EQDP-ESE-27
Rev. 0, 1/83

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 Performance Specifications section (Part 1) defines the assumed limits for the equipment qualification and constitutes interface requirements to the user.

N-16 Gamma Detector and High Voltage Distribution Box

APPROVED: _____
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EQUIPMENT QUALIFICATION DATA (PART 1-SPECIFICATIONS)

1.0 PERFORMANCE SPECIFICATIONS

1.1 Electrical Requirements

1.1.1 Voltage: 200-400 VDC

1.1.2 Frequency: N/A

1.1.3 Load: N/A

1.1.4 Electromagnetic Interference: None

1.1.5 Other: None

1.2 Installation Requirements:

N-16 Gamma Detector	E-3106, Rev. C
N-16 High Voltage Distribution Box	E-3072, Rev. F
N-16 Gamma Detector Interconnections	1191F11, Rev. 4
Collimator Box	1451E02, Rev. (later)
	1460E23, Rev. 2
	1225E53, Rev. 3
C&ES Std. 4.1, Revision 5	

1.3 Auxiliary Devices: Collimator Box, High Voltage Power Supply, A/E Designed Junction Box (NEMA 4 Enclosure)

1.4 Preventative Maintenance Schedule: None

1.5 Design Life: 5 years

1.6 Operating Cycles: Continuous Duty

1.7 Performance Requirements For[a]: N-16 Gamma Detector and Prefab Cable [b].

	Parameter	Normal Conditions	Abnormal Condition	Containment Pressure Test Condition	DBE Conditions (c) FLB/SLB	DBE Conditions (c) LOCA	DBE Conditions (c) SEISMIC	Post DBE Condition (c) FLB/SLB	Post DBE Condition (c) LOCA	Post DBE Condition (c) SEISMIC
1.7.1	Time requirement	Continuous	As normal	Test Duration	<5 min.	N/A	Event Duration	N/A	N/A	N/A
1.7.2	Performance requirement	Note (d)	As normal	No damage	Note (d)	N/A	Note (d)	N/A	N/A	N/A
1.8	Environmental Conditions for Same Function[a]									
1.8.1	Temperature (°F)	120-200°F	As normal	Ambient	Fig. 3	N/A	Ambient	N/A	N/A	N/A
1.8.2	Pressure (psig)	-0.1/+0.3	As normal	70	Fig. 3	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 (RADS)	7.2×10^6	As normal	None	$5.3 \times 10^3(\gamma)$ $3 \times 10^4(\beta)$	N/A	None	N/A	N/A	N/A
1.8.5	Chemicals	None	None	None	Fig. 3	N/A	None	N/A	N/A	N/A
1.8.6	Vibration	Fig. 4	None	None	None	N/A	None	N/A	N/A	N/A
1.8.7	Acceleration (g's)	None	None	None	None	N/A	Fig. 1	N/A	N/A	N/A

Notes:

(a) Margin is not included in the parmeters of this section.
(b) Detector connectors have environmental requirements identified in Section 1.9.
(c) DBE is the Design Basis Event.
(d) Performance requirements are specified in Section 1.11.

1.9 Performance Requirements For[a]: High Voltage Distribution Box[b].

	Parameter	Normal Conditions	Abnormal Condition	Containment Pressure Test Condition	DBE Conditions (c) FLB/SLB	DBE Conditions (c) LOCA	DBE Conditions (c) SEISMIC	Post DBE Condition (c) FLB/SLB	Post DBE Condition (c) LOCA	Post DBE Condition (c) SEISMIC
1.9.1	Time requirement	Continuous	8 hours	Test Duration	<5 min.	N/A	Event Duration	N/A	N/A	N/A
1.9.2	Performance requirement	Note (d)	As normal	No damage	Note (d)	N/A	Note (d)	N/A	N/A	N/A
1.10	Environmental Conditions for Same Function[a]									
1.10.1	Temperature (°F)	80-135°F	150°F	Ambient	Fig. 3	N/A	Ambient	N/A	N/A	N/A
1.10.2	Pressure (psig)	-0.1/+0.3	Ambient	70	Fig. 3	N/A	0	N/A	N/A	N/A
1.10.3	Humidity (RH)	0-95	95	Ambient	100	N/A	Ambient	N/A	N/A	N/A
1.10.4	Radiation (RADS)	2.2×10^6	As normal	None	5.3×10^3(γ) 3×10^4(β)	N/A	None	N/A	N/A	N/A
1.10.5	Chemicals	None	None	None	Fig. 3	N/A	None	N/A	N/A	N/A
1.10.6	Vibration	None	None	None	None	N/A	None	N/A	N/A	N/A
1.10.7	Acceleration (g's)	None	None	None	None	N/A	Fig. 2	N/A	N/A	N/A

Notes:

(a) Margin is not included in the parmeters of this section.
(b) N-16 Gamma Detector connectors and High Voltage Distribution Box connectors are included in this section.
(c) DBE is the Design Basis Event.

(d) Performance requirements are specified in Section 1.11.

1.11 Performance Requirements

1.11.1 N-16 Detector

1.11.1.1 Normal Conditions (Abnormal Conditions same as Normal)

A. The insulation resistance between the center wire and the inner shield of the signal cable and high voltage cable shall not be less than 10^8 ohms.

1.11.1.2 Seismic and HELB Conditions

A. The insulation resistance between the center wire and the inner shield of the signal cable and high voltage cable shall not be less than 10^8 ohms.

B. Continuity shall be maintained on all cables.

C. The output current error of the detector shall not exceed $\pm 3 \times 10^{-10}$ amperes.

1.11.1.3 Sensitivity

A. From the beginning to end of the qualification program the sensitivity shall not decrease by more than -1/2 percent (which is measurement error) as measured during the sensitivity test.

1.11.2 High Voltage Distribution Box

1.11.2.1 Normal Conditions

A. The insulation resistance between the center wire and the inner shield of the cables shall not be less than 10^7 ohms.

1.11.2.2 Seismic and HELB Conditions

A. The insulation resistance between the center wire and the inner shield of the cables shall not be less than 10^7 ohms.

B. Continuity shall be maintained on all cables.

1.12 Qualified Life

The demonstrated qualified life is 5 years based on the actual test conditions identified in Table 1 for the N-16 gamma detector, mineral insulated integral cable, and detector connectors. The high voltage distribution box qualified life is 5 years demonstrated by analysis described Section 4.

1.13 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 and at Cornell University, Ithaca, N.Y. under the sponsorship of WIGTD.

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

Containment pressure test was performed at the Forest Hills Site, Westinghouse 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.

2.1 Equipment Description: N-16 Gamma Detector

2.2 Number Tested: Four

2.3 Mounting:

2.3.1 Normal Operation.

The N-16 Gamma Detector was loaded horizontally into a temperature and humidity chamber.

2.3.2 Seismic

The N-16 Gamma Detector test units were installed for testing into collimator box assemblies, using methods indicated in Westinghouse drawing 1451E02, Rev. (later). The collimator box permits the detector to sense gamma radiation radially from the coolant pipe. The assemblies were then mounted to a rigid I-beam test fixture using the same size hardware required to mount the collimator box assembly to the main support assembly for in-service conditions. The test fixture was then secured to the shaker table.

2.3.3 HELB

The N-16 Gamma Detector was mounted inside the collimator box and was situated horizontally inside the test chamber.

2.4 Connections: Triax connector, plug - WIGTD Part No. 42-814

2.5 Aging Simulation Procedure: Thermal and irradiation aging for organic components.

Vibration aging for detector

2.6 Service Conditions for the N-16 Gamma Detector and Integral Cables to be Simulated by Test [a]

		Normal	Abnormal	Containment Pressure Test	Seismic	HELB
2.6.1	Temp. (°F)	120-200[b]	As Normal	Ambient	Ambient	Fig. 3
2.6.2	Pressure (psig)	0	0	70	0	Fig. 3
2.6.3	Humidity (RH)	95	95	Ambient	Ambient	100
2.6.4	Radiation (Rads)	7.2×10^6	None	None	None	None
2.6.5	Chemicals	None	None	None	None	Fig. 3
2.6.6	Vibration	Fig. 4	None	None	None	None
2.6.7	Acceleration (g's)	None	None	None	Fig. 1	None

Notes: (a) Service conditions for the detector connectors are identical to those given in Section 4.6
(b) 20 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	C,D	A,B
	2.7.5.2	Output Voltage		A,B,C,D
	2.7.5.3	Output Current	C,D	A,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: Tests A,B,C and D are applicable to the N-16 Gamma Detector only. The High Voltage Distribution Box is qualified by analysis.

A = Normal and Abnormal Operation

B = Containment Pressure

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:

Sequence	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 qualified 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 N-16 Gamma Detector meets or exceeds its 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 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 four N-16 Gamma Detectors, which contained components that had been previously thermally and irradiation aged.

2.10.2 Equipment Tested

2.10.2.1 N-16 Gamma Detector

2.10.3 Test Summary

2.10.3.1 Simulated Aging

The organic materials of the N-16 Gamma Detector 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 Environment Testing (Thermal Stress Cycling)

The cycling performed to address the normal environments was done in accordance with the simulated service conditions of Section 2.6. The detector functioned satisfactorily following the test.

2.10.3.3 Seismic Tests

Vibration aging tests were performed on the detector. The test power spectral density is shown in Figure 4. Electrically, the detector performed acceptably.

The test response spectra enveloped the required response spectra which is shown in Figure 1 for the detector. No structural failure was observed. Electrically, the detector performed acceptably.

2.10.3.4 High Energy Line Break Test

The detector was subjected to the HELB profile of Figure 3. Electrically, it performed acceptably.

2.10.4 Conclusion

The qualification of the N-16 Gamma Detector 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 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 - E27A, Miller, T. N. and Pareilo, J., Equipment Qualification Test Report - N-16 Gamma Detector (Environmental and Seismic Testing for Comanche Peak)

2. WCAP-8687, Supp. 2 - E27B, Miller, T. N., Equipment Qualification Test Report - Equipment Qualification Test Report - N-16 Gamma Detector High Voltage Distribution Box

3. N-16 TTFM/PM Support Assembly Stress Report (Number later)

SECTION 3 QUALIFICATION BY EXPERIENCE

Westinghouse does not employ operating experience in support of the qualification program for the N-16 Gamma Detector and the High Voltage Distribution Box.

SECTION 4 QUALIFICATION BY ANALYSIS

4.0 ANALYSIS PLAN

4.1 Objective

The objective of this qualification program is to demonstrate by analysis that a N-16 Gamma Detector High Voltage Distribution Box that has aged for five years will meet its safety related performance requirements defined in Section 1.9 for the Comanche Peak facility while subjected to the following conditions defined in Section 1.10: normal/abnormal temperature and humidity, containment pressure, seismic, and high energy line break (HELB) environments. The qualification is predicted on testing performed on the 4-Section Power Range Neutron Detector H.V./Signal Distribution Box and on establishing that both boxes are identical in construction and materials.

4.2 Equipment Description: N-16 Gamma Detector High Voltage Distribution Box.

4.3 Mounting: The N-16 Gamma Detector High Voltage Distribution Box is rigidly mounted in a NEMA 4 enclosure which is rigidly attached to the wall.

4.4 Connections: Triax connector, jack - WIGTD Part No. 42-813
Triax connector, plug - WIGTD Part No. 42-814

4.5 Aging Simulation Procedure: Identical materials were appropriately thermally and irradiation aged in the 4-Section Power Range Neutron Detector H.V./Signal Distribution Box.

4.6 Service Conditions for the N-16 Gamma Detector High Voltage Distribution Box to be Demonstrated by Analysis

		Normal	Abnormal	Containment Pressure Test	Seismic	HELB
4.6.1	Temp. (°F)	80-135	150	Ambient	Ambient	Fig. 3
4.6.2	Pressure (psig)	Ambient	Ambient	70	0	Fig. 3
4.6.3	Humidity (RH)	95	95	Ambient	Ambient	100
4.6.4	Radiation (R)	2.2×10^6	None	None	None	None
4.6.5	Chemicals	None	None	None	None	Fig. 3
4.6.6	Vibration	None	None	None	None	None
4.6.7	Acceleration (g's)	None	None	None	Fig. 2	None

4.7 Summary

The N-16 Gamma Detector High Voltage Distribution Box is identical to the 4-Section Power Range Neutron Detector H.V./Signal Distribution Box in materials and construction. Testing performed on the latter demonstrated that:

a. no changes occurred during thermal and irradiation aging which would have a deleterious effect on its functioning;

b. this equipment would function satisfactorily under the normal and abnormal service conditions of section 4.6;

c. this equipment would function satisfactorily for the response spectra given in Figure 2;

d. this equipment would function satisfactorily when subjected to the HELB profile of Figure 3.

4.3 Conclusions

The qualification of the N-16 Gamma Detector High Voltage Distribution Box is demonstrated for a qualified life of 5 years by analysis described herein and reported in Reference 2.

TABLE 1

ACTUAL QUALIFICATION TEST CONDITIONS

EQUIPMENT SYSTEM/CATEGORY	LOCATION STRUCTURE/AREA	MANUFACTURER TYPE/MODEL	ABNORMAL/ACCIDENT ENVIRONMENTAL EXTREMES PARAMETER	SPECIFIED (1)	QUALIFIED	OPERABILITY REQ	OPERABILITY DEM	ACCURACY (%) REQ	ACCURACY (%) DEM	QUAL LIFE (2)	QUAL METHOD	QUAL REF	QUAL PROGRAM STATUS
N-16 Gamma Detector	Containment Bldg/Reactor Coolant Pipe Hot leg	WIGTD WL-24076	Temperature		215°F	Trip	Trip	No change in sensitivity		5 yrs	Sequential test	ESE27	Completed
			Pressure		5 psig								
			Relative Humidity (%)		100								
			Radiation		detector 1.48×10^7 Rad (γ) connector 4.58×10^6 Rad (γ)								
			Chemistry		None								
High Voltage Distribution Box	Containment Bldg/Electrical Junction Box	WIGTD WL-24051	Temperature		215°F	Trip	Trip	Insulation Resistance $\geq 10^7$ ohms	Insulation Resistance $\geq 10^7$ ohms	5 yrs.	Analysis	ESE27	Completed
			Pressure		5 psig								
			Relative Humidity (%)		100								
			Radiation		4.48×10^6 Rad (γ)								
			Chemistry		None								

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

2. Based on actual thermal and radiation aging. Reference temperature is 200°F for the detector, and 135°F for detector connectors and high voltage distribution box.

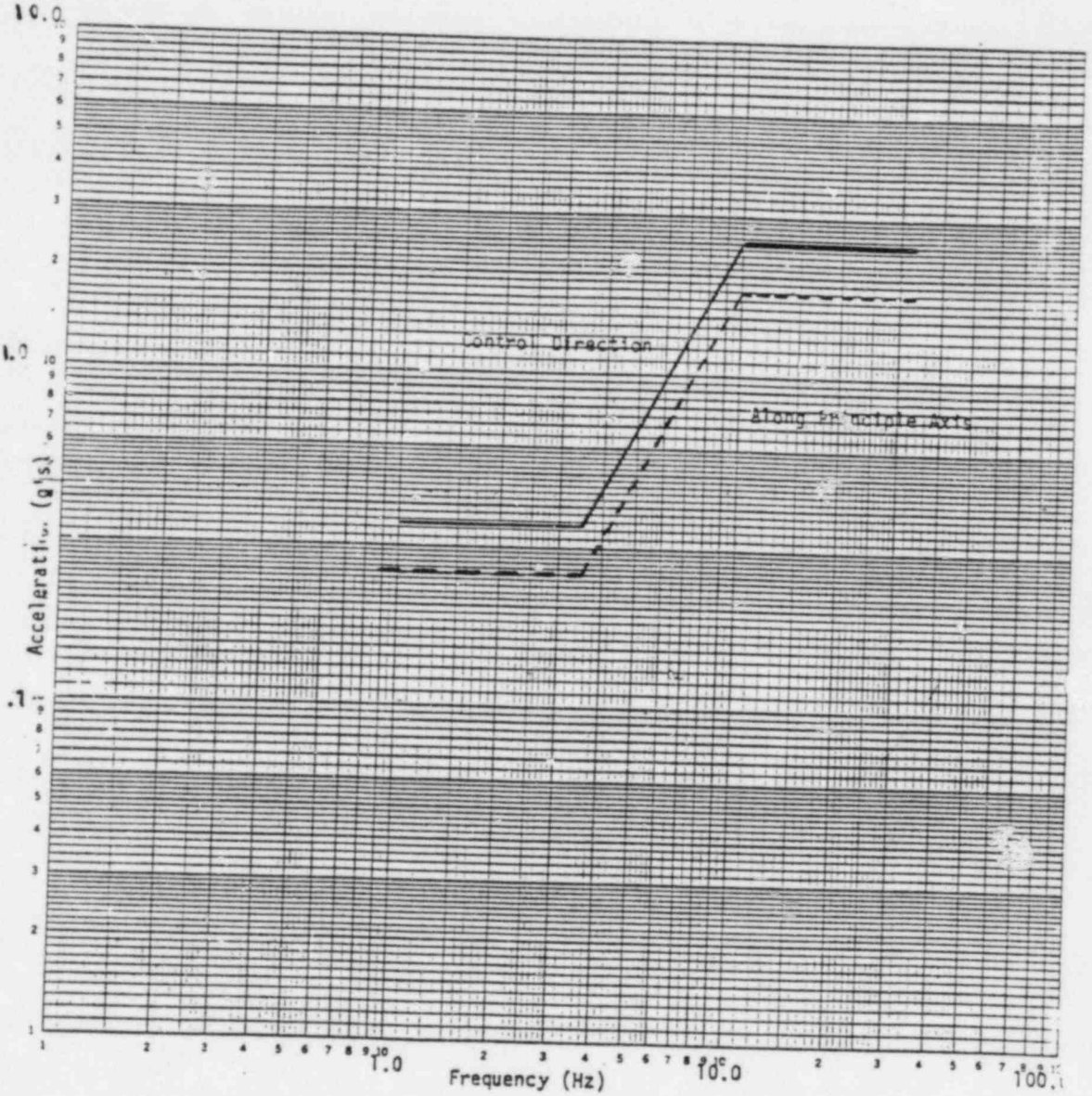

Figure 1 Safe Shutdown Earthquake Required Input Motion for N-16 Detector

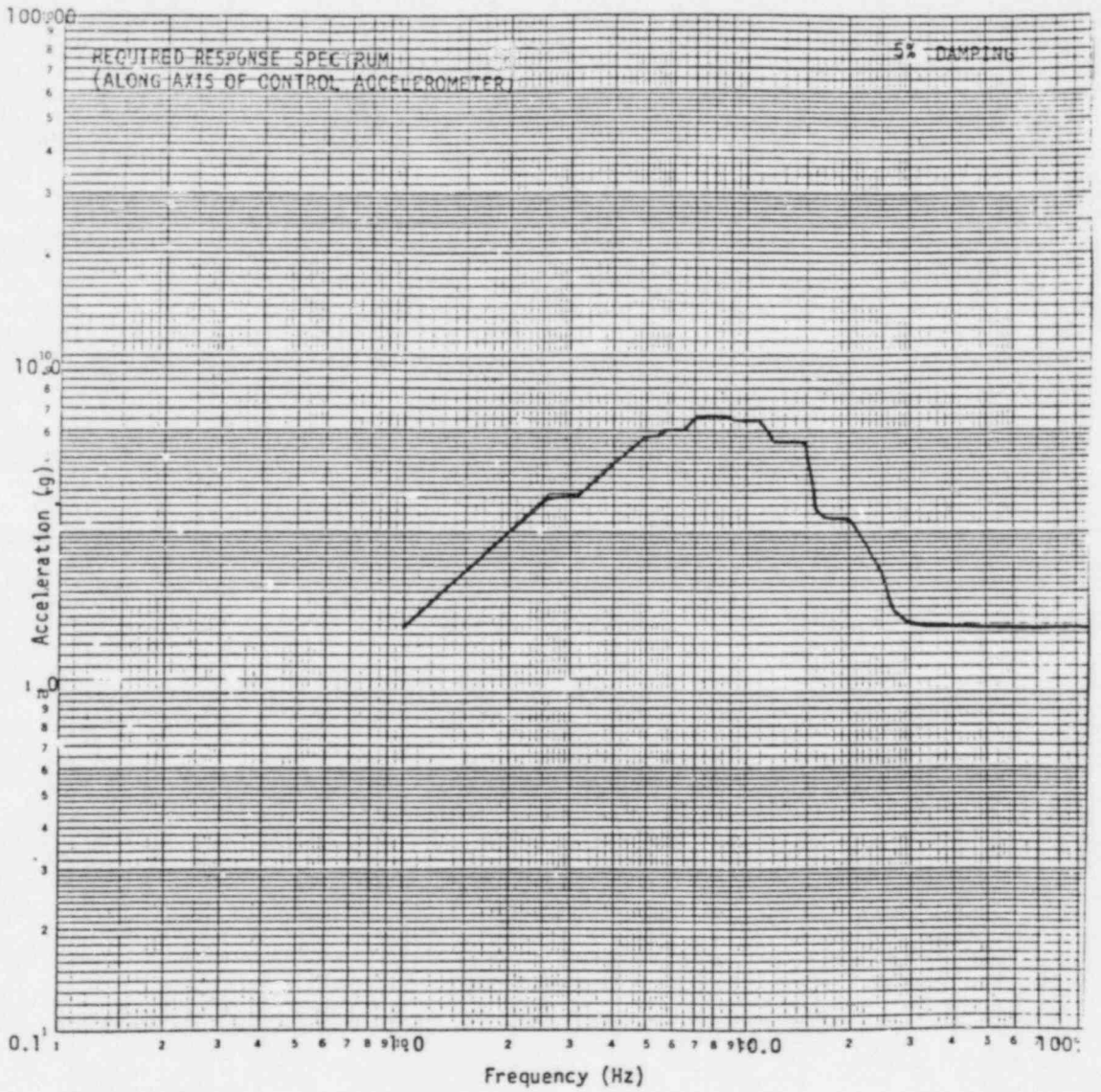

Figure 2 Required Response Spectrum
N-16 High Voltage Distribution Box

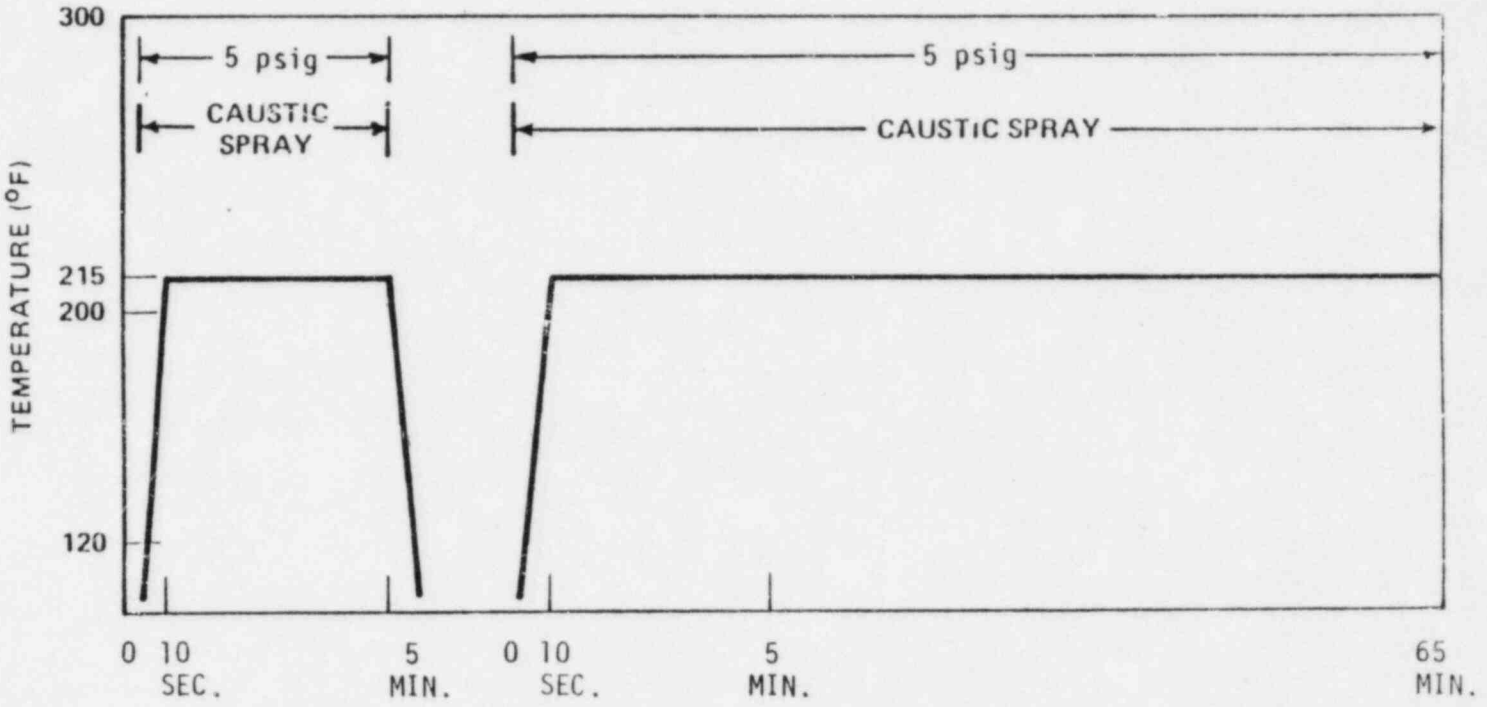

Figure 3 High Energy Line Break Test Profile

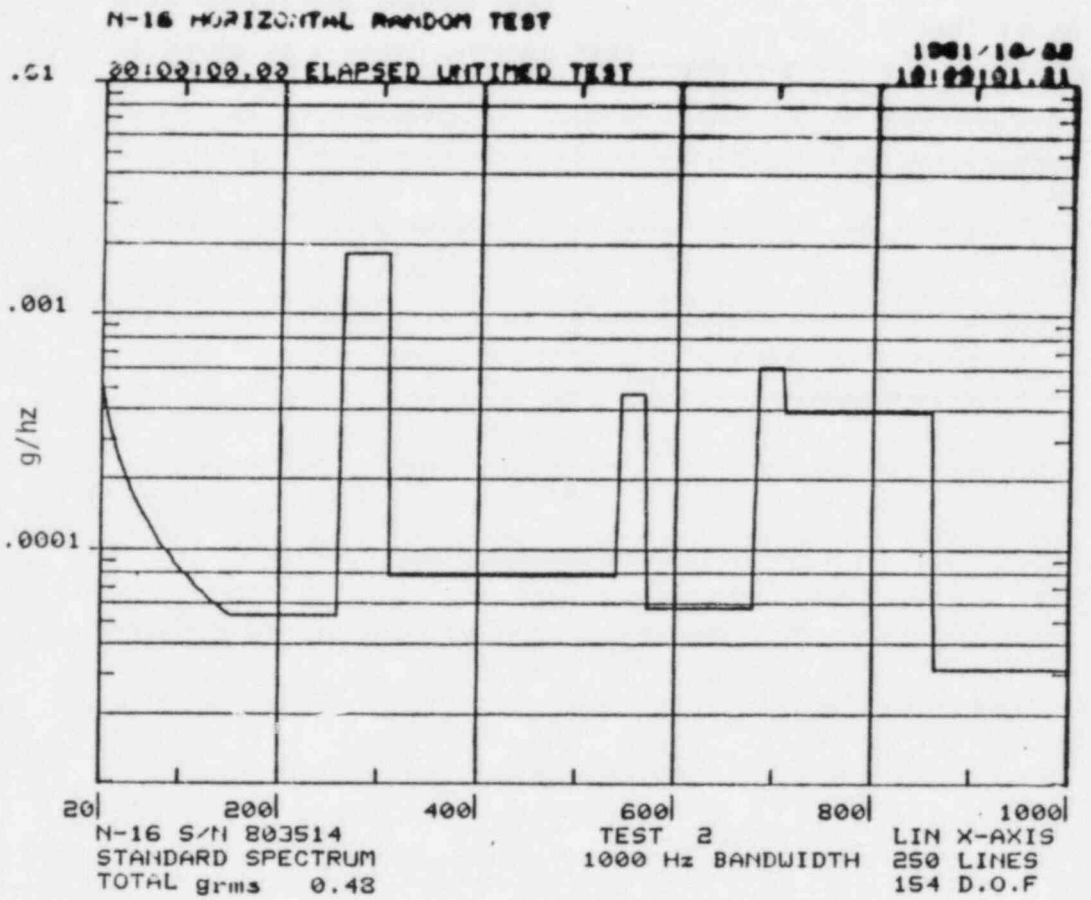

Figure 4 Vibration Spectrum