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.

LARGE PUMP MOTORS (OUTSIDE CONTAINMENT)

APPROVED: ______________________
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SECTION 1 - SPECIFICATIONS

1.0 PERFORMANCE SPECIFICATIONS

1.1 Electrical Requirements

1.1.1 Voltage: 460 to 6600 VAC ± 10%; Starting Voltage 80-110%*

1.1.2 Frequency: 50 or 60 Hz ± 5%

1.1.3 Load: 200 to 2000 Hp

1.1.4 Electromagnetic Interference: None

1.1.5 Other: Life line D motors have Class B or F thermo-lastic epoxy insulation system

1.2 Installation Requirements: As specified in the instruction manual

1.3 Auxiliary Devices: Qualified lubricants and connectors should be used with the motor.

1.4 Preventative Maintenance Schedule: Normal preventive maintenance must be performed in accordance with the instruction manual provided with the equipment.

1.5 Design Life: 40 years

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

Application	Pump Motor	40-yr. Total Start & Stops
312/412	Centrifugal charing	14,600
212/3xL/4xL/414	Centrifugal charging	14,600
212/412/3xL/4xL/414	Safety Injection (HH&LH)	480
212/312/412/414	Residual Heat Removal	1,000
All Models	Containment Spray	480
All Models	Component Cooling	480

*75 to 110% is applicable to certain applications.

1.7 Performance Requirements for[b]: Centrifugal Charging (312/412 Applications)

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	175,000 hrs.	12 hrs.	N/A	Event Duration	Event Duration	1 year	Continuous
1.7.2	Performance requirement	Continuous Full speed	As Normal		Full Speed[c] < 5 sec.	As Normal	As Normal	As Normal

1.8 Environmental Conditions for Same Function[b]

		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE LOCA FLB/SLB	DBE Seismic	Post DBE LOCA FLB/SLB	Post DBE Seismic
1.8.1	Temperature(^oF)	Figure 1 Part 2	Figure 1 Part 3	N/A	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.2	Pressure (psig)	0	0		0	0	0	0
1.8.3	Humidity (% RH)	Figure 1 Part 2	Figure 1 Part 3		Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.4	Radiation (R)	$1 \times 10^6\ \gamma$	Included Under Normal		See Post DBE	None	$4.3 \times 10^7\ \gamma$	None
1.8.5	Chemicals	None	None		None	None	None	None
1.8.6	Vibration (mils)[d]	2	2		2	2	2	2
1.8.7	Acceleration (g)	None	None		None	Figure 2	None	None

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: At minimum voltage (See Section 1.1.1)
d: Bearing housing vibration filtered to running speed

1.7 Performance Requirements for[b]: Centrifugal Charging (212/3xL/4xL/414)

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	260,000 hrs.	12 hrs.	N/A	N/A	Event Duration	24 hrs	Continuous
1.7.2	Performance requirement	Continuous Full speed	As Normal			Full Speed[c] < 5 sec.	As Normal	As Normal

1.8 Environmental Conditions for Same Function[b]

1.8.1	Temperature(°F)	Figure 1 Part 2	Figure 1 Part 3	N/A	N/A	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.2	Pressure (psig)	0	0			0	0	0
1.8.3	Humidity (% RH)	Figure 1 Part 2	Figure 1 Part 3			Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.4	Radiation (R)	1×10^6 γ	Included under normal			None	4.3×10^7 γ	None
1.8.5	Chemicals	None	None			None	None	None
1.8.6	Vibration (mils)[d]	2	2			2	2	2
1.8.7	Acceleration (g)	None	None			Figure 2	None	None

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: At minimum voltage (See Section 1.1.1)
d: Bearing housing vibration filtered to running speed

4

1.7 Performance Requirements for[b]: Residual Heat Removal (212/312/412/414 Applications)

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	24,000 hrs.	12 hrs.	N/A	Event Duration	Event Duration	1 year	Continuous
1.7.2	Performance requirement	Continuous Full speed	As Normal		Full Speed[c] < 5 sec.	Full Speed[c] < 5 sec.	As Normal	As Normal

1.8 Environmental Conditions for Same Function[b]

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.8.1	Temperature(^{o}F)	Figure 1 Part 2	Figure 1 Part 3	N/A	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.2	Pressure (psig)	0	0		0	0	0	0
1.8.3	Humidity (% RH)	Figure 1 Part 2	Figure 1 Part 3		Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.4	Radiation (R)	1×10^6 γ	Included Under Normal		See Post DBE	None	4.3×10^7 γ	None
1.8.5	Chemicals	None	None		None	None	None	None
1.8.6	Vibration (mils)	2	2		2	2	2	2
1.8.7	Acceleration (g)	None	None		None	Figure 2	None	None

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: At minimum voltage (See Section 1.1.1)
d: Bearing housing vibration filtered to running speed

1.7 Performance Requirements for[b]: Safety Injection (high and low-head) (212/412/3xL/4xL Applications)

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	240 hrs	12 hrs.	N/A	Event Duration	Event Duration	1 year	Continuous
1.7.2	Performance requirement	Continuous Full speed	As Normal		Full Speed[c] < 5 sec.	Full Speed[c] < 5 sec.	As Normal	As Normal

1.8 Environmental Conditions for Same Function[b]

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE LOCA FLB/SLB	DBE Seismic	Post DBE LOCA FLB/SLB	Post DBE Seismic
1.8.1	Temperature (^{o}F)	Figure 1 Part 2	Figure 1 Part 3	N/A	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.2	Pressure (psig)	0	0		0	0	0	0
1.8.3	Humidity (% RH)	Figure 1 Part 2	Figure 1 Part 3		Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.4	Radiation (R)	1×10^{6} γ	Included Under Normal		See Post DBE	None	4.3×10^{7} γ	None
1.8.5	Chemicals	None	None		None	None	None	None
1.8.6	Vibration (mils)[d]	2	2		2	2	2	2
1.8.7	Acceleration (g)	None	None		None	Figure 2	None	None

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: At minimum voltage (See Section 1.1.1)
d: Bearing housing vibration filtered to running speed

1.7 Performance Requirements for[b]: Containment Spray (All Applications)

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	240 hrs.	12 hrs.	N/A	Event Duration	Event Duration	1 year	Continuous
1.7.2	Performance requirement	Continuous Full speed	As Normal		Full Speed[c] < 5 sec.	Full Speed[c] < 5 sec.	As Normal	As Normal

1.8 Environmental Conditions for Same Function[b]

1.8.1	Temperature(^{o}F)	Figure 1 Part 2	Figure 1 Part 3	N/A	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.2	Pressure (psig)	0	0		0	0	0	0
1.8.3	Humidity (% RH)	Figure 1 Part 2	Figure 1 Part 3		Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.4	Radiation (R)	1×10^6 γ	Included Under Normal		See Post DBE	None	4.3×10^7 γ	None
1.8.5	Chemicals	None	None		None	None	None	None
1.8.6	Vibration (mils)[d]	2	2		2	2	2	2
1.8.7	Acceleration (g)	None	None		None	Figure 2	None	None

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: At minimum voltage (See Section 1.1.1)
d: Bearing housing vibration filtered to running speed

1.7 Performance Requirements for[b]: Component Cooling (All Applications)

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.7.1	Time requirement	175,000 hrs.	12 hrs.	N/A	Event Duration	Event Duration	1 year	Continuous
1.7.2	Performance requirement	Continuous Full speed	Normal		As Normal	As Normal	As Normal	As Normal

1.8 Environmental Conditions for Same Function[b]

Parameter		Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a) LOCA FLB/SLB	DBE Conditions(a) Seismic	Post DBE Conditions(a) LOCA FLB/SLB	Post DBE Conditions(a) Seismic
1.8.1	Temperature(°F)	Figure 1 Part 2	Figure 1 Part 3	N/A	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.2	Pressure (psig)	0	0		0	0	0	0
1.8.3	Humidity (% RH)	Figure 1 Part 2	Figure 1 Part 3		Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2	Figure 1 Part 2
1.8.4	Radiation (R)	$1 \times 10^6\ \gamma$	Included Under Normal		Normal	Normal	Normal	Normal
1.8.5	Chemicals	None	None		None	None	None	None
1.8.6	Vibration (mils)[c]	2	2		2	2	2	2
1.8.7	Acceleration (g)	None	None		None	Figure 2	None	None

Notes: a: DBE is the Design Basis Event.
b: Margin is not included in the parameters of this section.
c: Bearing housing vibration filtered to running speed.

1.9 Qualified Life: The demonstrated qualified life based on the testing is 3.8 years continuous operation at a maximum hot spot temperature of 130°C. However, under actual service conditions, the expected motor insulation life would be much greater than 3.8 years and must be determined for the individual application. The life will vary depending on the actual ambient temperature, operating horse-power, temperature rise in the motor, and operating time for each mode of operation.

1.10 Remarks: The motors are located outside contaiment.

SECTION 2 - QUALIFICATION BY TEST

2.0 TEST PLAN

2.1 Equipment Description:

Westinghouse Life Line [motor stator

2.2 Number Tested:

One stator was subjected to the entire series of tests

2.3 Mounting:

The stator was bolted to a seismic test table during vibration aging and seismic testing consistent with plant installation instructions.

2.4 Connections:

The stator was not provided with power during tests. No electrical connections.

2.5 Aging Simulation Procedure

The complete stator was subjected to thermal, radiation, and vibration aging as described in Reference 1.

2.6 Service Conditions to be Simulated by Test(1)

		Normal	Abnormal	Containment Test	Seismic	HELB	Post-HELB
2.6.1	Temp. (°F)	-20 to 120	Included under normal	N/A	Fig. 1 Part 2	Fig. 1 Part 2	Fig. 1 Part 2
2.6.2	Pressure (psig)	0	0		0	0	0
2.6.3	Humidity (% RH)	Fig. 1 Part 2	Fig. 1 Part 3		Fig. 1 Part 2	Fig. 1 Part 2	Fig. 1 Part 2
2.6.4	Radiation (R)	5×10^7	Included under normal		Included under normal	Included under normal	Included under normal
2.6.5	Chemicals	None	None		None	None	None
2.6.6	Vibration	Normal*	Normal		Normal	Normal	Normal
2.6.7	Acceleration (g)	None	None		Figure 2	None	None

* Simulate vibration aging with 1 hour at 60 hz and 1.5 g.

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,C,D
2.7.1.3	Moisture	D	A,B,C
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	D	A,B,C
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	B	A,C,D
2.7.4.2	Energy Level	B	A,C,D
2.7.4.3	Dose Rate	B	A,C,D
2.7.4.4	Integrated Dose	B	A,C,D

		Required	Not Required
2.7.5	Category V - Electrical Characteristics		
2.7.5.1	Insulation Resistance Following Test	A,B,C	D,
2.7.5.2	Output Voltage		A,B,C,D
2.7.5.3	Output Current		A,B,C,D
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
2.7.6	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

None required for safeguards operation

A Thermal aging

B Radiation aging

C Vibration & Seismic

D Hi Potential Test

2.8 Test Sequence Preferred

This section identifies the preferred test sequences as specified in IEEE-323-74

2.8.1 Inspection of Test Item
2.8.2 Operation (Normal Condition)
2.8.3 Operation (Performance Specifications Extremes, Section 1)
2.8.4 Simulated Aging
2.8.5 Vibration
2.8.6 Operation (Simulated High Energy Line Break Conditions)
2.8.7 Operation (Simulated Post HELB Conditions)
2.8.8 Inspection

2.9 Test Sequence Actual

This section identifies the actual test sequence employed which when used in conjunction with the seismic analysis described under Part 4, constitutes the overall qualification program for this equipment. The test sequence listed below was performed on the same motor and stator. The justification for employing the specific sequence listed below in lieu of the preferred sequence (Section 2.8) is as follows:

a. Additional inspections were performed to assure that the motor was undamaged by previous testing.

b. Test sequence 2.8.3 was performed after all aging and irradiation as a more conservative test. Operational ability was simulated by a high potential test.

c. Westinghouse requires that the large motors are located such that they do not experience a consequent adverse environment when required to operate following a high energy line break either inside or outside containment. Therefore test sequences 2.8.6 and 2.8.7 are not required and the only environmental testing required is to demonstrate equipment capability under normal and abnormal environmental extremes. An exception is that motors which drive pumps carrying sump water may be exposed to the radiation levels resulting from a HELB inside containment. This high radiation was considered in the normal radiation aging test of Section 2.9.2.

Step	Notes

2.9.1 Performance Test of Motors

2.8.1
2.8.2
2.8.8

2.9.2 Stator - Aging, Radiation and Seismic Test Sequence

2.3.1
2.8.4
2.8.5
2.8.3
2.8.8

2.10 Type Test Data

2.10.1 Objective

The objective of this program is to demonstrate by test and analysis, employing the recommended practices of Reg. Guide 1.89 (IEEE-323-1974) and Reg. Guide 1.100 (IEEE 344-1975), the capability of the Westinghouse Large Motors to complete their safety-related functions described in EQDP Section 1.7 while exposed to the applicable environments defined in EQDP Section 1.8.

2.10.2 Equipment Tested

One Westinghouse Life Line D motor was subjected to the tests described below.

2.10.3 Test Summary

2.10.3.1 Motor Performance Test

This motor received a complete initial test and a speed-torque test at reduced voltage. The complete initial test consisted of the following:

- Standard commercial test

  1. No load running current and power
  2. Current balance
  3. Winding resistance measurement
  4. High potential test
  5. Vibration test per NEMA MG1-20.53

- Full load heat run
- Percent slip
- Pull-out torque
- Locked rotor current
- Starting torque
- Efficiency at full, three-quarter, and half load
- Power factor at full, three-quarter, and half load
- Bearing inspection

This test assured that the motors would produce the required torque, at the required speed, within the required current, temperature, and vibration limits. The test procedures used are specified by IEEE-112A-1964.

2.10.3.2 Aging and Radiation Testing

The insulation resistance of the stator was measured. Then the stator was baked in an oven to accelerate the thermal aging of the motor. The aging is equivalent to 3.8 years of operating life at a maximum hot spot temperature of 130°C. The insulation resistance was measured again. The stator was then exposed to a Cobalt-60 gamma source. The stator was exposed to a gamma dose equivalent to the dosage that the motor would see during 40 years of service plus 1 year of post LOCA operation and includes margin. Following the radiation exposure, the insulation resistance of the stator was measured.

2.10.3.3 Vibration/Testing

The stator was installed on a biaxial seismic test machine at a 90° angle in relation to the test table. A mechanical aging test was performed at a vertical acceleration control of 1.5 g at 60 Hz for one hour per IEEE-275-1966. The insulation resistance measurement was then repeated. The stator assembly was mounted at a 45° angle in relation to the seismic test table and a resonance search was performed.

2.10.3.4 Seismic Testing

A seismic test was completed employing multi-axis, multi-frequency inputs in accordance with Regulatory Guide 1.100 (IEEE-344-1975). The response spectrum (Figure 2) contains significant margin with respect to any single plant application referencing this program[1].

2.10.3.5 High Potential Test

The stator was installed inside an environmental chamber and subjected to an environment of 100% relative humidity for 48 hours per IEEE-275-1966. Next the insulation resistance was measured. Finally, a voltage of 6000 VAC, 60 hz potential was applied to the stator for a period of one minute while the stator was in the environmental chamber. The stator passed the High Potential Test.

2.10.4 Conclusion

The results of the seismic and environmental testing described herein along with the analysis described in Section 4 demonstrates the qualification of the Westinghouse Large Motor, for a life as defined in Section 1.9, employing the practices recommended by Reg. Guide 1.89 and 1.100.

2.11 Section 2 Notes

(1) The generic tests completed by Westinghouse employ parameters designed to envelope a number of plant applications. Margin is a plant specific parameter and will be established by the applicant.

2.12 References

1. Anderson, A. A., "Equipment Qualification Test Report for the Westinghouse Large Pump Motor", WCAP-8687, Supplement 2-A02A (Proprietary); WCAP-8587, Supplement 2-A02A (Non-Proprietary), March 1981.

SECTION 3 - QUALIFICATION BY EXPERIENCE

Westinghouse does not employ operating experience in support of the qualification program for the Westinghouse Large Pump Motors.

Part 4 - Qualification By Analysis

4.0 Analysis

The seismic analysis described below is completed for each motor on each application.

4.1 Interface and Boundary Conditions

The analysis performed considers a rigidly mounted base. The external loads considered were the load torques and thrust from driven equipment and from piping connected to the motor heat exchanger (where applicable).

4.2 Specific Features Analyzed

The rotor deflection, shaft displacements, shaft stresses, bearing loads, stresss in the stator core welds, stator core to frame support welds, heat exchanger supports, stress in the heat exchanger bolts and stress in the motor feet (flanges) are considered in the analysis.

4.3 Assumptions and Models

Westinghouse performs a natural frequency test to demonstrate motor natural frequencies > 33 hz. On this basis a static analysis is performed.

4.4 Analytical Methods and Computer Programs

Qualification by static analysis is performed at the Westinghouse Large Motor Division.

4.5 Summary

The seismic analysis maintained by Westinghouse demonstrates both structural integrity and operability of the supplied motor.

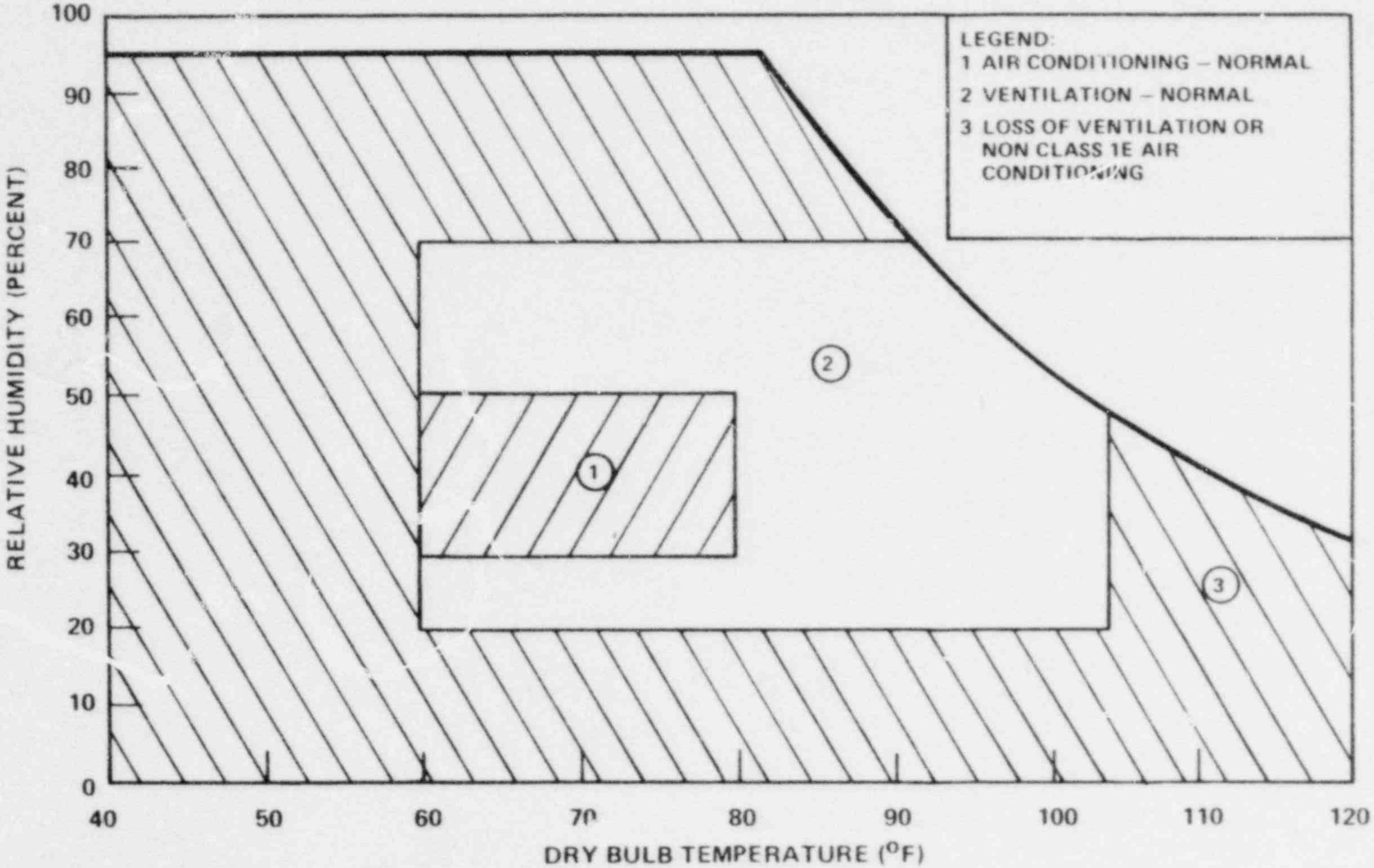

Figure 1. Temperature Versus Humidity-Enclosed Environments Outside Containment

SSE

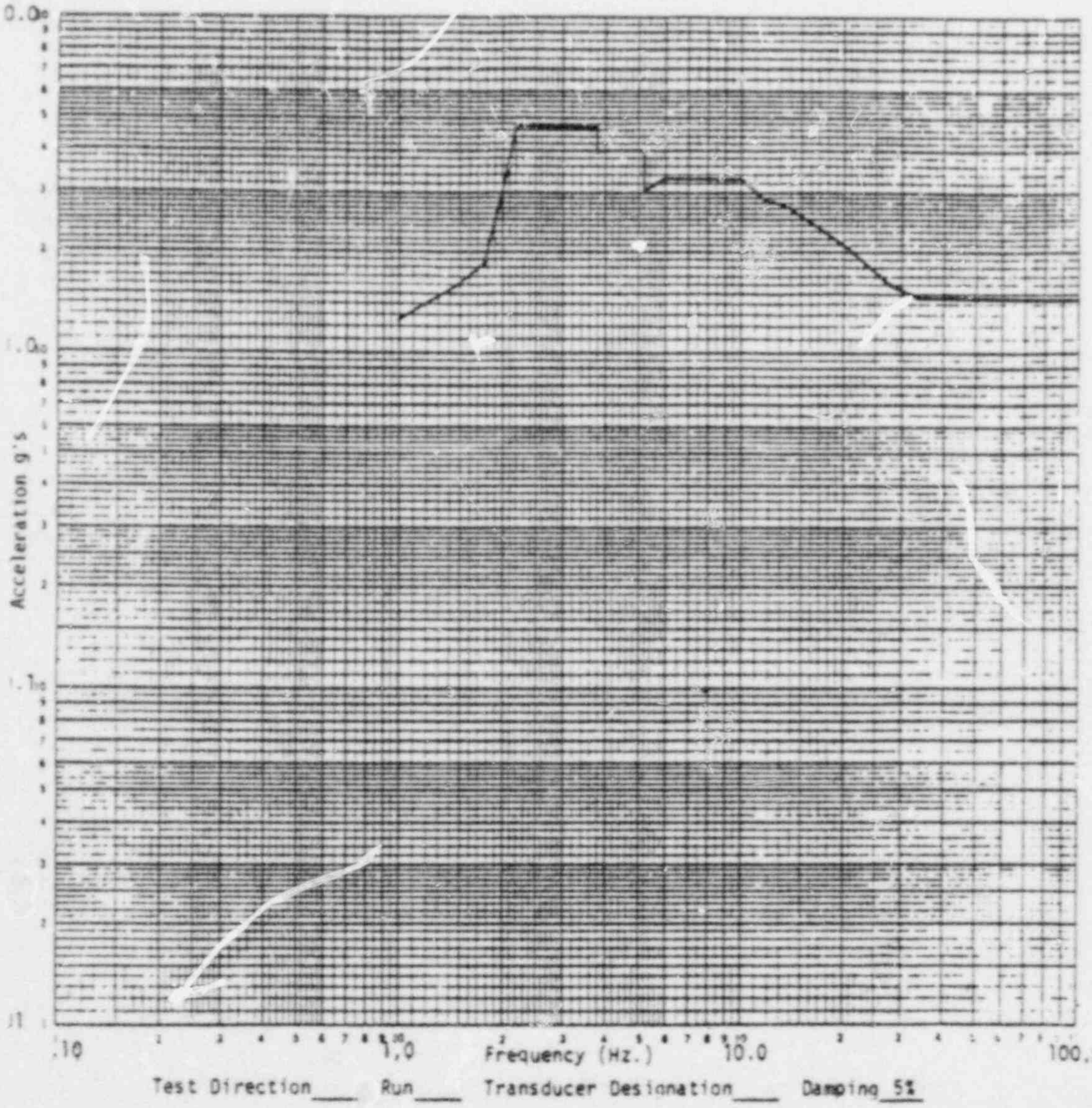

Figure 2. Response Spectrum for the Safe Shutdown Earthquake for Westinghouse Large Motors