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EQUIPMENT QUALIFICATION DATA PACKAGE

This document contains information, relative to the qualification of the equipment identified below, in accordance with the methodology of WCAP 8587. The Specification section (Section 1) defines the assumed limits for the equipment qualification and constitute interface requirements to the user.

Four Section Power Range Neutron Detectors

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SECTION 1 - SPECIFICATIONS

1.0 PERFORMANCE SPECIFICATIONS

1.1 Electrical Requirements

1.1.1 Voltage: 200 - 1500 VDC max.
1.1.2 Frequency: N/A
1.1.3 Load: N/A
1.1.4 Electromagnetic Interference: Per MIL-N-19900B
1.1.5 Other: None

1.2 Installation Requirements: Westinghouse Drawing 583F278
Westinghouse C&ES Std. 4.1

1.3 Auxiliary Devices: Moderator Assembly
High Voltage Distribution Box

1.4 Preventative Maintenance Schedule: None

1.5 Design Life: 5 Years

1.6 Operating Cycles (Expected number of cycles during design life, including test): Continuous duty

1.7 Performance Requirements for[b]:

	Parameter	Normal Conditions	Abnormal Conditions	Containment Pressure Test Conditions	DBE Conditions(a) FLB/SLB	DBE Conditions(a) LOCA	DBE Conditions(a) Seismic	Post DBE Conditions(a) FLB/SLB	Post DBE Conditions(a) LOCA	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	Continuous	8 Hours	Test Duration	5 Min	N/A	Event Duration	N/A	N/A	N/A
1.7.2	Performance[d] requirement	Note (c)	As Normal	No Damage	Note (c)	N/A	Note (c)	N/A	N/A	N/A

1.8 Environmental Conditions for Same Function[b]

1.8.1	Temperature(°F)	80-135	175	Ambient	Figure 3	N/A	Ambient	N/A	N/A	N/A
1.8.2	Pressure (psig)	-0.1/+0.3	Ambient	70	5	N/A	0	N/A	N/A	N/A
1.8.3	Humidity (% RH)	0-95	95	Ambient	100	N/A	Ambient	N/A	N/A	N/A
1.8.4	Radiation (R)	4.59×10^{17} nvt 2.19×10^{9} R (γ) 2.19×10^{6} R (γ) box & connectors	As Normal detector	None	As Normal Plus 3×10^{4} R (β) 5×10^{3} R (γ)	N/A	As Normal	N/A	N/A	N/A
1.8.5	Chemicals	None	None	None	Figure 3	N/A	None	N/A	N/A	N/A
1.8.6	Vibration	None	None	None	None	N/A	None	N/A	N/A	N/A
1.8.7	Acceleration (g)	None	None	None	None	N/A	Figures 1 and 2	N/A	N/A	N/A

Notes: (a) DBE is the Design Basis Event.
(b) Margin is not included in the parameters of this section.
(c) Performance requirements are specified in Section 1.7.2.
(d) The 4-Section Power Range Neutron Detector sensitivity is not expected to change from the beginning to the end of the test program. Therefore, the sensitivity shall not change by more than ± 5 percent (which is measurement error) as measured during the sensitivity test.

1.7.2 Performance Requirements

1.7.2.1 Normal Conditions - Resistance between the center wire and inner shield of the triax cables shall be greater than 1×10^7 ohms.

1.7.2.2 Seismic and HELB

1.7.2.2.1 No break in the continuity between the HV and signal cables.

1.7.2.2.2 Resistance from HV cable to ground and signal cable to ground shall not be less than 10^7 ohms.

1.7.2.2.3 The NIS output shall not change.

1.9 Qualified Life: The demonstrated qualified life is 5 years based on the actual test conditions identified in Table 1.

1.10 Remarks: None

SECTION 2 - QUALIFICATION BY TEST

2.0 TEST PLAN

Thermal aging of selected components and assemblies was performed at the Westinghouse Industrial and Government Tube Division (WIGTD), Horseheads, N.Y.

Radiation aging of selected components and assemblies was performed at the NY State University of Buffalo, Buffalo, NY under the sponsorship of WIGTD and at Cornell University, Ithaca, N.Y.

Thermal stress cycling and normal/abnormal environmental tests were performed at the Westinghouse Industrial and Government Tube Division, Horseheads, NY.

Containment pressure tests were performed at Westinghouse Industrial and Government Tube Division and the Forest Hills Site, Forest Hills, Pennsylvania.

Seismic environment testing was performed at the Westinghouse Advanced Energy Systems Division (WAESD), Large, Pennsylvania.

HELB environment testing, was performed at the Westinghouse Forest Hills Site, Forest Hills, Pennsylvania and at the Westinghouse Industrial and Government Tube Division (WIGTD), Horseheads, N.Y.

2.1 Equipment Description: 4-Section Power Range Neutron Detector
Moderator Assembly
High Voltage Distribution Box

2.2 Number Tested: One each of the above items went through the entire test sequence.

2.3 Mounting:

2.3.1 Normal and Abnormal Operation.

The total assembly (One Detector, Moderator, and High Voltage Distribution Box), was loaded horizontally into a temperature and humidity chamber.

2.3.2 Seismic

A 4-Section Power Range Neutron Detector positioning device and test fixture were mounted in a vertical position on a steel cover plate of the shaker table (simulating in-plant conditions). The detector and moderator assembly were inserted into the positioning device.

The High Voltage Distribution Boxes were mounted on the test fixture which in turn was bolted to the cover plate of the shaker table.

2.3.3 HELB

The total assembly (as described in 2.3.1) was mounted vertically inside the test chamber.

2.4 Connections: Triax connectors, Jack - Amphenol 52975
Plug - Amphenol 53175

2.5 Aging Simulation Procedure: On organic components by thermal and irradiation aging, both neutron and gamma as appropriate.

2.6 Service Conditions to be Simulated by Test

		Normal	Abnormal	Containment Pressure Test	Seismic	HELB
2.6.1	Temp. (^{o}F)	80-135[a]	175[b]	Ambient	Ambient	Fig. 4
2.6.2	Pressure (psig)	2	2	70	0	5
2.6.3	Humidity (% RH)	95	95	Ambient	Ambient	100
2.6.4	Radiation (R)	None	None	None	None	None
2.6.5	Chemicals	None	None	None	None	Fig. 4
2.6.6	Vibration	None	None	None	None	None
2.6.7	Acceleration (g)	None	None	None	Figs. 1&2 TRS>RPS	None

Notes: (a) 18 cycles
(b) 2 cycles

2.7 Measured Variables

This section identifies the parameters required to be measured during the test sequence(s).

		Required	Not Required
2.7.1	Category I - Environment		
2.7.1.1	Temperature	A,D	B,C
2.7.1.2	Pressure	A,B,D	C
2.7.1.3	Moisture		A,B,C,D
2.7.1.4	Composition		A,B,C,D
2.7.1.5	Seismic Acceleration	C	A,B,D
2.7.1.6	Time	A,B,C,D	
2.7.2	Category II - Input Electrical Characteristics		
2.7.2.1	Voltage	A,B,C,D	
2.7.2.2	Current		A,B,C,D
2.7.2.3	Frequency		A,B,C,D
2.7.2.4	Power	-	A,B,C,D
2.7.2.5	Other		A,B,C,D
2.7.3	Category III - Fluid Characteristics		
2.7.3.1	Chemical Composition		A,B,C,D
2.7.3.2	Flow Rate		A,B,C,D
2.7.3.3	Spray		A,B,C,D
2.7.3.4	Temperature		A,B,C,D
2.7.4	Category IV - Radiological Features		
2.7.4.1	Energy Type		A,B,C,D
2.7.4.2	Energy Level		A,B,C,D
2.7.4.3	Dose Rate		A,B,C,D
2.7.4.4	Integrated Dose		A,B,C,D

			Required	Not Required
2.7.5	Category V - Electrical Characteristics			
	2.7.5.1	Insulation Resistance	A,C,D	B
	2.7.5.2	Output Voltage		A,B,C,D
	2.7.5.3	Output Current	A,C,D	B
	2.7.5.4	Output Power		A,B,C,D
	2.7.5.5	Response Time		A,B,C,D
	2.7.5.6	Frequency Characteristics		A,B,C,D
	2.7.5.7	Simulated Load		A,B,C,D
	2.7.5.8	Continuity	C,D	A,B
2.7.6	Category VI - Mechanical Characteristics			
	2.7.6.1	Thrust		A,B,C,D
	2.7.6.2	Torque		A,B,C,D
	2.7.6.3	Time		A,B,C,D
	2.7.6.4	Load Profile		A,B,C,D
2.7.7	Category VII - Auxiliary Equipment			

Note: For tests A and D, the parameters measured include the High Voltage Distribution Box coupled with the Detector as an Assembly. For test C, the boxes were tested individually.

A = Normal and Abnormal Operation

B = Containment

C = Seismic

D = HELB

2.8 Test Sequence Preferred

This section identifies the preferred test sequence as specified in IEEE-323-74 and as applicable to the equipment's performance requirements.

2.8.1 Inspection of Test Item
2.8.2 Operation (Normal Condition)
2.8.3 Operation (Abnormal Condition)
2.8.4 Simulated Aging
2.8.5 Seismic
2.8.6 High Energy Line Break
2.8.7 Disassembly and Inspection

2.9 Test Sequence Actual

This section identifies the actual test sequence which, in total, constitutes the overall qualification program for this equipment. The justification for employing anything other than the preferred sequence is as follows:

Step	Justification
2.8.4 2.8.1 2.8.2 2.8.3 2.8.5 2.8.6 2.8.7	In order to demonstrate the safety related function at end of design life (5 years), it was necessary to age the appropriate components prior to normal and abnormal operation. Also, the aging - for the most part - was conducted on unassembled components because of the wide disparities in Arrhenius plots.

2.10 Type Test Data

2.10.1 Objective

The objective of this qualification program is to demonstrate, employing the recommended practices of Reg. Guide 1.89 (IEEE-323-1974) and Reg. Guide 1.100 (IEEE 344-1975), that the 4-Section Power Range Neutron Detector, Moderator Assembly and High Voltage Distribution Box meet or exceed their safety-related performance requirements defined in Section 1.7 for the Comanche Peak facility while subjected to the following conditions defined in Section 1.8: normal/abnormal temperature and humidity, containment pressure, seismic and high energy line break (HELB) environments. The qualification testing, except for the containment pressure test encompassing the above conditions, was performed on a 4-Section Power Range Neutron Detector, Moderator and High Voltage Distribution Boxes which, where required, contained components that had been previously thermal and irradiation aged. Containment pressure qualification is accomplished by comparison with similar equipment.

2.10.2 Equipment Tested

2.10.2.1 4 Section Power Range Neutron Detector
Moderator Assembly
High Voltage Distribution Box

2.10.2.2 One each of the above items went through the entire test sequence.

2.10.3 Test Summary

2.10.3.1 Simulated Aging

The organic materials of the test items were thermally and irradiation aged (where required) for a

simulation of 5 years of service. No changes occurred due to aging which would have a deleterious effect on the functioning of the equipment.

2.10.3.2 Normal/Abnormal Environment Testing

The cycling performed to address the normal and abnormal environments was done in accordance with the simulated service conditions of Section 2.6. The test items functioned satisfactorily for the duration of the test.

2.10.3.3 Seismic Tests

The test response spectra enveloped the required response spectra which is shown in Figures 1 and 2 for the Detector/Moderator and the High Voltage Distribution Box respectively. In both cases, no structural failure was observed. Electrically, the test items performed acceptabily.

2.10.3.4 High Energy Line Break Test

The test items were subjected to the HELB profile of Figure 4. Electrically, the test items performed acceptably.

2.10.4 Conclusion

The qualification of the 4-Section Power Range Neutron Detector, Moderator Assembly and High Voltage Distribution Box is demonstrated for a qualified life of 5 years by the completion of the simulated aging and design basis event testing as described herein and reported in Reference 1.

2.11 The generic tests - normal/abnormal environment test - completed by Westinghouse employ parameters designed to envelop a number of plant applications. However, the seismic and HELB tests employ parameters designed to envelope Comanche Peak's application. Margin is a plant specific parameter and will be established by the applicant.

2.12 References

1. WCAP-8687, Supp. 2 - E22A, Chang, S.-M., Miller, T. N., Vogeding, E. L., "Equipment Qualification Test Report - 4 Section Power Range Neutron Detector (Environmental and Seismic Testing for Comanche Peak)".

SECTION 3 QUALIFICATION BY EXPERIENCE

Westinghouse does not employ operating experience in support of the qualification program for the 4-Section Power Range Neutron Detector, Moderator Assembly, and High Voltage Distribution Box.

SECTION 4 QUALIFICATION BY ANALYSIS

Analysis is employed in two areas.

1. Aging simulation of the polyethylene moderator material.

2. Containment pressure test.

Both of these analyses are discussed in Reference 1.

TABLE 1

ACTUAL QUALIFICATION TEST CONDITIONS

EQUIPMENT SYSTEM/CATEGORY	LOCATION STRUCTURE/AREA	MANUFACTURER TYPE/MODEL	ABNORMAL/ACCIDENT ENVIRONMENTAL EXTREMES PARAMETER	SPECIFIED (2)	QUALIFIED	OPERABILITY REQ	OPERABILITY DEM	ACCURACY(%) REQ	ACCURACY(%) DEM	QUAL LIFE	QUAL METHOD	QUAL REF	QUAL PROGRAM STATUS
4-Section power range neutron detector/ RPS/ Category c (1)	Containment Bldg./inside missile shield	W IGTD 24045	Temperature		≤ 200°F	Trip 8 hrs.	Trip 8 hrs.	No change in sensitivity	No change in sensitivity	5 yrs.	Seq. Test	ESE-22	Completed
			Pressure		5 psig								
			Rel. humidity		95 %								
			Radiation		2.2×10^9 R(γ)								
					4.59×10^{17} nvt								
					Detector and Moderator								
					4.48×10^6 R(γ)								
					Box and Connector								
			Chemistry		None								

1. The 2 and 4 Section Power Range Neutron Detectors are only required to perform a safety function for contained faults. Although there are no adverse environments present when these instruments must perform their safety functions, these instruments are being subjected to high energy line breaks (HELB) environments to ensure no adverse affects on the protection system.

2. Plant specific environmental parameters are to be inserted by the applicant.

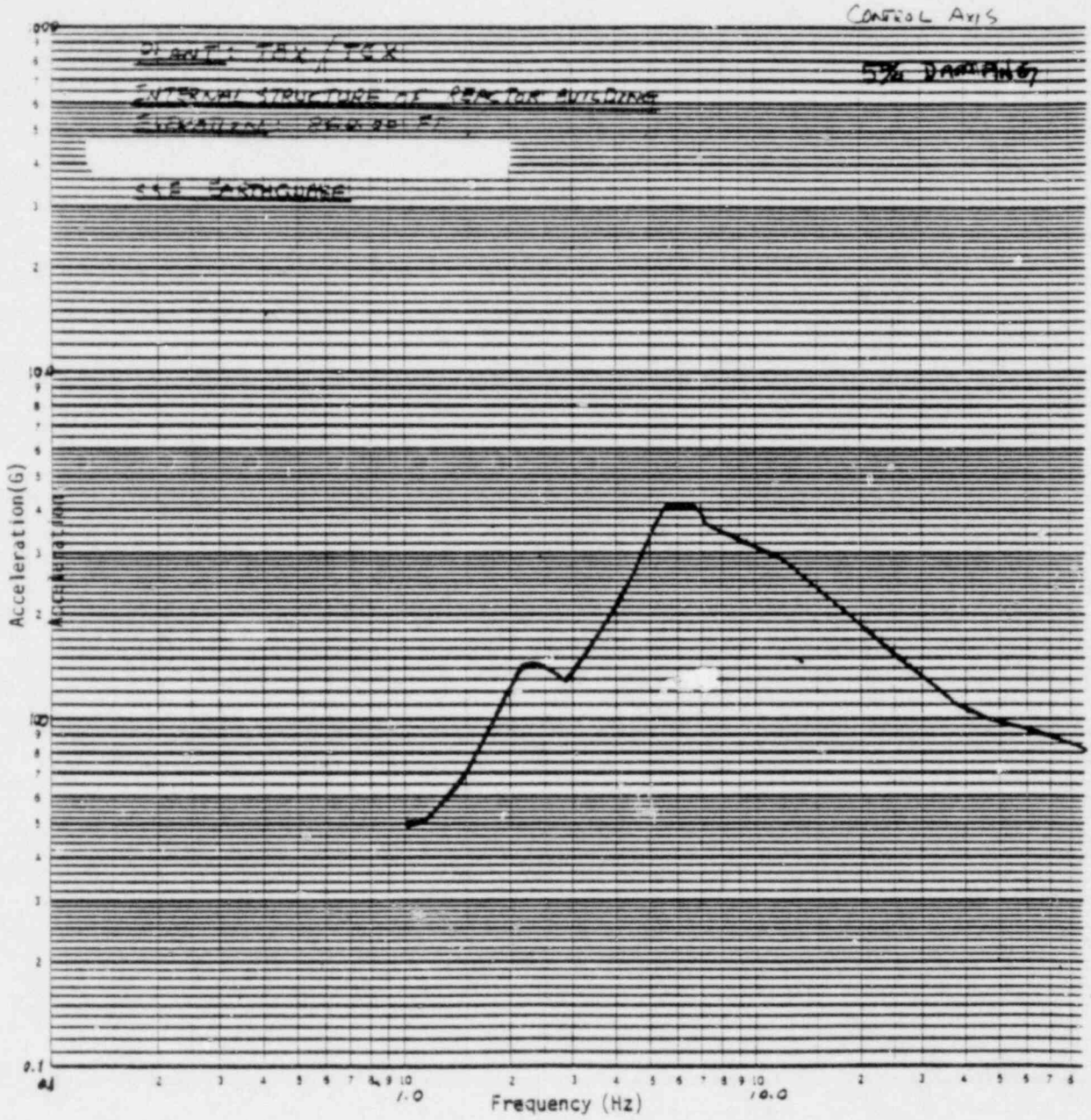

Figure 1. Required Response Spectrum-Neutron Detector/Moderator

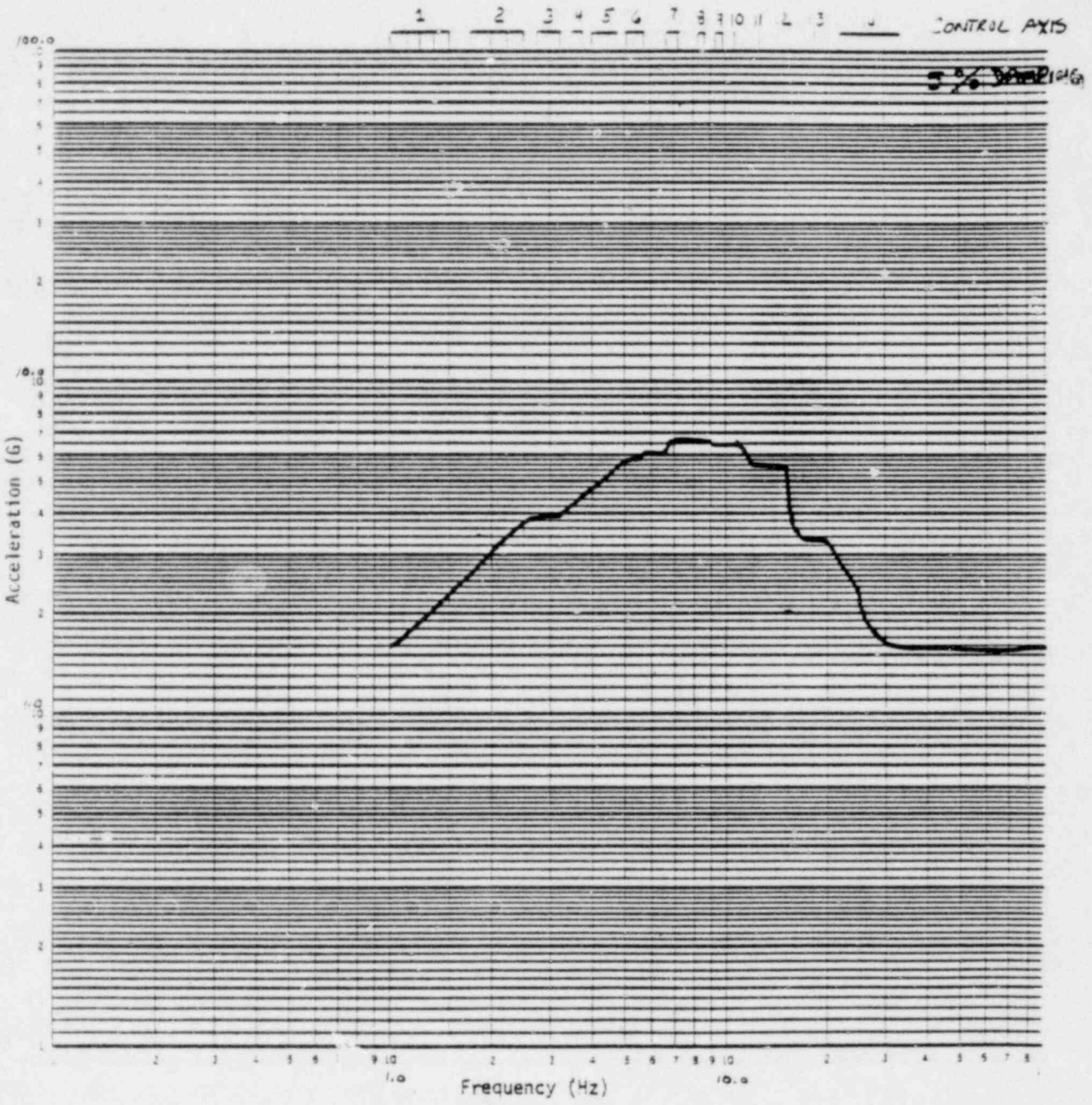

Figure 2. Required Response Spectrum-High Voltage Distribution Box

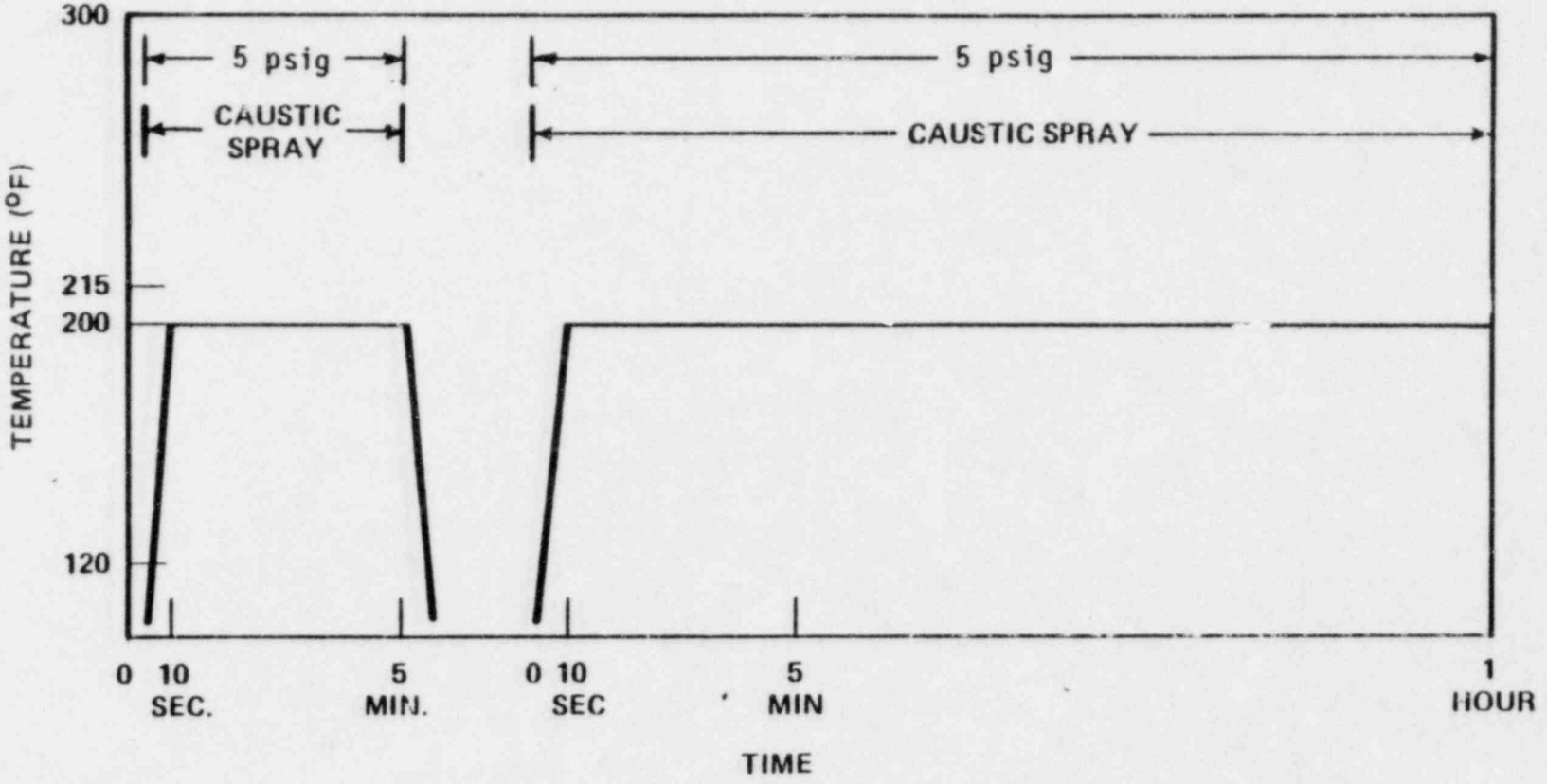

Figure 3. High Energy Line Break (HELB) Environmental Requirement

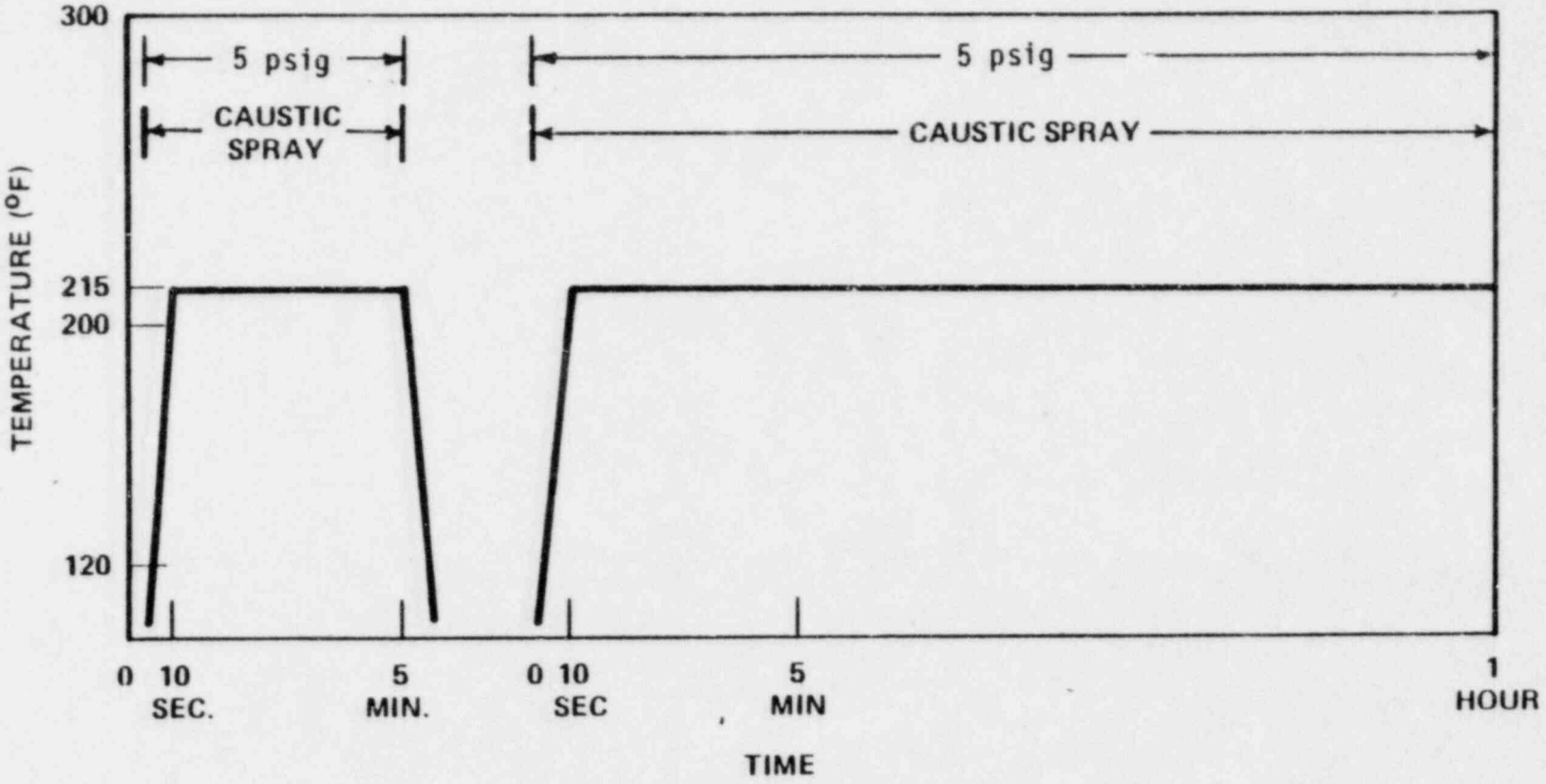

Figure 4. High Energy Line Break (HELB) Test Profile