WESTINGHOUSE CLASS 3

WCAP-8587-
SUPP 2-E10A

EQUIPMENT QUALIFICATION
TEST REPORT
NUCLEAR INSTRUMENTATION SYSTEM
(Normal and Abnormal Temperature and Humidity Testing)

by

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1.0 OBJECTIVE

The objective of this qualification program is to demonstrate that the Power Range Channel of the Nuclear Instrumentation System (NIS) meets or exceeds its safety-related performance requirements while subjected to the normal and simulated abnormal service conditions specified in Figure 1. A qualification test was completed on one typical set of Power Range electronic equipment drawers mounted in a single-bay Nuclear Instrumentation System cabinet.

2.0 EQUIPMENT TESTED

2.1 The equipment tested consisted of a single-bay console selected from the four bay NIS console assembly [ ]^{a,c}. Figure 2 provides an outline drawing of the unit. The serial number for the tested console is [ ]^{a,c}. Located in the single-bay console were the following Power Range assemblies. The associated schematics are also identified;

2.1.1 Power Range "A" Drawer Assembly, [ ]^{a,c}.

2.1.2 Printed Wiring Assembly, Summing and Level Amplifier, [ ]^{a,c}.

2.1.3 Printed Wiring Assembly, Rate Circuit, [ ]^{a,c}.

2.1.4 Printed Wiring Assembly, Power Range Calibrate Module, [ ]^{a,c}.

2.1.5 Power Range "B" Drawer Assembly, [ ]^{a,c}.

2.1.6 Printed Wiring Assembly, Bistable Amplifier, [ ]^{a,c}.

2.2 Additional Reference drawings are:

2.2.1 NIS Console Outline, 6055D66, Revision C

2.2.2 NIS Remote Connections, 1046F50, Revision B

2.2.3 Power Range "A" Drawer Assembly Test Spec. - [ ]^{a,c}.

2.2.4 Power Range "B" Drawer Assembly Test Spec. - [ ]^{a,c}.

3.0 PERFORMANCE SPECIFICATION

The Power Range Channel of the Nuclear Instrumenation System was tested to verify its functional operability as defined below:

3.1 Twelve hours continuous operation at the maximum temperature and twelve hours continuous operation at the maximum numidity conditions of Figure 1 (Condition 3 - Loss of Ventilation or Non-Class 1E Air Conditioning).

3.2 The following accuracy and response times:

3.2.1	Bistable Setpoints	± 1 Power Unit
	Analog Output (Isolation)	± 1 Power Unit (0-120 P.U.)
		± 5 Power Unit (120-200 P.U.)

Power Unit (P.U.) = 1 percent of rated Reactor Full Power

3.2.2 Response Time

3.2.2.1 Level Trip 65 millisecond. Δ input from 5 percent below to 5 percent above setpoint

3.2.2.2 Flux Rate - 0.2 second for Δ input of 20 percent.

4.0 DESCRIPTION OF TEST FACILITY

The environmental qualification of the Power Range Channel of the Nuclear Instrumentation System was performed at the Westinghouse Nuclear Instrumentations and Control Department Environmental Facility located at Hunt Valley, Maryland.

4.1 TEST EQUIPMENT

The Monitoring Equipment and NIS Test Fixture (see Figures 3 and 4) were located on a test bench outside the chamber. The monitoring test equipment is listed in Table III. The environmental test chamber was a Tenny model, capable of producing environments from 32°F to 120°F and reaching a relative humidity of [ ]a,b,c percent and, was large enough to totally contain the NIS single-bay console. The use of a test chamber with a relative humidity [ ]b,c,e of [ ]a,b,c percent was necessitated due to test facility availabilities and schedular constraints (See Section 7.1 for a discussion).

4.2 MOUNTING

The NIS console containing the Power Range Channel was mounted on 2 inch by 4 inch wooden blocks and located in the environmental chamber.

4.3 CONNECTIONS

External cables from the test fixture and monitoring equipment were routed through the chamber port hole, under the base of the NIS console and up to the Power Range drawers. A.C. power to the NIS console was supplied by a motor-generator (M-G) set located outside the chamber next to the chamber control console (See Figure 5). The A.C. line voltage and frequency was controlled by the panel directly above the M-G set.

5.0 TEST PROCEDURES

5.1 NORMAL ENVIRONMENTAL TESTING

A number of performance checks (i.e., burn-in, systems calibration, etc.) are carried out by Westinghouse to verify capability to meet performance requirements under ambient conditions. These normal environmental tests are performed on all production units prior to release and, as a consequence, are not reported in this generic test report, which is limited to reporting the results of abnormal environmental testing of a representative unit. However, the results of these normal environmental production unit tests are maintained by Westinghouse, and are available for audit for any particular project. The generic abnormal environmental testing described in this report do, furthermore, cover a range of temperature and humidity parameters that encompass the specified range of these parameters for its normal environment (Figure 1).

5.2 ABNORMAL ENVIRONMENTAL TESTING

5.2.1 Service Conditions

The safety-related functions of the Power Range Channel of the Nuclear Instrumentation System were tested while subject to the simulated service conditions specified in Table I. During the same testing period, the input voltage and frequency were varied above and below the normal values as also shown in Table I.

5.2.2 Monitored Functions

Analog output voltages and bistable trip voltages were monitored for correctness and accuracy during each abnormal service condition cycle. See Appendix A tables for a detailed list of the functions monitored.

6.0 TEST DATA AND ACCURACY

A representative sample of the test data for the environmental qualification test of the Power Range Channel of the Nuclear Instrumentation System is contained in Appendix A. Contained in Appendix B are graphs showing the temperature and humidity conditions for two of the six cycles performed. The test data of Table II summarizes the results obtained from all six cycles identified in Table 1 and demonstrates that the equipment under test meets the accuracies specified in Section 3.2.

7.0 SUMMARY

7.1 The Power Range Channel of the Nuclear Instrumentation System has been tested under normal and simulated abnormal service conditions (environmental and input voltage and frequency) to demonstrate its capability to perform its safety-related function under these conditions. The test results show the equipment remained within the specified accuracy and trip time requirements when subjected to the environmental and supply extremes shown in Table I. Due to [ ]b,c,e in the environmental chamber a relative humidity of [ ]b,c,e. The maximum conditions tested were [ ]b,c,e°F and [ ]b,c,e percent RH. [

]b,c,e

7.2 The specification requires the safety-related performance requirements be met for a duration of 12 hours at abnormal conditions. EQDP-ESE-10, Section 2.6, requires a test of four (two for margin) 12 hour cycles of temperature, humidity, voltage and frequency extremes. During the actual test, two additional 12 hour cycles were run at, 1) [ ]b,c,e°F, [ ]b,c,e percent relative humidity, [ ]b,c,e VAC and [ ]b,c,e hertz line voltage and frequency, and 2) [ ]b,c,e°F, [ ]b,c,e percent relative humidity, [ ]b,c,e VAC and [ ]b,c,e hertz line voltage and frequency for a total of six cycles to provide additional margin in the qualification programs.

TABLE I

SPECIFIED SERVICE CONDITIONS

Cycle	Time Hrs.	Temp. (°F)	Humd. (%RH)	Line Vac	Line Freq. (Hz)
1	12	[			] b,c,e
2	12				
3	12				
4	12				
5	12				
6	12	]			

TABLE II
SUMMARY OF TEST RESULTS

Cycle	Time Hrs.	Actual Test Conditions: Nominal Temp. (°F) (1)	Nominal Humd. (%RH)	Nominal Line VAC (1)	Nominal Line Freq. (HZ) (1)	Bistable Setpoints (P.U.)(3) (2)	Analog Output (Isolation) (P.U.)(3) (2)	Response Time: Flux Rate (SEC.)	Level Trip (SEC.)
1	12	[					]b,c,e	(Note 4)	(Note 5)
2	12							(Note 4)	(Note 5)
3	12							(Note 4)	(Note 5)
4	12							(Note 4)	(Note 5)
5	12							(Note 4)	(Note 5)
6	12							(Note 4)	(Note 5)

Notes

1. Conditions were within the tolerances specified in Table I.
2. Data shown is maximum deviation from normal.
3. P.U. = 1 percent of rated reactor full power.
4. Flux rate response time was recorded during the pre and post abnormal environmental acceptance test (approx. [ ]b,c,e) but was not recorded during the abnorml environmental tests.
5. Level trip response time was recorded during the pre and post abnormal environmental acceptance test (approx. [ ]b,c,e) but was not recorded during the abnormal environmental tests.

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TABLE III

TEST EQUIPMENT LIST

Name	Model No.	Serial No.
Digital Multimeter	8375A	N-1224
Digital Multimeter	8800A	N-0979
Digital Multimeter	8600A	N-1530
Digital Multimeter	8100	N-0492
Oscilloscope	7603	N-1256
Vertical Plug-in	7A13	N-1181
Horizontal Plug-in	7B53A	N-1297
Diff. Amp.	7A13	N-1523
Variac	W 10MT3A	N-0723
Hypot JR	4045	N-0674
Megger	2851	N-0685
Pulse Generator	8012B	N-1207
Sweep Generator	185	N-1492
70 OHM Alternator	31-0-442	N-0275
DC Power Supply	TW-5005	N-0503
DC Power Supply	TW-5005	N-0052
DC Power Supply	TW-5005	N-0506
DC Power Supply	3650-S	N-0619
Counter	8010A	N-0670
Measuring System	5307A	N-1488
Timer Counter	5300A	N-1517
Measuring System	5300A	N-0700
Timer Counter	5304A	N-0589
Recorder	322	N-0850
Simpson	260-6M	N-0713
Scaler Timer	5201L	N-0208
Dial-A-Volt	460	N-0358
Electronic Tube	WL-6377	T-0618
Digital Thermometer	2100A	N-1051
Tenny	-	N-0396
Power Supply	KR-12M N-1529	N-1529

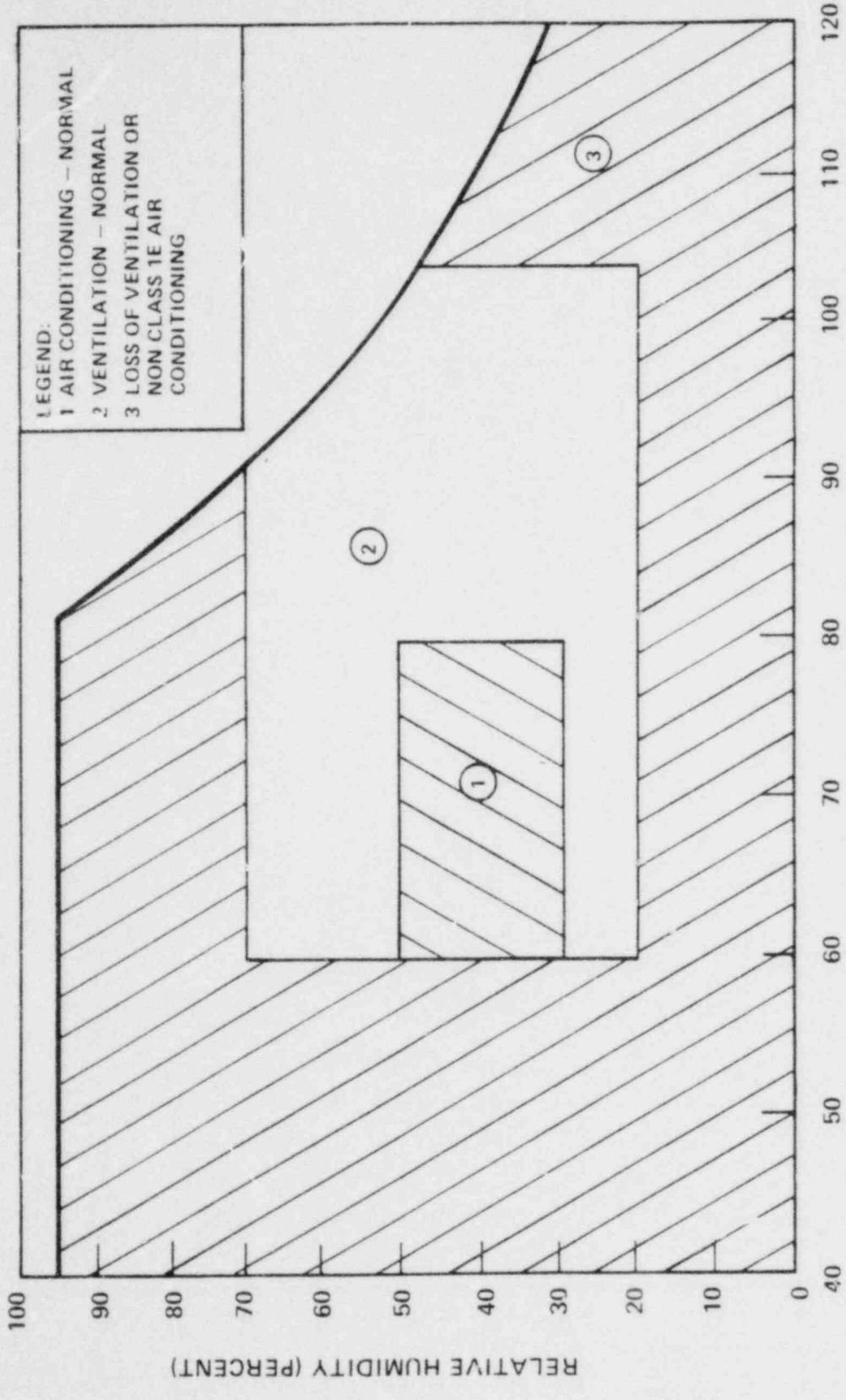
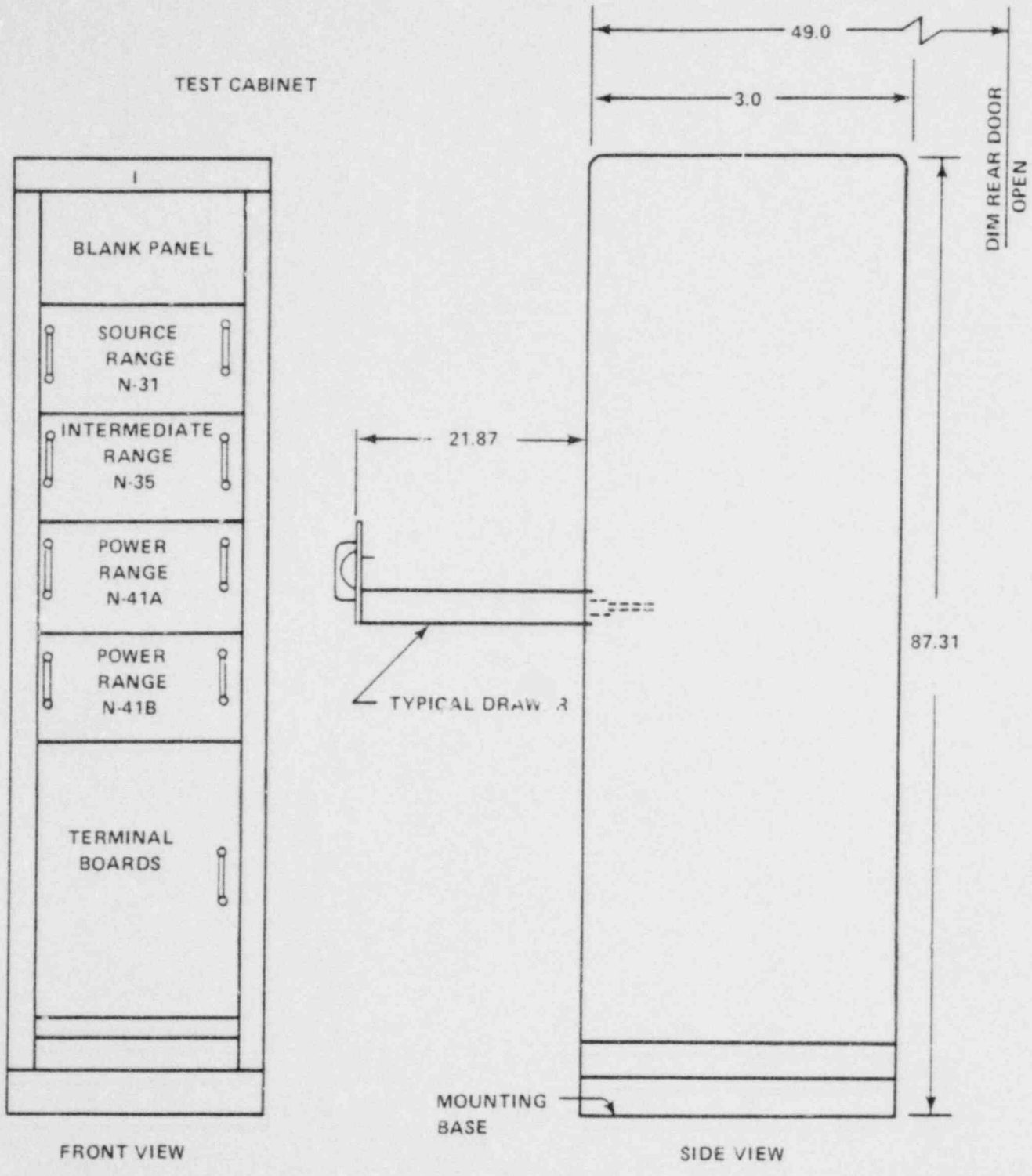


Figure Temperature Versus Humidity - Enclosed Environments Outside Containment



WEIGHT 800 LBS.
ALL DIMENSIONS IN INCHES

NOTE: THE SOURCE AND INTERMEDIATE RANGE DRAWERS WERE INCLUDED TO SIMULATE AS INSTALLED CONDITIONS ONLY.

Figure 2 Description of Test Specimen

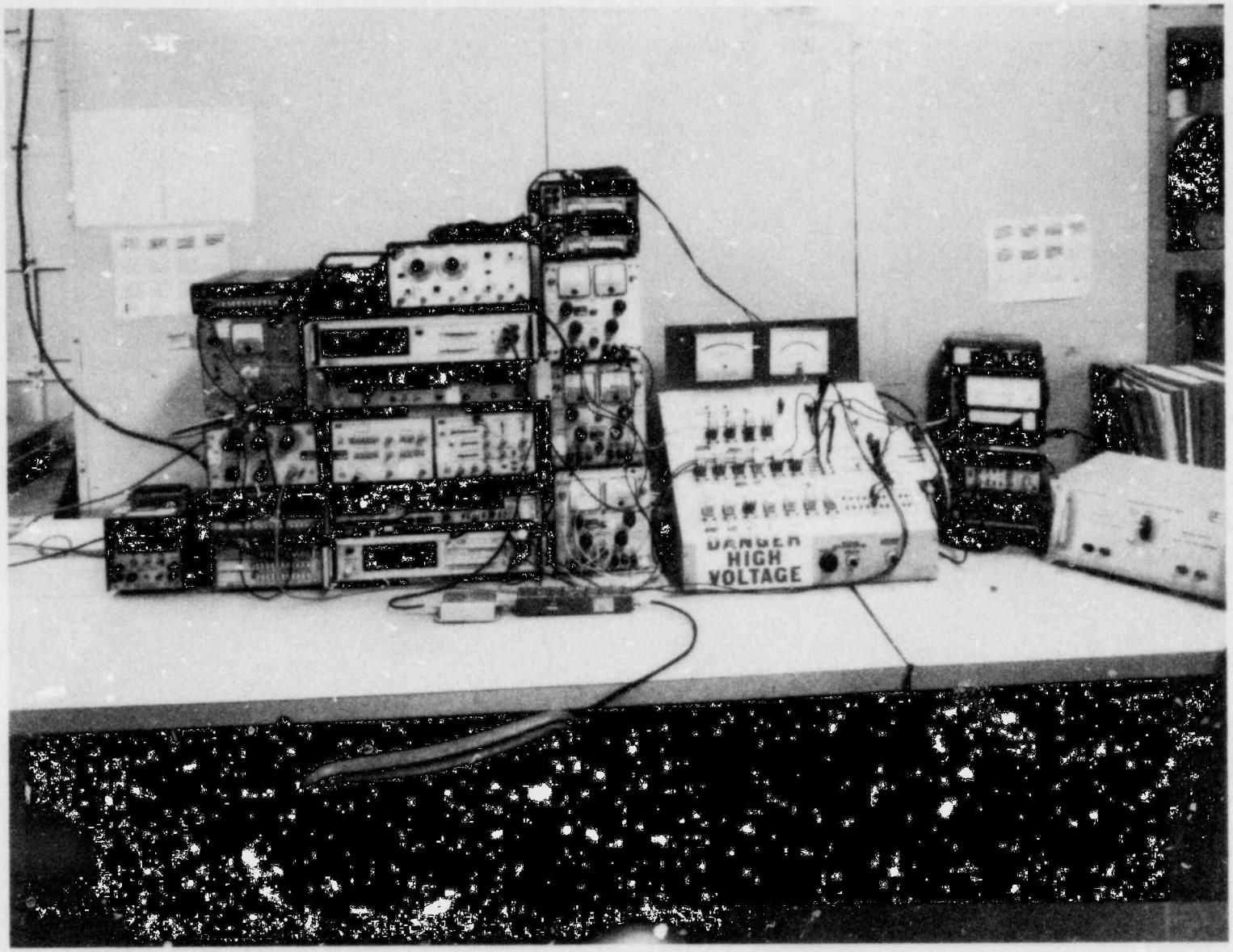


Figure 3 NIS Monitoring and Test Equipment

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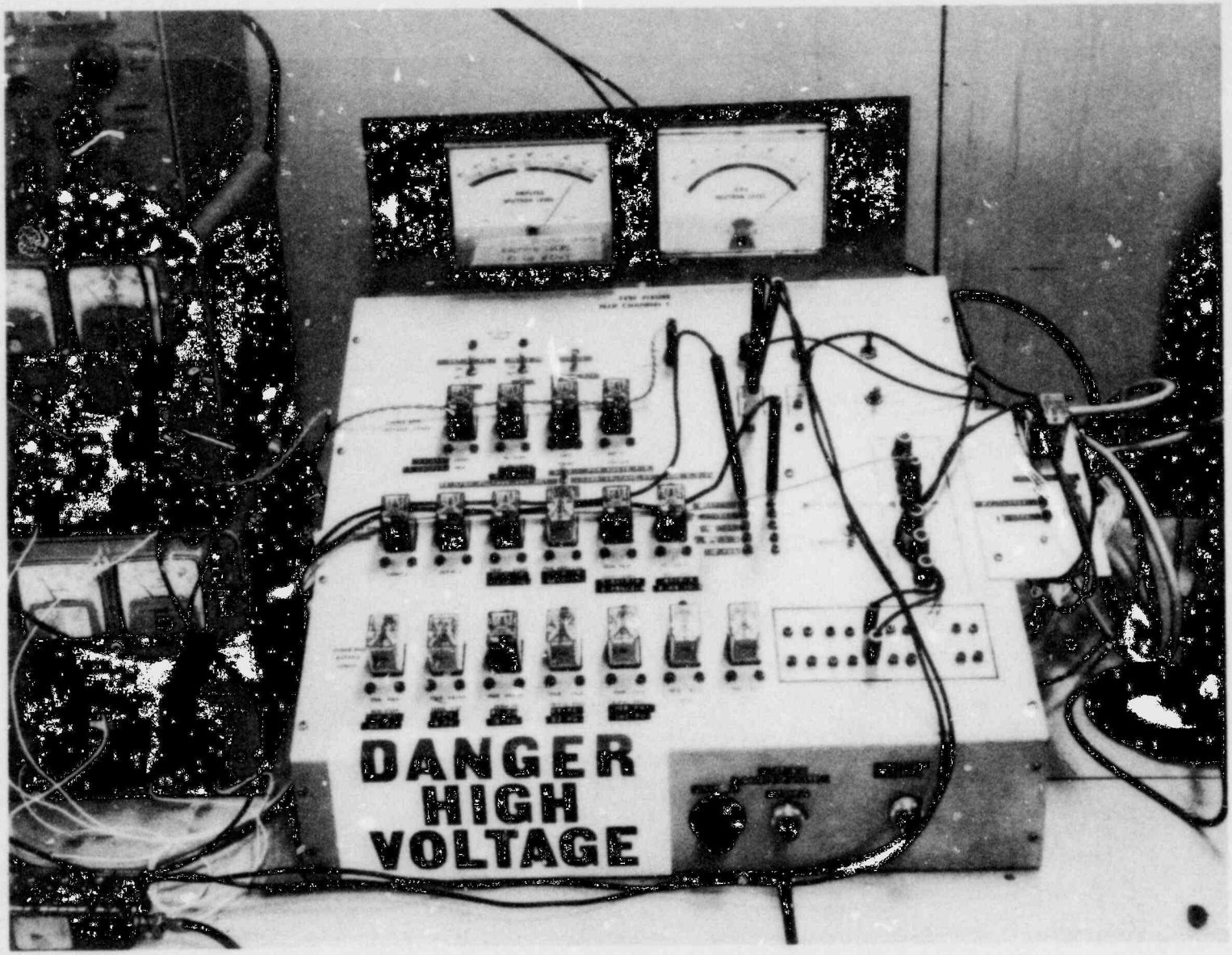

Figure 4 NIS Test Fixture

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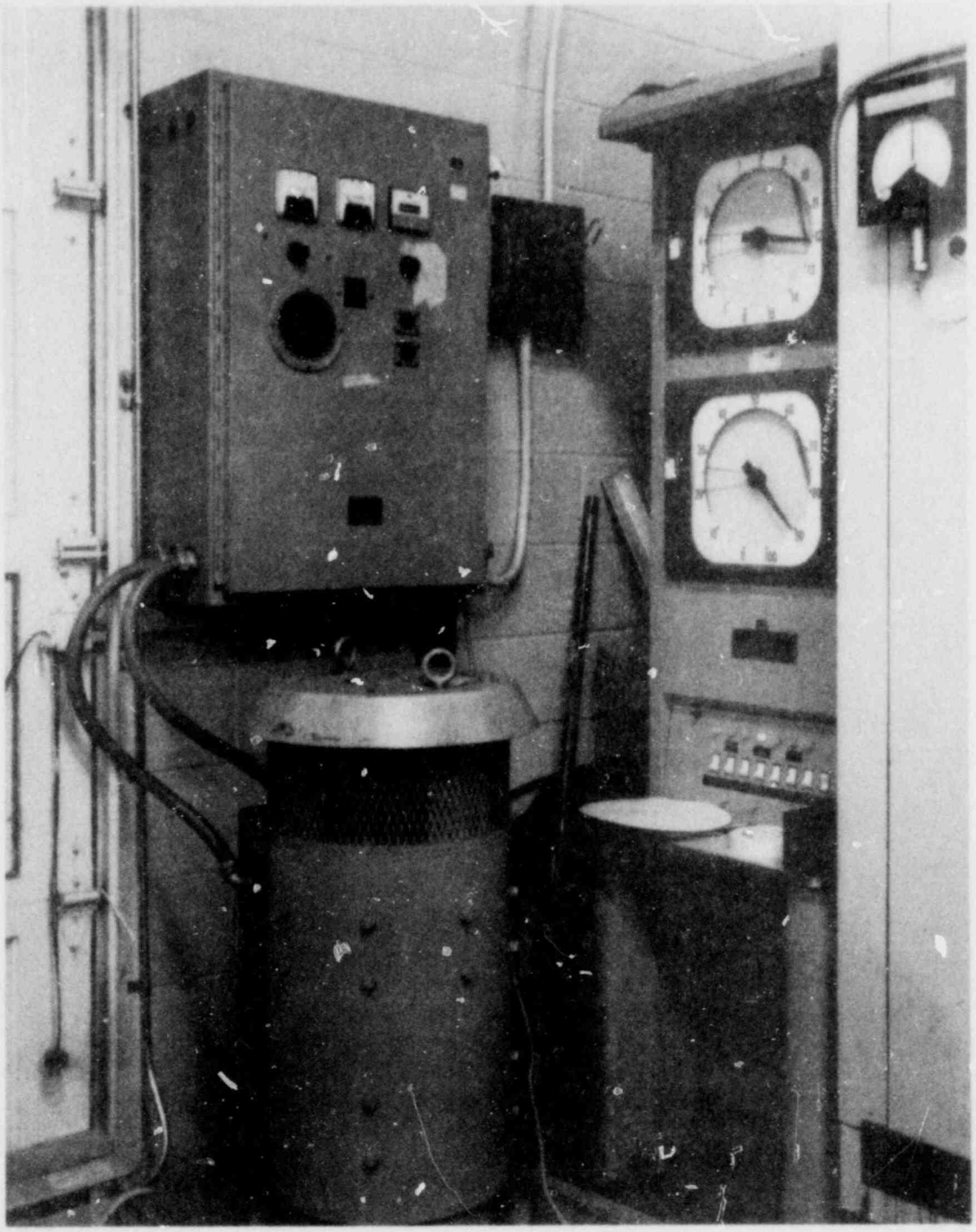

Figure 5 Motor Generator Set and Environmental Chamber Control Panel

APPENDIX A

Test Results

A.1 Cycle 1 Test Results

A.2 Cycle 4 Test Results

CYCLE 1 TEST RESULTS

A.1 Chamber Conditions

Temperature [ ]b,c,e °F
Humidity [ ]percent

Start of 12 Hour Cycle (Table A-1)

[ ]b,c,e Hz [ ]b,c,e vac test data

End of 12 Hour Cycle (Table A-2)

[ ]b,c,e Hz at [ ]b,c,e vac test data

Data taken while environmental chamber is at test temperature and humidity.

TABLE A-1

CYCLE TEST DATA

(Start of 12 Hour Test)

Power Range		Test Fixture Outputs	Required
Over Pwr. Trip H.R.	TRIP		b,c,e ± 1 PU
NC 306	RESET		± 1 PU
Power Above P10	TRIP		± 1 PU
NC308	RESET		± 1 PU
Power Above P8	TRIP		± 1 PU
NC304	RESET		± 1 PU
Neg. Rate Trip NC301	TIME		± .5 sec
Pos Rate Trip NC303	TIME		± .5 sec
O.P. Trip Low Range	TRIP		± 1 PU
NC305	RESET		± 1 PU
Over Power Rod Stop	TRIP		± 1 PU
NC302	RESET		± 1 PU
Isolation Amp 301 DET A-100 µa			± .037
Isolation Amp 306 DET A-100 µa			± .037 VDC
Isolation Amp 307 DET B-100 µa			± .037 VDC
Isolation Amp 303 120 per. Pwr			± .062 VDC
Isolation Amp 302 120 per. Pwr			± .062 VDC
Summing and Level Out (NM310)			
With DET A and B at 100 µa			± .037 VDC
With DET A and B at 50 µa			± .037 VDC
With DET A and B at 0 µa			± .037 VDC

TABLE A-2

CYCLE 1 TEST DATA

(End of 12 Hour Test)

Power Range		Test Fixture Outputs	Required
Over Pwr. Trip H.R.	TRIP		D,C,E ± 1 PU
NC 306	RESET		± 1 PU
Power Above P10	TRIP		± 1 PU
NC308	RESET		± 1 PU
Power Above P8	TRIP		± 1 PU
NC304	RESET		± 1 PU
Neg. Rate Trip NC301	TIME		± .5 sec
Pos Rate Trip NC303	TIME		± .5 sec
O.P. Trip Low Range	TRIP		± 1 PU
NC305	RESET		± 1 PU
Over Power Rod Stop	TRIP		± 1 PU
NC302	RESET		± 1 PU
Isolation Amp 301 DET A-100 µa			± .037 VDC
Isolation Amp 306 DET A-100 µa			± .037 VDC
Isolation Amp 307 DET B-100 µa			± .037 VDC
Isolation Amp 303 120 per. Pwr			± .062 VDC
Isolation Amp 302 120 per. Pwr			± .062 VDC
Summing and Level Out (NM310)			
With DET A and B at 100 µa			± .037 VDC
With DET A and B at 50 µa			± .037 VDC
With DET A and B at 0 µa			± .037 VDC

CYCLE 4 TEST RESULTS

A.2 Chamber Conditions

Temperature [ ]b,c,e °F
Humidity [ ]percent

Start of 12 Hour Cycle (Table A-3)

[ ]b,c,e Hz [ ]b,c,e vac test data

End of 12 Hour Cycle (Table A-4)

[ ]b,c,e Hz at [ ]b,c,e vac test data

Data taken while environmental chamber is at test temperature and humidity.

TABLE A-3

CYCLE 4 TEST DATA

(Start of 12 Hour Test)

Power Range		Test Fixture Outputs	Required
Over Pwr. Trip H.R.	TRIP	[	] b,c,e ± 1 PU
NC 306	RESET		± 1 PU
Power Above P10	TRIP		± 1 PU
NC308	RESET		± 1 PU
Power Above P8	TRIP		± 1 PU
NC304	RESET		± 1 PU
Neg. Rate Trip NC301	TIME		± .5 sec
Pos Rate Trip NC303	TIME		± .5 sec
O.P. Trip Low Range	TRIP		± 1 PU
NC305	RESET		± 1 PU
Over Power Rod Stop	TRIP		± 1 PU
NC302	RESET		± 1 PU
Isolation Amp 301 DET A-100 µa			± .037 VDC
Isolation Amp 306 DET A-100 µa			± .037 VDC
Isolation Amp 307 DET B-100 µa			± .037 VDC
Isolation Amp 303 120 per. Pwr			± .062 VDC
Isolation Amp 302 120 per. Pwr			± .062 VDC
Summing and Level Out (NM310)			
With DET A and B at 100 µa			± .037 VDC
With DET A and B at 50 µa			± .037 VDC
With DET A and B at 0 µa			± .037 VDC

TABLE A-4

CYCLE 4 TEST DATA

(End of 12 Hour Test)

Power Range		Test Fixture Outputs	Required
Over Pwr. Trip H.R.	TRIP		D,C,E ± 1 PU
NC 306	RESET		± 1 PU
Power Above P10	TRIP		± 1 PU
NC308	RESET		± 1 PU
Power Above P8	TRIP		± 1 PU
NC304	RESET		± 1 PU
Neg. Rate Trip NC301	TIME		± .5 sec
Pos Rate Trip NC303	TIME		± .5 sec
O.P. Trip Low Range	TRIP		± 1 PU
NC305	RESET		± 1 PU
Over Power Rod Stop	TRIP		± 1 PU
NC302	RESET		± 1 PU
Isolation Amp 301 DET A-100 µa			± .037 VDC
Isolation Amp 306 DET A-100 µa			± .037 VDC
Isolation Amp 307 DET B-100 µa			± .037 VDC
Isolation Amp 303 120 per. Pwr			± .062 VDC
Isolation Amp 302 120 per. Pwr			± .062 VDC
Summing and Level Out (NM310)			
With DET A and B at 100 µa			± .037 VDC
With DET A and B at 50 µa			± .037 VDC
With DET A and B at 0 µa			± .037 VDC

APPENDIX B

TEST CONDITIONS

B.1 Cycle 1 Temperature and Humidity Graph

B.2 Cycle 4 Temperature and Humidity Graph

b,c,e

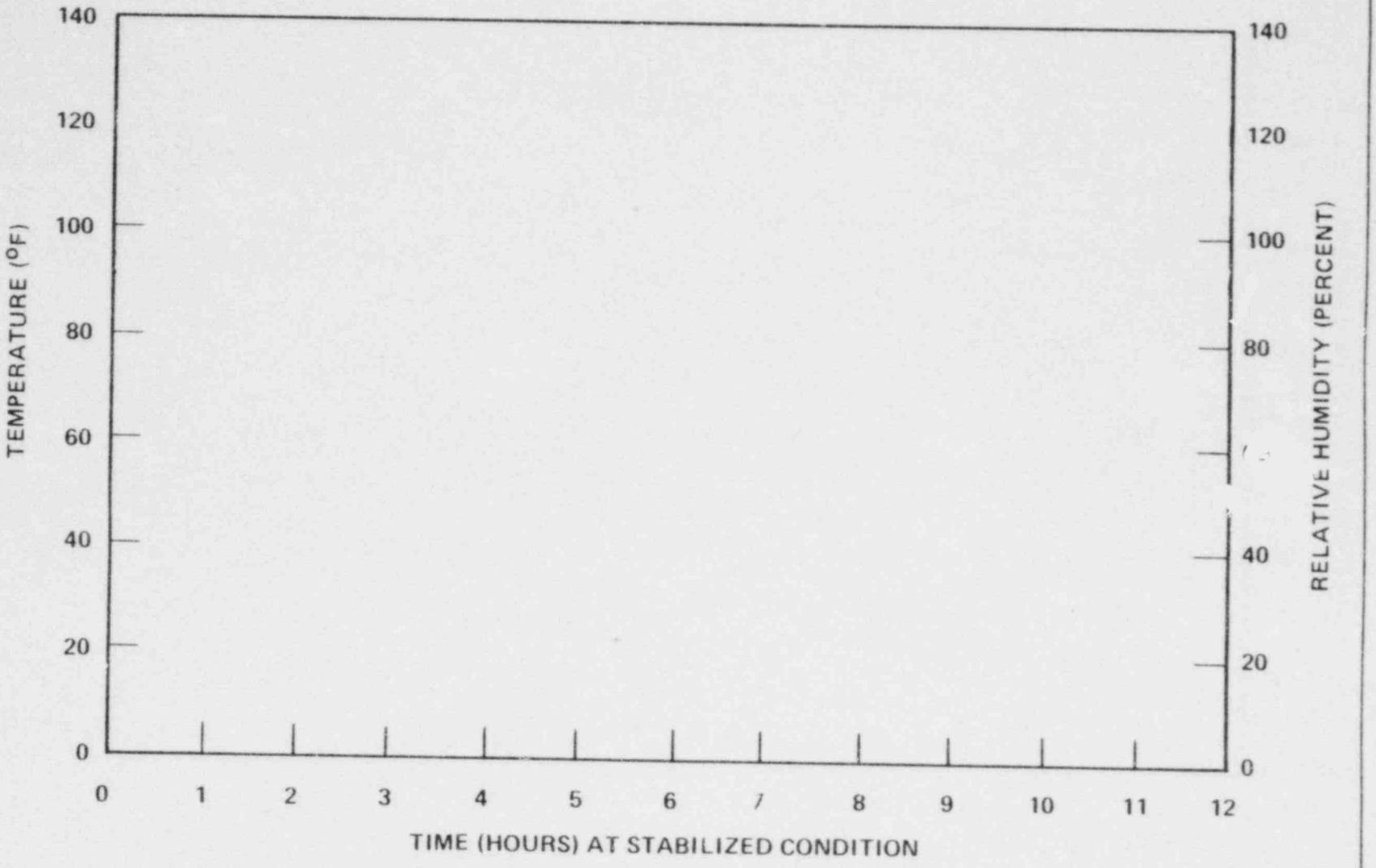

Figure B.1 Cycle 1 Conditions

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b,c,e

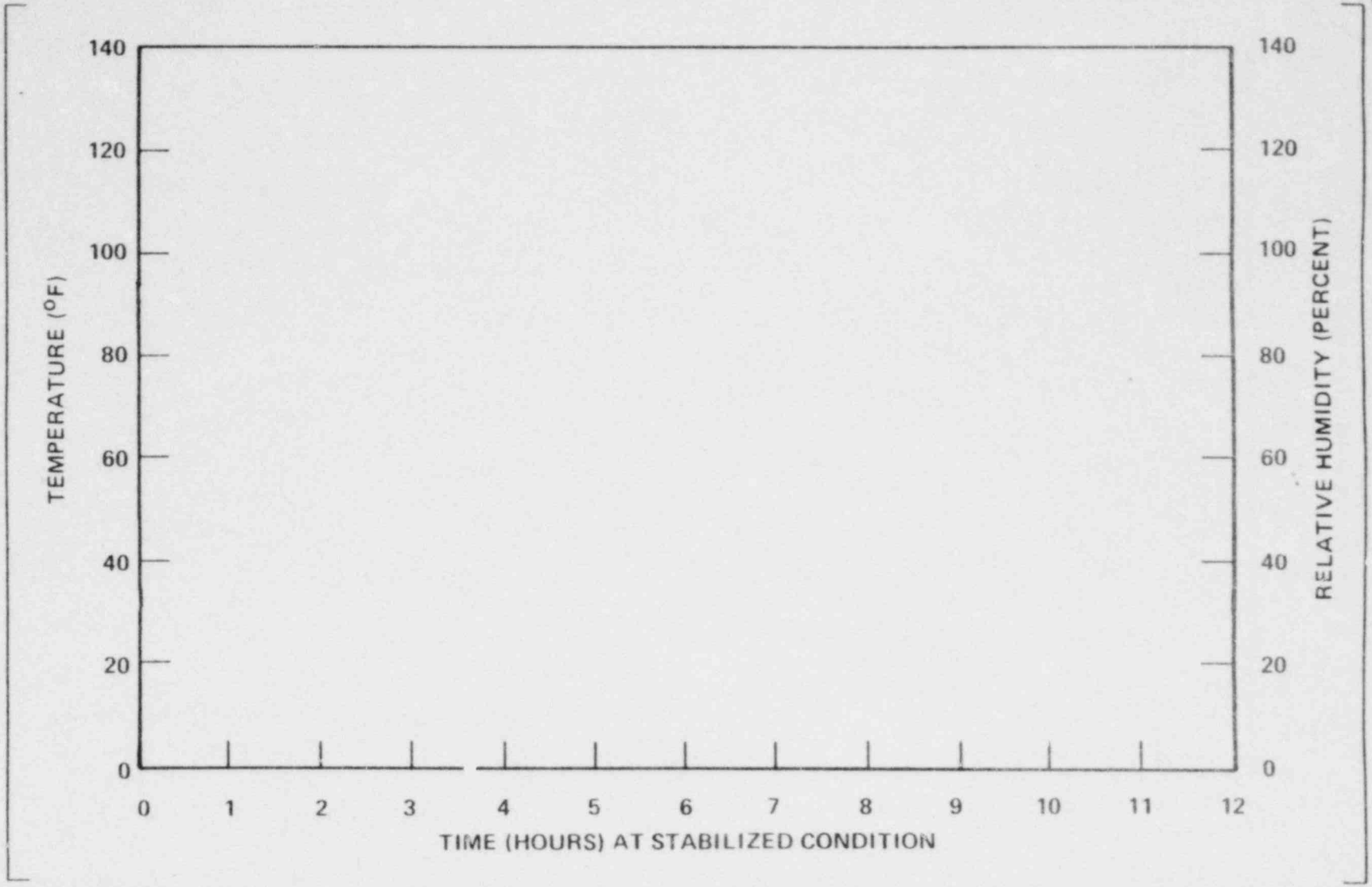

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Figure B.2 Cycle 4 Conditions