The only requirement that must be satisfied relative to the safety of the plant is the maintenance of structural integrity.

c. The component represents a simple linear system or nonlinearities can be conservatively accounted for in the analysis.

This methodology is employed for passive equipment. Active equipment associated with systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, containment and reactor heat removal or otherwise essential in preventing significant release of radioactive material to the environment are qualified by test or a combination of testing and analysis. Active pump motors and valve operators are covered by this methodology. Report No. PVO-TGX/THX-1, Revision 1, titled "Pump and Valve Operability Report for South Texas Units 1 and 2" explains in detail how active pump and valve assemblies are qualified and references applicable analyses and test reports.

Response to FSAR Question 7 (BOP)

Active equipment (valves, dampers, devices, etc.) other than NSSS discussed above and associated with systems that are essential to emergency reactor shutdown, containment and reactor heat removal or otherwise essential in preventing significant release of radioactive material to the environment are qualified by test or a combination of testing and analysis. However, in the case of active pumps qualified by analysis, a deflection analysis is also performed to show that the impeller will not rub the casing or the shaft will not bind.

Analysis is utilized for the seismic qualification of passive and some active BOP equipment only when one of the following conditions is met:

a. The equipment is too large or the external loads, connecting elements or appurtenances cannot be simulated with a shaker table test.

FSAR Question 8

Paragraph 3.9.3.2.3, Item 2, on page 3.9-46a is confusing in stating that an individual valve is tested separately for plant loadings (including SSE loads) that the valve is expected to withstand in combination during valve operation. Assurance has to be provided that the valve can sustain the combined loads during operation.

Response to FSAR Question 8

This optional qualification method has not been used to date. The various loadings on the valves have either been simulated in total or the various loading components tested in combination at the manufacturers' shops or test laboratories within the capabilities of existing facilities, e.g., operating time and pressure at the manufacturer's shop and seismic, pressure, and nozzle (for valves up to 6" maximum) loads at a test laboratory. An analysis backed by these test results is performed to ensure that the valve is operable when subjected to the total plant loading combination.

b. The only requirement that must be satisfied relative to the safety of the plant is the maintenance of structural integrity.

c. The component represents a simple linear system or nonlinearities can be conservatively accounted for in the analysis.

Table 3.9-11 has been deleted from the FSAR by Amendment 41, and as discussed with NRC during Pre-SQRT/PVORT audit meeting on 9/16/86 Table 3.9-10, too, could be deleted since the seismic qualification information is contained in the Master List.

FSAR Question 9

Paragraph 3.10.1 on page 3.10-3 states that several instrumentation and electrical equipment items were qualified to IEEE Std. 344-1971, but does not indicate whether any of this equipment was later qualified to IEEE Std. 344-1975 requirements. The NRC has accepted IEEE Std. 344-1971 testing for specific pieces of equipment but has not accepted these qualifications on a generic basis. Therefore, the qualification of equipment to IEEE Std. 344-1971 requirements has to be evaluated on an item-by-item basis and may in some cases be found unacceptable when IEEE Std. 344-1975 requirements are considered.

Response to FSAR Question 9

Table 7.1 of WCAP-8587, "Methodology for Qualifying Westinghouse WRD Supplied NSSS Safety Related Electrical Equipment", March 1983, lists the equipment tested to single frequency single-axis sine beat testings which are considered to be qualified to IEEE Std. 344-1975. This list of equipment for your reference is provided below:

Equipment for Which Previous Seismic Tests Demonstrate Capability to IEEE 344-1975

Equipment	EQDP Reference
Nuclear Instrumentation System (NIS) Console (Power Range Channel)	EQDP-ESE-10
Process Protection System	EQDP-ESE-13
Solid State Protection System and Safeguards Test Cabinets (2 Train)	EQDP-ESE-16
Instrument Bus Power Supply (Static Inverter) - 7.5 KVA	EQDP-ESE-18
Instrument Bus Distribution Panel - 7.5 KVA	EQDP-ESE-19

The qualification programs for this equipment have been reviewed by the NRC and their consultants as part of the NRC Safety Evaluation Report (SER) for Westinghouse Equipment Qualification Documentation.