APPENDIX II

S-1410

GENERAL QUALIFICATION TEST PROCEDURE

FOR

CLASS IE NUCLEAR SERVICE VALVES

CODE IDENT. NO.	SIZE	QR-526
96487	A	
SCALE /	VALCOR ENG. CORP.	SHEET 52

REVISIONS

ECO	LTR	DESCRIPTION	DATE	APPROVED
12640	B	REDRAWN & EXTENSIVELY REVISED	4-21-77	[illegible]
12657	C	REVISED SHEET 19	5-2-77	[illegible]
12889	E	Incorporates Advance Rev. D.1 Deleted Ref. TO IEEE-382 in Para's 1.0 and 2.0. Added IEEE-101 Ref. to Para. 2.0 PG15, DELETED "TBD", ADDED "1720-2460", PG18, SUBSTITUTED "RESPONSE SPECTRA" BY "REQUIRED INPUT MOTION"	9/21/77	EM
13239	F	Para. 4.4.2.2.1, "5% damping factor" was "2% damping factor. Para. 4.4.2 Added velocity limit. Para. 4.4.2.1, "50HZ" was "100HZ". Para. 4.4.2.2.1 Added 1st sentence, and Velocity Limit; added switch monitoring. Page 13 retyped. Renumbered pages 14 to 17 because text was shortened due to revision. Figure 2, added control accelerometer. Fig. 3 added velocity limit.	4/10/78	EM
13630	G	ADDED p:18, FIGURE 4, CORRECTED PARA. 4.4.2.2	10/24/78	[illegible]

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REV.																												
SHEET	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52

REV. STATUS OF SHEETS																								
REV.	G	E	E	B	B	B	B	B	F	F	F	G	F	F	F	F	F	G						
SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
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DRAWN [illegible] DATE [illegible]	VALCOR ENGINEERING CORPORATION KENILWORTH, NEW JERSEY
CHECKED [illegible] 4/27/77	
ENGINEER	TITLE: GENERAL QUALIFICATION TEST PROCEDURE FOR CLASS IE NUCLEAR SERVICE VALVES
Q.C. [illegible] 9/21/76	
PRODUCTION [illegible] 12/8/76	

SIZE	CODE IDENT. NO.	DOCUMENT NO.
A	96487	51410
SCALE		SHEET 1 of 18

1.0 GENERAL

This test procedure describes the qualification tests, and methods to be used to verify that the subject valve and operator meet the specified design and operator requirements. The tests listed herein have been established in accordance with the guides of IEEE Standard 101, IEEE Standard 323 and IEEE Standard 344.

2.0 APPLICABLE DOCUMENTS

Valcor Engineering Corporation

S1602	General Acceptance Test Procedure for Nuclear Solenoid Valves.

IEEE

101-1972	Statistical Analysis of Thermal Life Test Data.
323-1974	Standard for Qualifying Class IE Equipment for Nuclear Power Generating Stations.
344-1975	Recommended Practices for Seismic Qualification of Class I Electric Equipment for Nuclear Power Generating Stations.

Military

MIL-P-27401	Propellant Pressurizing Agent, Nitrogen.
MIL-C-45662A	Calibration System Requirements

3.0 TEST CONDITIONS AND EQUIPMENT

3.1 Test Conditions and Tolerances

3.1.1 All tests shall be performed at the following conditions, unless specified otherwise:

Temperature: 57°F to 97°F

Relative Humidity: 90% or less

3.0 TEST CONDITIONS AND EQUIPMENT (Continued)

3.1.2 The maximum tolerances of environmental test conditions shall be as follows:

a. Pressure:	±10% of gage, not to exceed 10 PSIG
b. Vibration Amplitude:	+6db to the acceleration of the response spectrum at a mounting point.
c. Vibration Frequency:	±2%
d. Temperature:	+15 F°; except at saturated steam conditions not to exceed 10 PSIG
e. Radiation:	+10%
f. Time:	+10% of the period of time the equipment is to be operational following a DBE.
g. Environmental Transients:	The initial transient and the dwell at the peak temperature shall be applied at least twice.
h. Voltage:	+10% of rated value unless otherwise specified.

3.2 Equipment and Calibration

All equipment requiring calibration is to be calibrated in accordance with MIL-C-45662A. The equipment of outside testing laboratories shall be capable of measuring and/or controlling within the limits specified in para. 3.1

All measurements shall be made with instruments which are within the current calibration period.

Prior to using an instrument, it shall be verified that the instrument does not become due for calibration during the time period when it will be used for test purposes.

3.3 Test Fluid

Test gasses shall be GN_2 or air for all tests herein. All gasses shall be clean, dry and filtered to 50 microns minimum.

4.0 QUALIFICATION TESTS

Tests are to be performed on one test sample in accordance with the following sequence, which is the sequence as suggested in IEEE Std. 323.

a. Acceptance tests per Valcor S1602.

b. Aging.

   1. Thermal Aging

   2. Cyclic Aging

c. Acceptance tests per Valcor S1602.

d. Radiation.

e. Dielectric and Insulation Resistance tests per Valcor S1602.

f. Seismic Simulation.

g. Acceptance tests per Valcor S1602.

h. LOCA Simulation.

i. Acceptance Test per Valcor S1602.

j. Disassembly and inspection.

4.1 Acceptance Tests

These tests are to be performed in order to establish a base line of data for comparison of performance under,

4.1 Acceptance Tests (Continued)

the more highly stressed test conditions.

Perform the acceptance tests in accordance with Valcor Test Procedure S1602 and the respective valve TR (Test Report). The valve must meet all the acceptance test criteria. Record all results on the test data sheets.

4.2 Aging

4.2.1 Thermal Aging

This test is to be performed in accordance with the provisions of IEEE Std. 101. The test is to be performed at an elevated temperature for a corresponding time duration. The temperature and time duration of the test are to be determined from equations (1) and (2). These equations are based upon a relationship thant for every 10°C rise in temperature above the normal operating temperature, the test time duration is halved. Reference IEEE Std. 101A, Appendix B.

(1) $T_t = T_o + (10°C)N$

Where:

T_t = Test Temperature (°C)

T_o = Normal ambient operating temperature (°C)

N = Number of 10°C increments above normal ambient operating temperature.

4.2.1 Thermal Aging (Continued)

(2) $A = (0.5)^N L$

Where:

A = Actual required test time (hours)

N = Number of 10°C increments above normal ambient operating temperature.

L = Expected valve life (hours)

The following example illustrates the use of equations (1) and (2).

EXAMPLE: Given conditions: A valve is to operate at a 60°C normal ambient temperature for 40 years.

Test Temperature and Duration: It is desired to perform the test in approximately one week. Proceed per the following steps to determine the test temperature and actual test time.

(a) Convert expected life, in years, to hours:

L = (40Years) (8766 hours/year) = 350,640 hrs.

(b) Re-arrange equation (2) to solve for N as given:

Log A = N log (.5) + log L

N = (log A - log L) / log (.5)

Substituting for A (estimated test time) and L, and solving for N:

N = (log 168 hrs. - log 350,640 hrs.)/ log (o.5)

N = (2.225 - 5.544)/ (-.3010) = 11.02

4.2.1 Thermal Aging (Continued)

Rounding N to the nearest whole number and solving for equation (1):

$T_t = 60°C + (10°C)\ (11)$

$T_t = 170°C.$

Solving equation (2) for the actual required test time by substituting for N and L:

$A = (0.5)^{11}\ (350{,}640 \text{ hrs.})$

$A = 171.1 \text{ hours}$

Therefore the required test temperature and time would be 170°c, and 171.1 hours.

During this test, the valve is to be pressurized at its normal operating pressure. The minimum allowable test time under any condition is 100 hours.

4.2.1.1 Post Thermal Aging

Perform the acceptance tests per Valcor S1602 and the respective valve TR (Test Report).

4.2.2 Cyclic Aging

This test is to be performed at room ambient temperatures, unless specifically amended by an Engineering Order (E.O.).

4.2.2 Cyclic Aging (Continued)

Pressurize the valve inlet port to its normal operating pressure with GN_2 or water. GN_2 is to be the test media for gas valves, and water is to be used for liquid valves. The test media shall be room ambient temperature unless amended by an Engineering Order (E.O.).

Cycle the valve open and closed, at the nominal rated voltage, by means of a cycle timer. Cycle the valve for 7500 cycles, or for a greater number of cycles if specifically amended by an Engineering Order (E.O.). The valve "open" time shall be set for 1/2 second, minimum, and the cycle rate shall not exceed 20 cycles per minute.

At approximately each 1000 cycles of operation perform an internal leak test in accordance with s-1602, and the respective valve TR. Record all leakage results on the test data sheets.

4.2.2.1 Post Cycling Aging

Perform the acceptance tests per Valcor S-1602 and the respective valve TR.

4.3 Radiation Resistance

This test is to be performed to radiation age all non-metallic parts, particularly electrical insulating materials.

This test is to be performed by installing the valve in a chamber and irradiating it with gamma radiation from a Cobalt-60 source.

The radiation dose rate will be 0.75 megarads per hour, nominal. The irradiation will be applied until a total dose of 2×10^8 rads has been attained.

4.3.1 Post Radiation

Perform the dielectric and insulation resistance tests of Valcor S1602. Record the dielectric leakage current and actual insulation resistance on the test data sheets. The acceptable test values shall not exceed the limits listed in the acceptance test requirements.

4.4 Seismic Vibration

This test will be performed only on one unit at room ambient conditions.

4.4.1 Test Preparation

4.4.1.1 Mounting

The valve shall be mounted and fixtured in a manner similar to that as shown in Figure 2.

4.4.1.2 Instrumentation

Install 3 accelerometers onto the valve solenoid. The accelerometers shall be mounted along planes which pass through the solenoid center of gravity.

4.4.1.3 Operational Loading

After being mounted to the fixture as given in paragraph 4.4.1.1, and prior to application of the vibration, the valve inlet port shall be pressurized to operating line pressure with air or GN_2. Connect indicating switches (if applicable) to individual ohm meters to monitor switch performance during the seismic tests.

4.4.2 Seismic Tests

The physical limitations of the test machine are 5 inches double amplitude, and a maximum velocity of 40 inches per second. The actual acceleration versus frequency profile shall be recorded during the period that double amplitude and velocity are limited.

4.4.2.1 Resonant Frequency Survey

With the valve mounted as given in paragraph 4.4.1.1, and pressurized as given in paragraph 4.4.1.3, sweep the frequency range from 1.0 HZ to 50 HZ at a level of 0.2 g peak or 5 inches double amplitude, whichever is greater. The sweep rate shall be one octave per minute. The input levels shall be controlled by piezoelectric or piezorestive accelerometers mounted at the test fixture. During the

4.4.2.2.1 OBE Test (continued)

incoherent motion is independently applied to the test axes. The duration of each dwell shall be 30 seconds minimum and uninterrupted, repeated five (5) times for a minimum total of 150 seconds per dwell axis.

During each dwell, energize the valve at least once with minimum operating voltage to its alternate operating condition to demonstrate operability during a seismic event. When energized, the valve must shuttle to its alternate operating condition, and indicating switches (if applicable) must change state. Record the operation as accept or reject on the data sheet. When not being operated, monitor the valve for internal leakage. Record the leakage rate on the test data sheet.

At the completion of testing in the first dwell axis, rotate the valve 90 degrees about the vertical test axis and repeat the 5 OBE tests.

4.4.2.2.2 SSE Tests

Upon completion of the OBE Tests, perform the SSE test in both sets of axes in accordance with the procedure of paragraph 4.4.2.2.1, except that the test response spectra shall be in accordance with Figure 3 , Curve 'B', and only 3 dwells per axis need be performed, for a minimum total test time of 90 seconds per dwell axis.

4.4.2.3 Post Seismic Tests

Perform the acceptance tests in accordance with Valcor Test Procedure S1602 and the respective valve TR. The valve must meet all the acceptance test criteria. Record all results on the test data sheets. (Note: The dielectric test shall not be repeated).

4.5 LOCA Simulation

During the entire test period the valve inlet port shall be pressurized with air or GN_2 at operating pressure. The outlet port shall be vented to room ambient atmosphere.

4.5.1 Base Line Test (I)

With the valve installed in a test chamber at room ambient pressure and temperature, perform the acceptance tests of Valcor S1602, except that an external leakage test need not be performed.

4.5.2 Test Conditions and Performance

Expose the valve to the pressure-temperature test profile as given in Figure 4, and the conditions given in Table I. Operate the valve at each period designated in Figure 4 to verify the operability of the valve, i.e., the valve must open or close as required. The valve shall be operated at least one cycle with minimum operating voltage. Valves containing indicating switches shall be monitored for switch operation during each designated test period.

TABLE I

TEST CONDITIONS

(1) Steam Exposure as per Figure 4.

(2) Spray Exposure

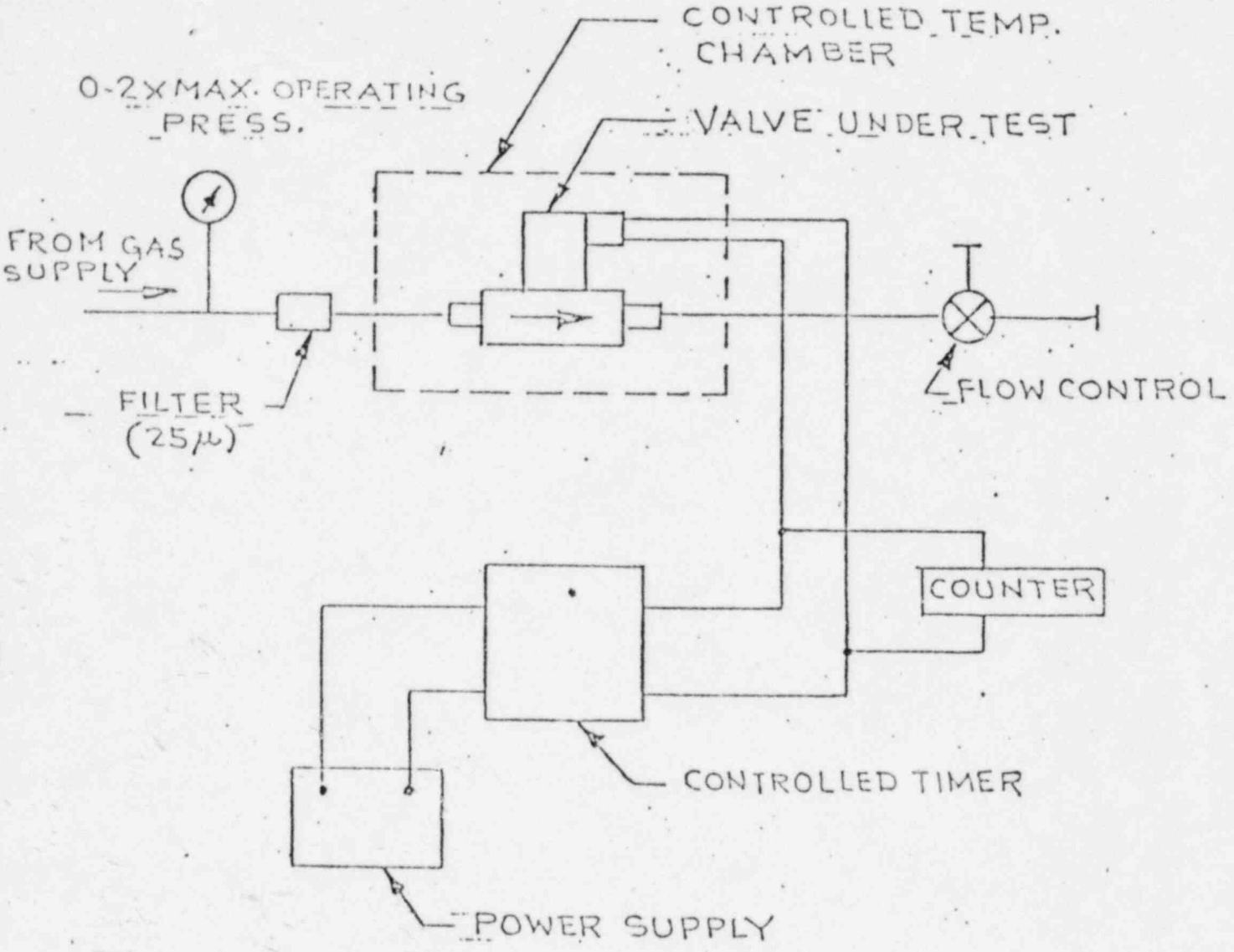
Continuously spray vertically downward for the first 24 hours with a test solution (1720 to 2460 PPM boric acid 0.064 molar $Na_2S_2O_3$ with sodium hydroxide added to produce a pH of 10.5 at 77°F) at a rate of 0.15 GPM/ft^2 of area of the test chamber projected on a horizontal plane.

4.5.3 Post LOCA Tests

Return the LOCA test chamber conditions to room ambient temperature and pressure, then perform the acceptance tests of Valcor S1602, except that the external leakage test will be performed after the valve is removed from the chamber.

4.6 Disassembly and Inspection

Upon completion of all tests visually examine all external and internal valve parts, recording all results of the physical inspection, particularly wear of parts.



THERMAL AND CYCLIC AGING TEST SCHEMATIC

FIGURE 1

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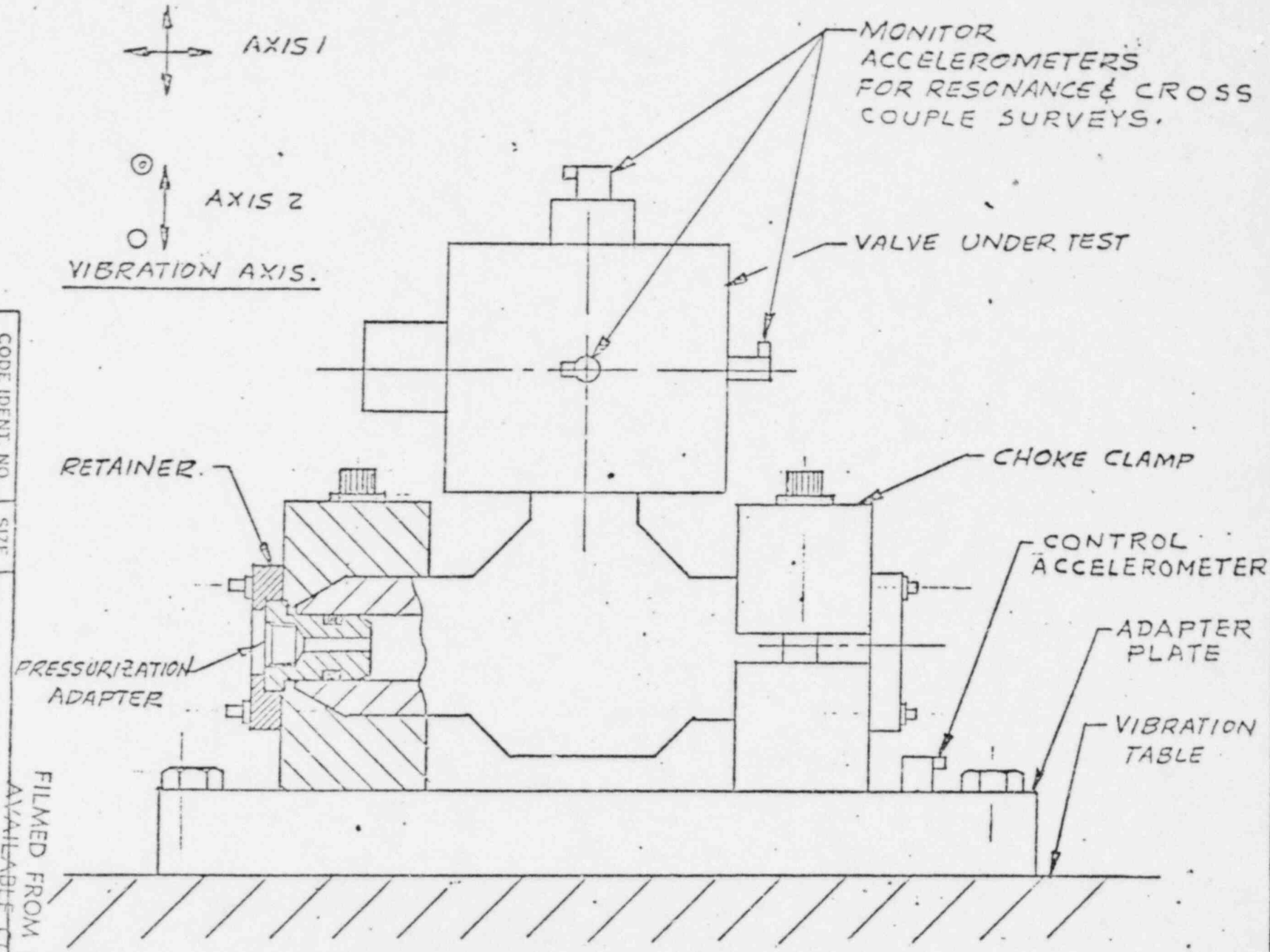

FIGURE. 2

SEISMIC VIBRATION TEST SET-UP

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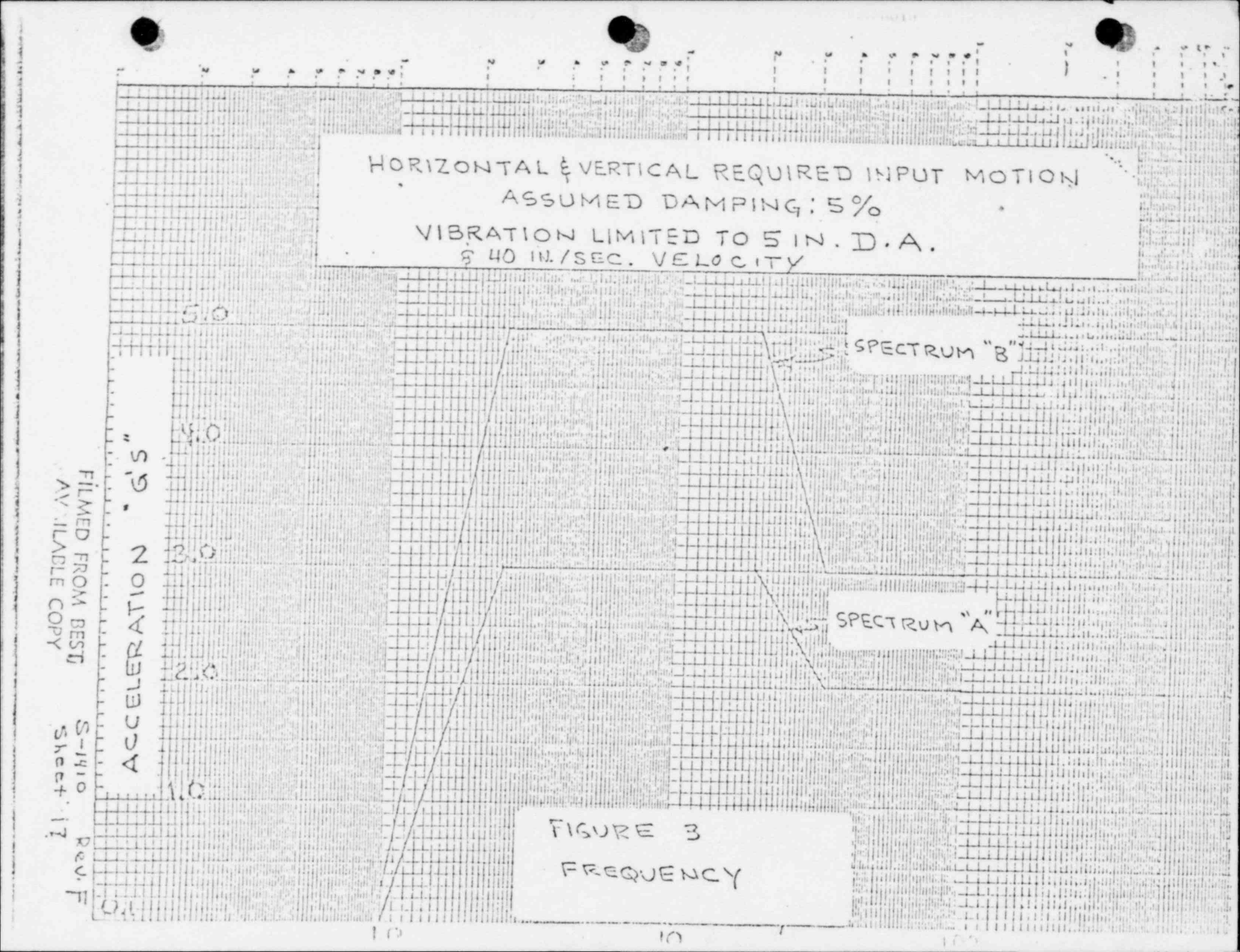
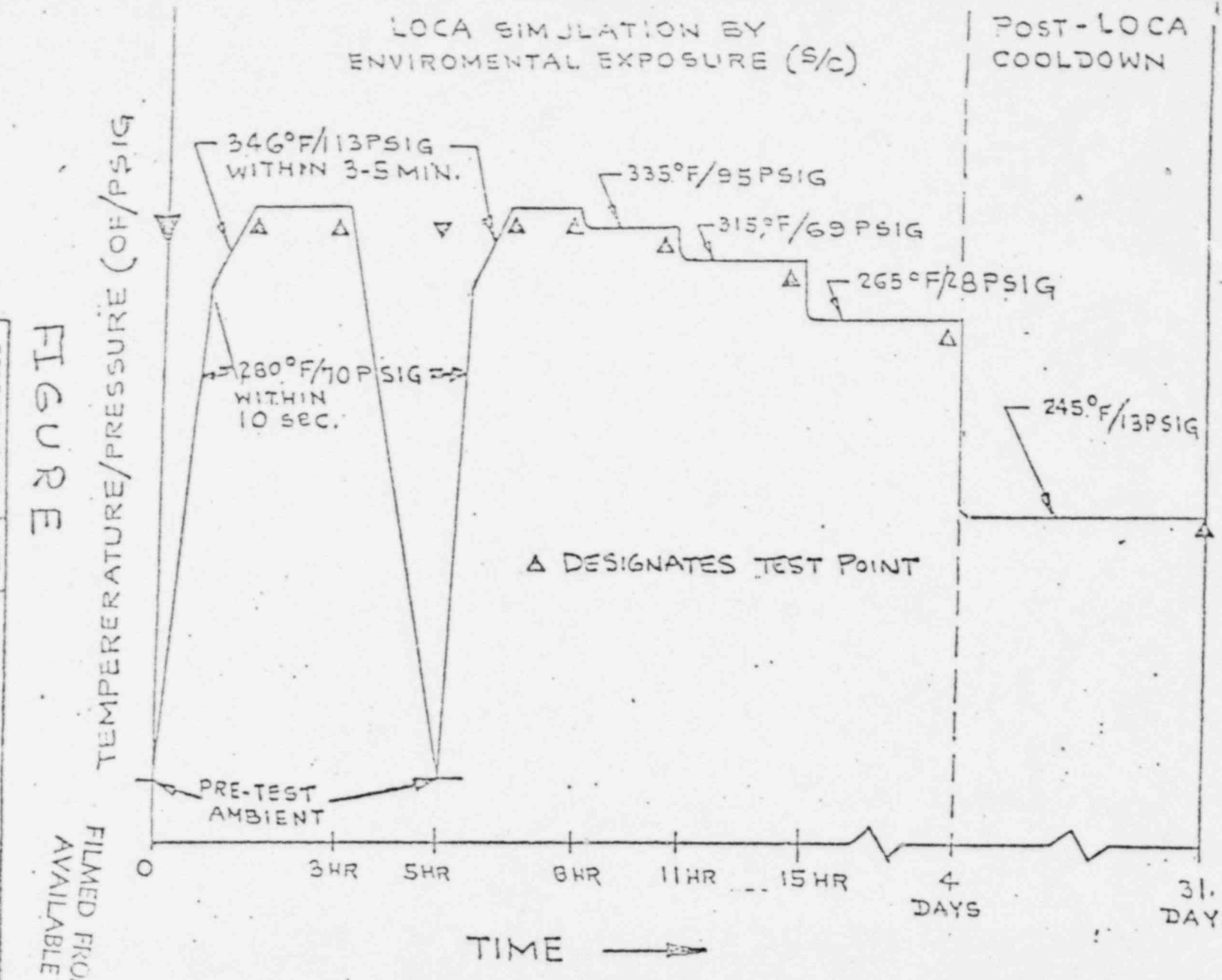


FIGURE 3



FIGURE

TEMPERATURE/PRESSURE PROFILE FOR SIMULATION OF LOSS-OF-COOLANT ACCIDENT (LOCA) DESIGN BASIS EVENT (DBE) BY STEAM/CHEMICAL-SPRAY ENVIRONMENTAL EXPOSURE. (PER IEEE 323-1974 FIGURE A1 OF APPENDIX A)

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