

WCAP 8587

"Equipment Qualification Data Packages"

Supplement 1

EQDP-ESE-13

Process Protection System

Revision 3

Instruction Sheet

The following instructional information and checklist is being furnished to help insert the following into WCAP-8587 Supplement 1 EQDP-ESE-13 Class 3 (Non-Proprietary). Discard the old sheet and insert the new sheets as listed below. Revised information is indicated by a bar and number 3 on the outside margin of the page. Retain this sheet in the front of your WCAP.

Remove
(Front/Back)

EQDP-ESE-13
Revision 2 1/81

Insert
(Front/Back)

EQDP-ESE-13
Revision 3 7/81

8108250531 810803
PDR TOPRP EMVWEST
C PDR

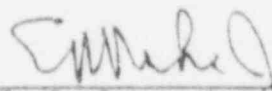
Rev. 3
July, 1981

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.

PROCESS PROTECTION SYSTEM

APPROVED:



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SECTION 1 - SPECIFICATIONS

1.0 PERFORMANCE SPECIFICATIONS

1.1 Electrical Requirements

1.1.1 Voltage: $118 \pm 5\%$ VAC

1.1.2 Frequency: $60 \pm 3\%$ Hz; 5% max. harmonic distortion

1.1.3 Load: 21.5 amp. max. steady state; inrush 10 times steady state

1.1.4 Electromagnetic Interference: None

1.1.5 Other: N/A

1.2 Installation Requirements: Installation in accordance with W drawings 8797D33 Revision 9 and 8797D34 Revision 9.

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1.3 Auxiliary Devices: Field mounted process sensors, Solid State Protection System, Nuclear Instrumentation System, various EQDP's, ESE-1 thru ESE-7, 16 or 17, 21, 27.

1.4 Preventative Maintenance Schedule: As a result of the completion of the Westinghouse Aging Evaluation Program (Phase 1, Short Term Aging described in WCAP-8687 and discussed in WCAP-8687 Supplement 2, Appendix A1 (Component Aging) Reference 7 and Appendix A2 (Materials Aging) Reference 8 (Proprietary), no maintenance beyond that defined in the equipment instruction manual is required to support the qualified life defined in Section 1.9.

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1.5 Design Life: 40 years

1.6 Operating Cycles (Expected number of cycles during design life, including test): Continuous. Refer to Appendix A1 of WCAP-8587, Reference 7 for mechanical cycling of the potentiometer and relay.

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1.7 Performance Requirements for^(b): Reactor Trip, Engineered Safeguard Functions and Post Accident Monitoring

Parameter	Normal Conditions	Abnormal Conditions	Containment Test Conditions	DBE Conditions(a)			Post DBE Conditions(a)		
				FLB/SLB	LOCA	Seismic	FLB/SLB	LOCA	Seismic
1.7.1 Time requirement	Continuous	12 hours	N/A	Event duration	Event duration	Event duration	Continuous	Continuous	Continuous
1.7.2 Performance requirement	Note c	Note d		Note c	Note c	Note c	Note c	Note c	Note c

1.8 Environmental Conditions for Same Function^(b)

1.8.1 Temperature(°F)	60-80	Fig. 1		Ambient Conditions	Ambient Conditions	Ambient	Ambient Conditions	Ambient Conditions	Ambient Conditions
1.8.2 Pressure (psig)	Atmos.	Atmos.				Atmos.			
1.8.3 Humidity (% RH)	30-50	Fig. 1				Ambient			
1.8.4 Radiation (R)	<400	None				None			
1.8.5 Chemicals	None	None				None			
1.8.6 Vibration	None	None				None			
1.8.7 Acceleration (g)	None	None				See Section 2.10.3.2			

Notes: a: DBE is the Design Basis Event.
 b: Margin is not included in the parameters of this section.
 c: Channel accuracy + 0.5% span, time response of 0.1 secs for a bistable output trip to an input step change.
 d: Channel accuracy ± 1.0% span, time response as c).

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1.9 Qualified Life: The currently demonstrated qualified life is 5 years based on the actual test conditions identified in Table 2. Westinghouse is planning an extension of Subprogram C of the Aging Evaluation Program (Appendix B to WCAP-8587) to increase the demonstrated qualified life.

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1.10 Remarks: None

SECTION 2 - QUALIFICATION BY TEST

2.0 TEST PLAN

3 | Seismic and environmental tests were performed in the testing laboratory at Westinghouse Advanced Energy Systems Division (WAESD) in Large, Pennsylvania.

2.1 Equipment Description: Westinghouse-ISD Model 7300 rack mounted equipment, NIS and N-16 subsystems, 2-bay and 3-bay cabinets

2.2 Number Tested: Type test on one (1) of each equipment type

2.3 Mounting: Cabinet-floor mounted with bolts, cards-mounted in card frames.

2.4 Connections: Power and field wires to terminal strips. Output to multiconductor cables.

2.5 Aging Simulation Procedure:

3 | By a separate component test program described by Subprogram C of Appendix B to WCAP-8587 and reported in Reference 7.

2.6 Service Conditions to be Simulated by Test⁽¹⁾

		Containment					
		<u>Normal</u>	<u>Abnormal</u>	<u>Test</u>	<u>Seismic</u>	<u>HELB</u>	<u>Post-HELB</u>
2.6.1	Temp. (°F)	Ambient	Fig. 2	N/A	Ambient	N/A	N/A
2.6.2	Pressure (psig)	0	0		0		
2.6.3	Humidity (% RH)	Ambient	Fig. 2		Ambient		
2.6.4	Radiation (R)	None	None		None		
2.6.5	Chemicals	None	None		None		
2.6.6	Vibration	None	None		None		
2.6.7	Acceleration (g)	None	None		See Section 2.10.3.2		

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2.7 Measured Variables

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

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

RequiredNot Required

2.7.5 Category V - Electrical Characteristics

2.7.5.1	Insulation Resistance		A,B
2.7.5.2	Output Voltage	A,B	
2.7.5.3	Output Current		A,B
2.7.5.4	Output Power		A,B
2.7.5.5	Response Time		A,B
2.7.5.6	Frequency Characteristics		A,B
2.7.5.7	Simulated Load		A,B

2.7.6 Category VI - Mechanical Characteristics

2.7.6.1	Thrust		A,B
2.7.6.2	Torque		A,B
2.7.6.3	Time		A,B
2.7.6.4	Load Profile		A,B

2.7.7 Category VII - Auxiliary Equipment

None

A. Seismic Test

B. Operational Test, Normal and Abnormal Conditions

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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(s) which constitute the qualification program for this equipment. The separate subsections indicate the separate test sequences completed on different, but essentially identical, equipment and/or components. The justification for employing anything other than the preferred sequence is provided below:

The DBE is simulated during the Environmental and Seismic Test Sequence of Section 2.9.2. The HELB Tests (Sections 2.8.6 and 2.8.7) have been excluded since the 7300 Process Protection equipment is not exposed to the HELB environment due to its location. The aging test employs the preferred test sequence (Section 2.8) excluding HELB and Abnormal Extremes (Sections 2.8.6, 2.8.7 and 2.8.3) on a representative sample of components from the Process Protection System. The Aging Tests demonstrate that during the qualified life there are no in-service aging mechanisms capable of reducing the capability of the Process Protection System to perform during or after a seismic event. As a consequence, the seismic testing on the un-aged 7300 Series Process Protection equipment is not prejudiced by any in-service aging mechanisms.

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	<u>Step</u>	<u>Notes</u>
2.9.1	Production Test Sequence	
	2.8.1	
	2.8.2	System test performed on all
	2.8.8	production units
2.9.2	Environmental Sequence	
	2.8.1	
	2.8.3	Abnormal environment simulation
	2.8.8	
2.9.3	Seismic Test Sequence	
	2.8.1	
	2.8.5	Seismic Simulation
	2.8.8	
2.9.4	Aging Test Sequence	
	2.8.1	
	2.8.2	Aging is addressed by separate testing as
	2.8.4	described in Subprogram C of Appendix B to
	2.8.5	WCAP-8587 and reported in References 7 and 8.
	2.8.8	

The seismic testing performed as described in References 3, 4 and 5 did not follow the test plan described herein, but were tested via production and seismic only. Westinghouse feels that environmental tests on a separate piece of equipment adequately demonstrates total qualification.

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2.10 Type Test Data

2.10.1 Objective

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The objective of this qualification test program is to demonstrate, employing the recommended practices of Regulatory Guide 1.89 (IEEE-323-1974) and Regulatory Guide 1.100 (IEEE-344-1975) the structural integrity of the two and three bay configurations of the 7300 Series Process Protection System Cabinets to meet or exceed their safety related performance requirements described in EQDP Section 1.7 while subjected to simulated abnormal environments and seismic service conditions defined in EQDP Section 1.8. In addition, the tests will provide cabinet amplification information for use in demonstrating operability of the electrical devices mounted within.

2.10.2 Equipment Tested

2.10.2.1 Normal Environment Testing

A system test under normal environmental conditions is performed on each Process Protection System at the completion of the manufacturing process.

2.10.2.2 Abnormal Environment and Seismic Testing

Process Protection modules and components were assembled in a test system configuration and installed in a standard, three bay, 7300 series process cabinet. The modules selected for the test system were chosen to include at least one of each module used in Westinghouse Nuclear Steam Supply System Process Protection Systems. The test system was designed to provide automatic electrical exercising of many of the system modules during the abnormal environment test cycles.

2.10.2.3 Aging Evaluation Program

A representative sample of critical components from the Process Protection System is included in Subprogram C of the Aging Evaluation Program described in Appendix B to WCAP-8587 and reported in Reference 7.

2.10.3 Test Summary

2.10.3.1 Environment Test

Westinghouse requires that the 7300 Series Process Protection equipment be located such that it does not experience a consequent adverse environment when required to operate following a high energy line break either inside or outside containment. Therefore the only testing required is to demonstrate equipment capability under normal and abnormal service conditions (temperature, humidity and A.C. Power Voltage and frequency). (See Table 3)

Reference 6 summarizes the results of available radiation testing of organic and inorganic materials and justifies that for radiation doses less than 10^4 rads, no deterioration in material structural properties is detectable. As a consequence, irradiation simulation is not required on this equipment, since estimated in-service radiation doses will not prejudice the capability of the equipment to perform under design basis event (i.e. seismic event) conditions.

The environmental testing reported in Reference 1 is intended to demonstrate the capability of the

process protection modules, to meet the safety-related performance requirements specified in EQDP Section 1.7 when exposed to the variations in temperature, humidity, voltage and frequency specified by Figure 2. The modules and system components were installed in a system configuration designed to simulate typical operating process channels. The testing successfully demonstrated the specified safety related requirements. Additional margin was, furthermore, included in this test by submitting the equipment to two additional cycles of electrical and environmental extremes also described by Figure 2. Because of differences in individual NSSS Process Protection Systems, test results must be considered on a plant specific basis to establish the qualification of a particular Process Protection System. This test is considered to satisfactorily demonstrate the Process Protection system capability to meet its safety-related functional requirements when exposed to the specified abnormal environments (EQDP Section 1.7) and the permitted range of frequency and voltage variations (EQDP Section 1.1) in accordance with IEEE-323-1974 Section 6.3.2.(2) and (3).

2.10.3.2 Seismic Tests

The single design basis event capable of producing an adverse environment at the equipment location is a seismic event. Following the abnormal environment testing of all modules, the Nuclear Instrumentation/Nitrogen-16 subsystem modules and components were subjected to a multi-axis, multi-frequency inputs in accordance with requirements of Reg. guide 1.100 (IEEE 344-1975), as described in Reference 1. Figure 3 also shows a typical test response spectrum (TRS) showing the

acceleration levels achieved in a single SSE simulation. All TRS curves were recorded against the same RRS shown in Figure 3 and were verified to meet or exceed that curve. These modules are of limited use and were qualified to a reduced envelope. The seismic testing of other 7300 series modules and cabinets reported in references 2, 3, 4 and 5 was completed on new equipment employing single-axis sine-beat (IEEE-344-71) and multi-axis, multi-frequency inputs in accordance with Reg Guide 1.100 (IEEE-344-1975). Reference 2 describes testing of the two and three bay cabinets. Frequency and acceleration figures for different locations in the cabinets are compared with conditions to which the 7300 series modules have been tested. Comparison of these envelopes indicates that the "generic" qualification discussed in Reference 4 does not envelop all plants. Comparison must be done on a plant by plant basis.

2.10.3.3 Aging Evaluation

Subprogram C of the Westinghouse Aging Evaluation Program (Appendix B, WCAP 8587) has incorporated a representative sample of components from the Process Protection System. This program is completed and is reported in WCAP-8687, Supplement 2, Appendix A1 (Proprietary). Subprogram C demonstrates that during the qualified life there are no in-service aging mechanisms capable of reducing the capability of the Process Protection System to perform during or after a seismic event.

2.10.4 Conclusion

The currently demonstrated qualified life of the Process Protection System is 5 years. Westinghouse is planning an extension of Subprogram C of the Westinghouse Aging Evaluation Program to increase the demonstrated qualified life. The results of the aging program, together with the seismic

and environmental testing described herein, demonstrate the qualification of the Process Protection Equipment. The qualification status of each module is shown in Table 1.

2.11 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.

SECTIONS 3 & 4 QUALIFICATION BY EXPERIENCE AND/OR ANALYSIS

Westinghouse does not employ operating experience or analysis in support of the qualification program for the Process Protection System.

2.12 References

1. Skeers, D. M. "Equipment Qualification Test Report Process Protection System": WCAP-8687, Supplement 2-E13B (Proprietary), January 1981.
2. Coslow, B. J., "Equipment Qualification Test Report, Process Protection System (Seismic Testing)" WCAP 8687, Supplement 2-E-13A (Proprietary), October 1980.
3. Jarecki, S. J., Coslow, B. J., Ellis, A. E., Miller, R. B., "Seismic Operability Demonstration Testing of the Westinghouse ISD 7300 Series Process Instrumentation Bistables," WCAP-8828 (Proprietary), WCAP-8829 (Non-Proprietary), December 1976.
4. Reid, J. B., "Seismic Testing of Electrical and Control Equipment (WCID Nucana 7300 Series) (Low Seismic Plants)" WCAP-7817, Supplement 4, November 1972.
5. Reid, J. B., "Seismic Testing of Electrical and Control Equipment (WCID Nucana 7300 Series) (High Seismic Plants)," WCAP-7821, Supplement 3, September 1972.
6. Damerow, F. W., "Effects of Gamma Radiation Doses Below 10^4 Rads on the Mechanical Properties of Materials," Appendix C WCAP 8587 (Non-Proprietary) January 1981.
7. Jabs, R., Parello, J., Huang, J., Yalick, M., "Equipment Qualification Test Report Short Term Component Aging Test Program," WCAP-8685, Supplement 2 Appendix A1 (Proprietary), March 1981.
8. "Equipment Qualification Test Report Material Aging Analysis," WCAP-8687, Supplement 2, Appendix A2 (Proprietary), March 1981.

TABLE 1

QUALIFICATION STATUS OF PROCESS PROTECTION SYSTEM DEVICES

- A. Seismically Qualified by either of References 2 through 5
Environmentally Qualified by Reference 1

NAL	Signal Comparator	NMD	Multiplier/Divider
NCH	Function Generator	NRA	RTD Amplifier
NCT	Channel Test	NSA	Summing Amplifier
NLL	Lead/Lag Amplifier	NTC	Temperature Channel Test
NLP	Loop Power Supply	NTP	Test Point
NCI	Computer Input	NSC	Signal Converter

- B. Seismically and Environmentally Qualified by Reference 1

NIS	Amplifier	Field Cable Interface Panel
N-16	Amplifier	N-16 Detector Power Supply

- C. Environmentally Qualified by Reference 1

NAI	Annunciator Interface	NPL	Prom Logic
NAS	Auxiliary Solid State Relay	NQC	High Current Output
NCB	Controller	NQI	Quad Input
NCD	Controller Driver	NQO	Quad Output
NDI	Digital Input	NRC	Relay
NMT	Master Test	NTD	Tracking Driver
NPC	Potentiometer		

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TABLE 2

ACTUAL QUALIFICATION TEST CONDITIONS

EQUIPMENT (1) SYSTEM/CATEGORY	LOCATION STRUCTURE/AREA	MANUFACTURER TYPE/MODEL	ABNORMAL/ACCIDENT ENVIRONMENTAL EXTREMES		OPERABILITY		ACCURACY(%)		QUAL	QUAL	QUAL	QUAL
			PARAMETER	SPECIFIED (2)	QUALIFIED	REQ	DEM	REQ	DEM	LIFE	METHOD	REF
Process protection system/ RPS/ Category d	Control building/ MCR	W Model No. 7300	Temperature Pressure Rel. humidity Radiation Chemistry	120 ⁰ F Atmos. 95% 10 ⁴ R(y) None	12 hr. cycles	Two 12 hr. cycles	+0.5 span	+0.1 span	5 yrs. (3)	Seq. Test	ESE- I3	Completed

Notes:

- For definitions of category letters, refer to NUREG-0588 "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment," Appendix E, Section 2.
- Plant specific environmental parameters are to be inserted by the applicant.
- Phase I of the Westinghouse Aging Evaluation Program as described in WCAP-8587 Appendix B has established a qualified life of at least 5 years for this equipment, Phase II of this program will extend the qualification life to a maximum of 20 years or as far as is achievable.

TABLE 3

DESIRED ENVIRONMENTAL CHAMBER CONDITIONS

<u>Cycle</u>	<u>Time</u> <u>(hrs)</u>	<u>Temperature</u> <u>°F</u>	<u>Humidity</u> <u>(%RH)</u>	<u>Line</u> <u>Voltage (AC)</u>	<u>Line</u> <u>Frequency (Hz)</u>
1	12	120	35	124	58.2
2	12	82	95	112	61.8
3	12	120	35	124	61.8
4	12	82	95	112	58.2

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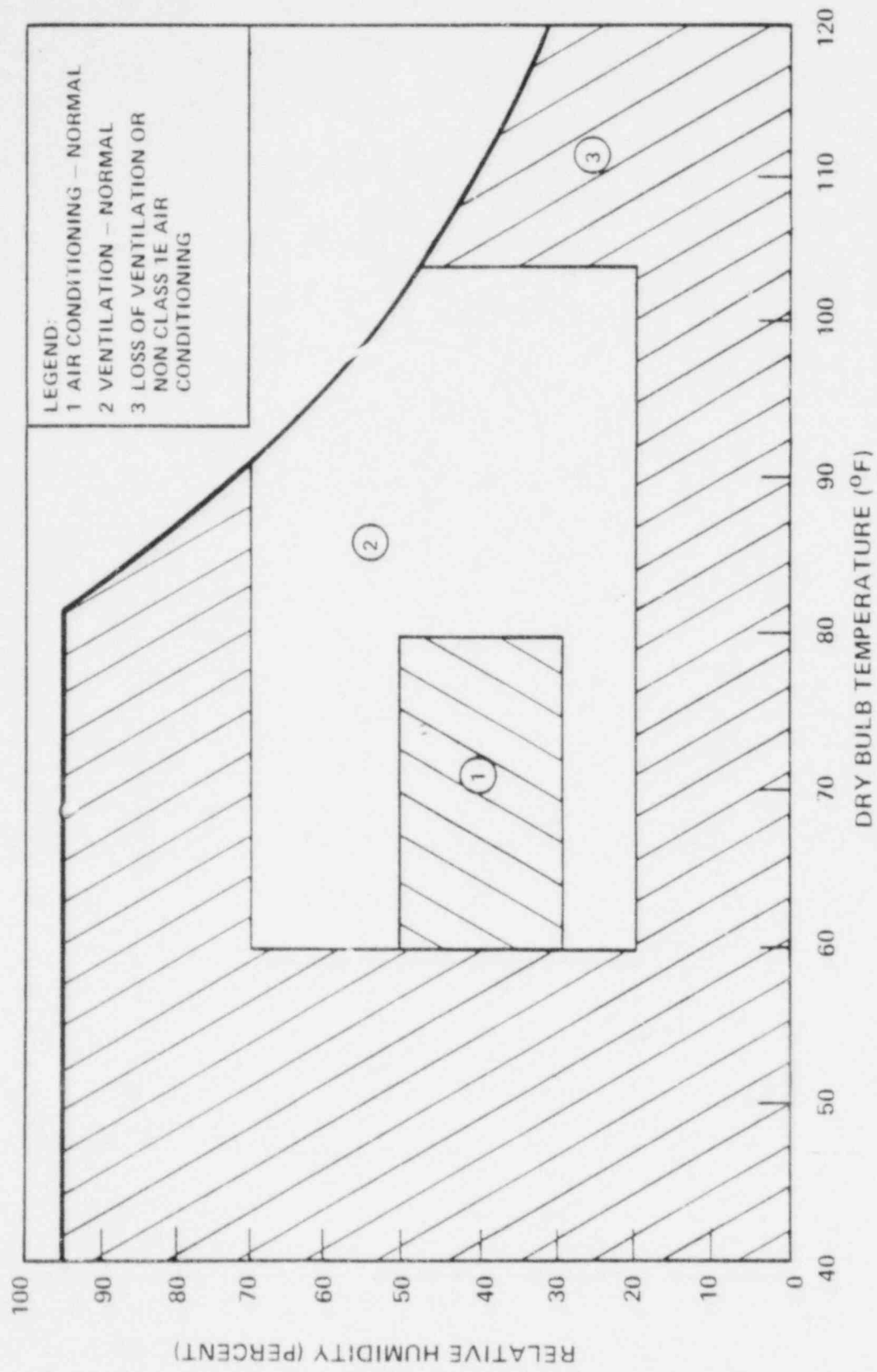


Figure 1 Temperature Versus Humidity - Enclosed Environments Outside Containment

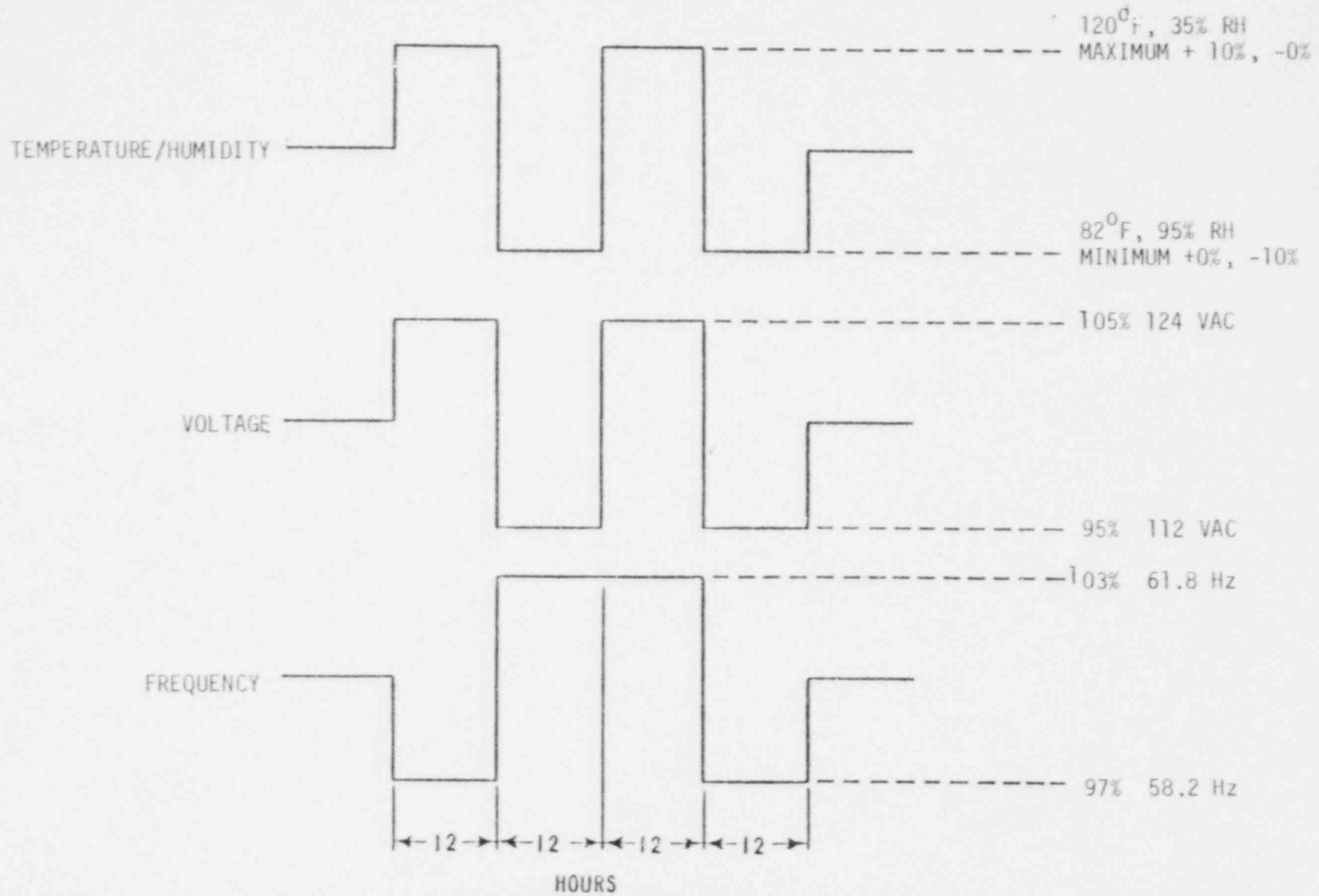
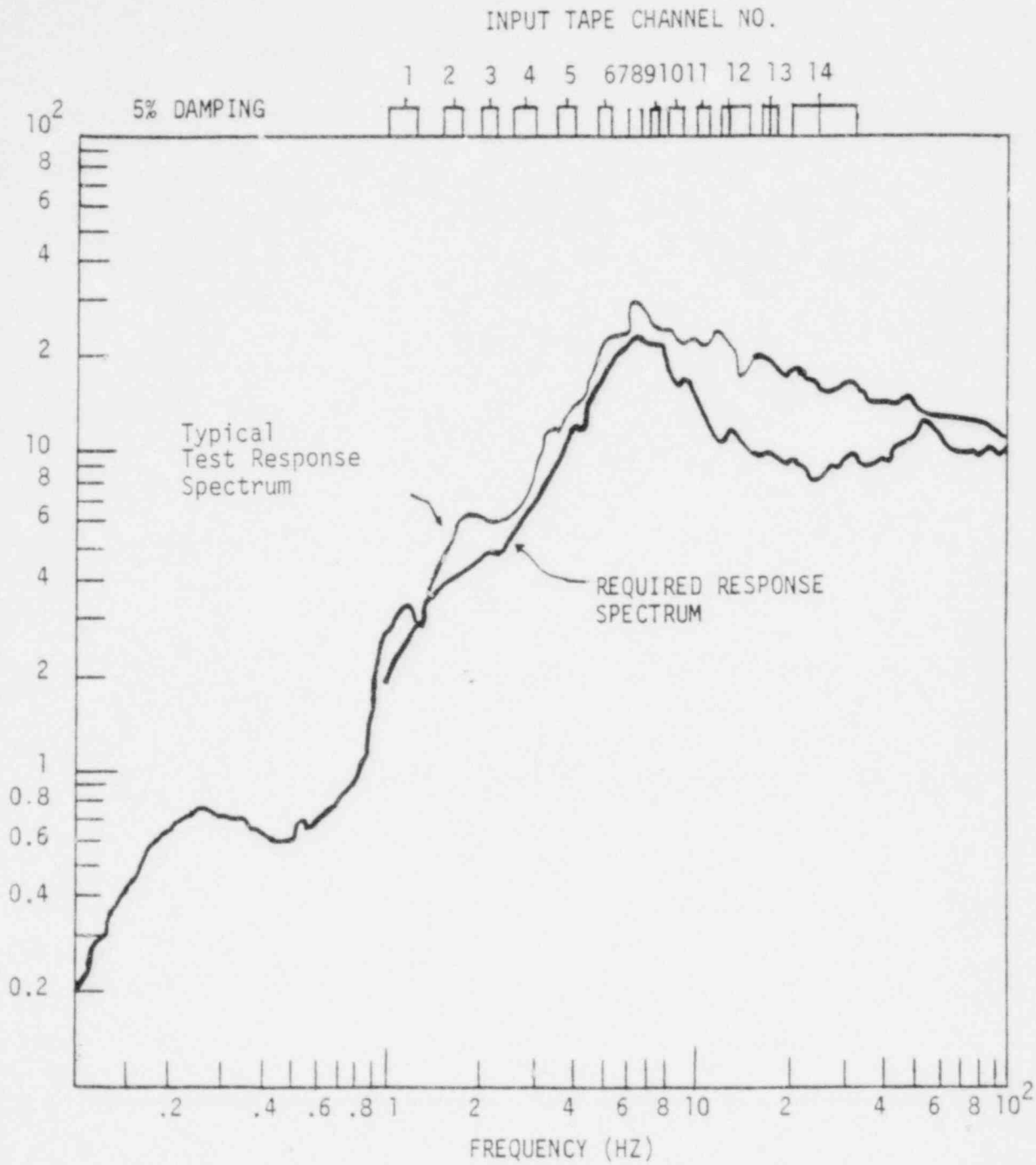


Figure 2. Verification Test Profile

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TEST DIRECTION 4 RUN 1 TRANSDUCER DIRECTION CONTROL
 FILTERS USED _____

Figure 3 RRS FOR SSE