WESTINGHOUSE CLASS 3

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Environmental

EQUIPMENT QUALIFICATION
TEST REPORT
TWO TRAIN SOLID STATE PROTECTION SYSTEM
(NORMAL AND ABNORMAL TEMPERATURE AND HUMIDITY TESTING)

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1.0 OBJECTIVE

1.1 The objective of this qualification program is to demonstrate that the safety related functions of the Solid State Protection System (SSPS) meets or exceeds their performance requirements while subjected to the normal and simulated abnormal service conditions specified in Figure 1. A qualification test was completed on a single train of the Three Train SSPS.

2.0 EQUIPMENT TESTED

2.1 The equipment tested was a single train of the pre-production Three Train SSPS specified in Design Base and Difference Document [ ]^{a,c} which consisted of the following components:

2.1.1 Logic Train A [ ]^{a,c}

2.1.2 Actuation Train A [ ]^{a,c}

2.1.3 Safeguards Test Cabinet [ ]^{a,c}

2.1.4 Relay Enclosure [ ]^{a,c}

2.1.5 Prefabricated Cables

2.1.5.1 Demux cable [ ]^{a,c}
2.1.5.2 OR Cable [ ]^{a,c}
2.1.5.3 Reset Cable [ ]^{a,c}
2.1.5.4 Actuation Cable [ ]^{a,c}
2.1.5.5 Test Cable [ ]^{a,c}
2.1.5.6 Sync Cable [ ]^{a,c}

2.2 Included as part of the system but not tested since it was not located in the environmental chamber during testing.

2.2.1 Control Board Demultiplexer [ ]^{a,c} with Demultiplexer assembly [ ]^{a,c}

2.3 The equipment tested above was the Three Train Solid State Protection System, which is made up of component parts, sub-assemblies, power supplies and printed circuit boards which are identical to the Two Train Solid State Protection System, in so far as part number, function and circuit configuration. The major

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* Drawings appear in Section 8.

difference is that the Two Train System consists of two redundant protection trains while the Three Train System consists of three. This results in a variation in the amount and packaging of equipment which has no significant impact on this qualification, rather than the types of equipment.

3.0 PERFORMANCE SPECIFICATIONS

The SSPS was tested to verify its functional operability as defined below:

3.1 Twelve hours continuous operation at the extreme temperature and humidity conditions of Figure 1 (Condition 3 - loss of ventilation or non-class 1E air conditioning).

3.2 Initiate a reactor trip or safeguards actuation, (by changing state) on demand.

4.0 DESCRIPTION OF THE TEST FACILITY

The environmental qualification of the SSPS was performed at Westinghouse NICD (Normal, Section 5.1), Hunt Valley, Maryland and Westinghouse DESC (Abnormal, Section 5.2), Baltimore, Maryland.

4.1 Test Equipment

4.1.1 Special purpose test tool (Figure 2) designed exclusively for testing of the SSPS production units. It simulates all inputs to and monitors all outputs from the system which is in itself an interconnection of several assemblies. Being a digital system test, the test tool monitors on or off conditions only.

4.1.2 Environmental test chamber with a temperature capability of [ ]a,b,c and reaching a relative humidity of [ ]a,b,c percent with integral controlling thermocouple and temperature recorder.

4.1.3 Other associated setup test equipment:

4.1.3.1 Oscilloscope, Tektronix 545
4.1.3.2 Digital voltmeter, Fluke 8100A
4.1.3.3 Digital frequency counter, CMC-901

4.2 Mounting

4.2.1 The equipment was pallet mounted for ease of handling or rested on 4-inch by 4-inch blocks. No other bolting or fastening to the floor was considered since it was not germane to this test.

4.3 Connections

4.3.1 All necessary connections were made via connectors. Terminal board connections were made using alligator clips (this form of connection was used for test convenience, however the variation from the as installed connection does not effect the qualification, since these connections are employed for monitoring purposes and do not contribute to the equipment function). Interconnecting cabling between the various assemblies were made with typical prefabricated cables (with connectors).

5.0 TEST PROCEDURE

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 SSPS were tested while subject to the simulated service conditions specified in Table 1. During the same testing period, the input voltage and frequency were varied above and below the normal values as also shown in Table 1.

5.2.2 Monitored Functions

The SSPS reactor trip output and selected safeguards actuation outputs were initiated and monitored via the system test tool. Functional tests were chosen such that a variety of circuits and components, in addition to a variety of locations within each cabinet, would be operated. These selected system functions were

exercised at 0 hours, 6 hours and 12 hours into each test cycle and proper operation verified. Functional operability of the equipment was also demonstrated before and after the start of the abnormal service condition testing to ensure proper pre and post test operation.

6.0 TEST RESULTS

6.1 All reactor trip and safeguards actuation functions were successfully demonstrated while subjecting the equipment to the test conditions summarized in Table 2. A plot of temperature and relative humidity variations during Cycles 1 and 2 are depicted in Figures 4 and 5, respectively as a sample of the test data. The hourly data points presented were taken from analog circular graphs which are not of reproducible quality but are maintained by Westinghouse for inspection. All specified conditions for Cycle 1 (Table 1) were met or exceeded.

During cycle 2 (Table 1) the equipment was operated at the voltages and frequencies specified. However during this and later test cycles a relative humidity of only 88Δ was maintained, which justifies equipment acceptability up to and including 88Δ RH.

6.2 The SSPS was exercised three times during each 12 hour cycle at stabilized environmental conditions; 0 hours, 6 hours and 12 hours. Figure 6 is the typical sequence of tests performed at each time above. All reactor trip and safeguards actuations function exercised changed state as required.

7.0 SUMMARY

7.1 The SSPS was 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 data shows that all reactor trip and safeguards actuation functions changed state when exercised while subjected to the environmental and supply extremes shown in Table 2,. Therefore, the interface requirements in the EQDP-ESE-16 have been changed to reflect a maximum humidity requirement of 88Δ RH.

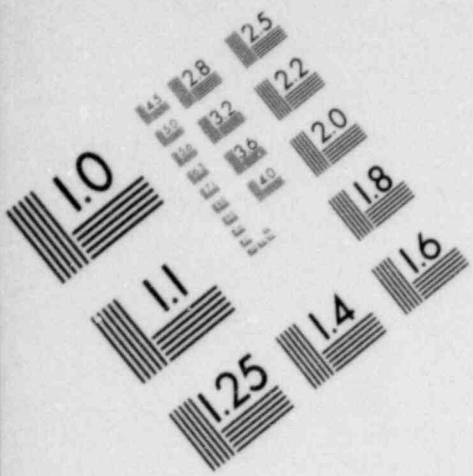
7.2 The specified performance requirements for function are 12 hours at abnormal conditions. EQDP-ESE-16, Section 2.6, requires a test of four (two for margin) 12 hour cycles of temperature, humidity, voltage and frequency extremes. During the actual test, two additional 12 hour cycles were run at, 1) [

]^{b,c} to provide additional margin in the qualification programs.

TABLE 1

SPECIFIED SERVICE CONDITIONS

Cycle	Time-Hrs.	Temp. (°F)	Humid. (% RH)	Line VAC	Line VDC	Line Freq. (Hz)
1	[					] b,c
2						
3						
4						
5						
6	]					



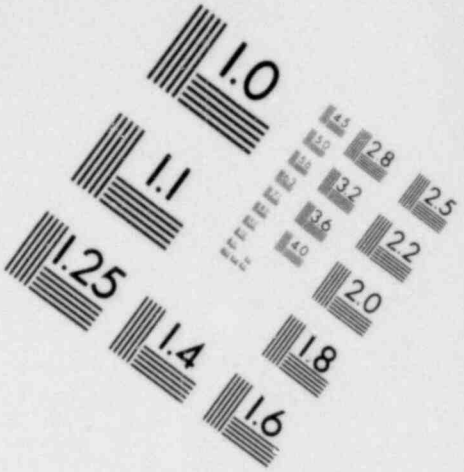
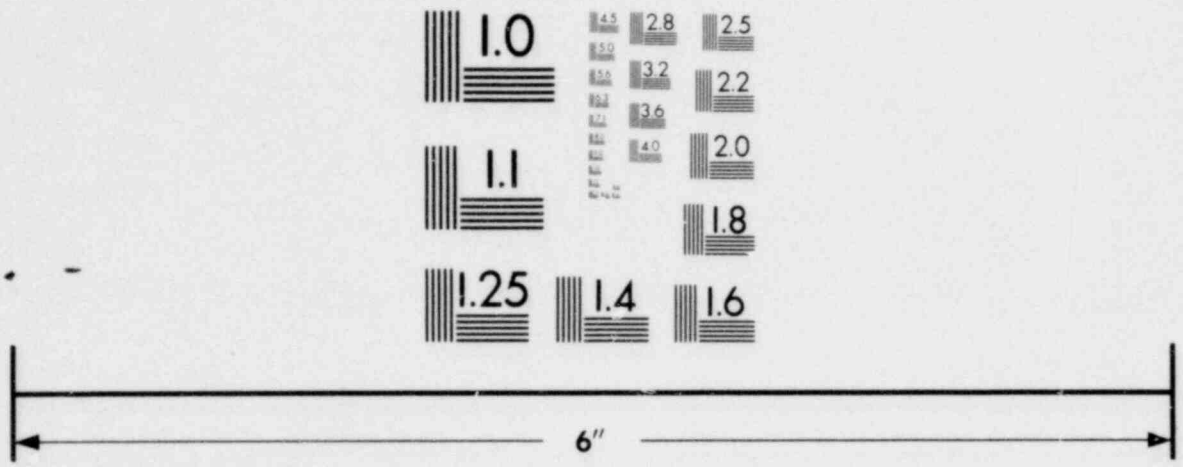
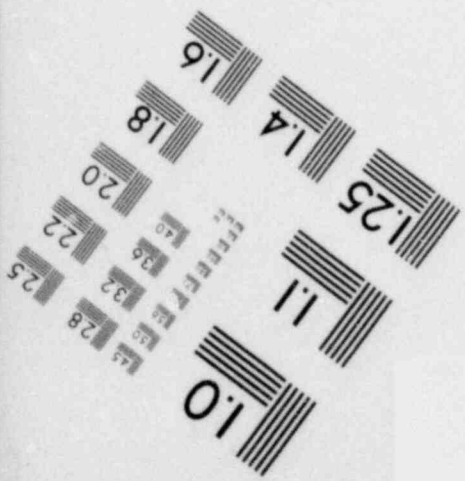
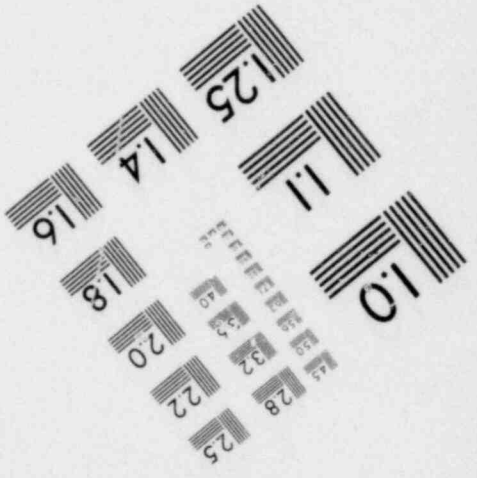
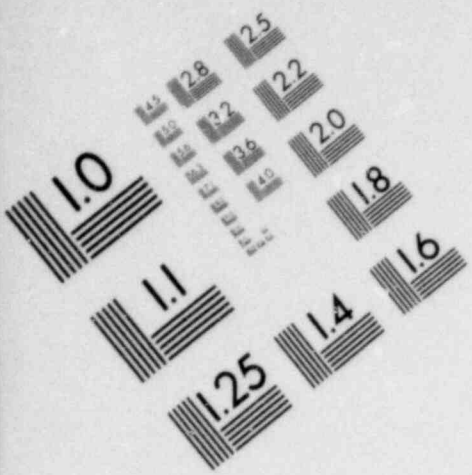


IMAGE EVALUATION TEST TARGET (MT-3)









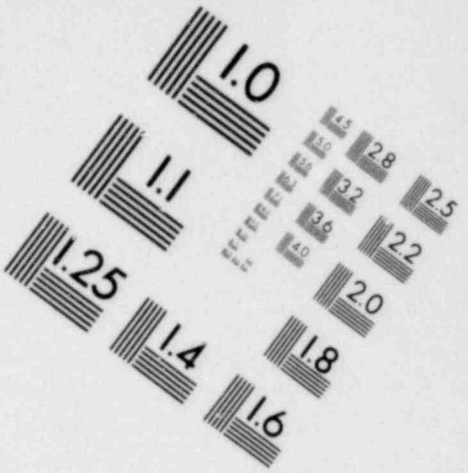
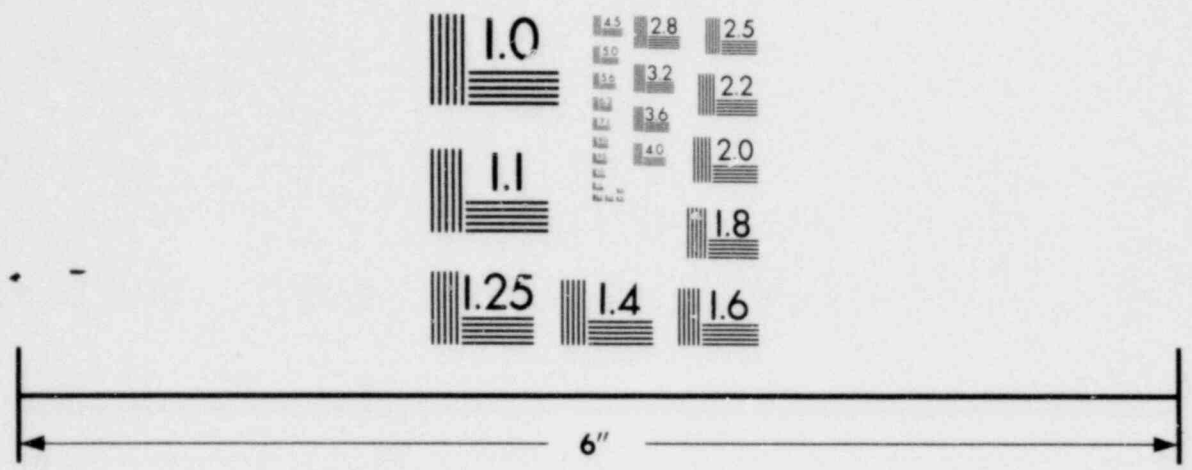
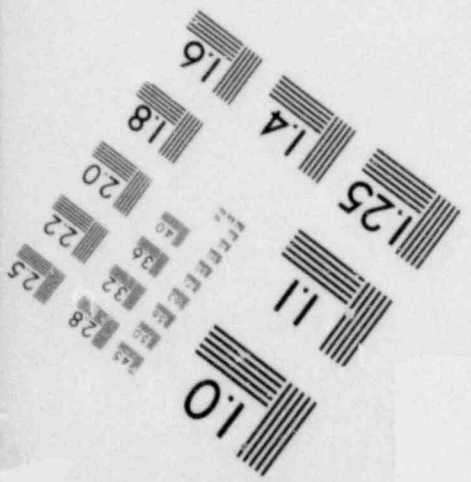


IMAGE EVALUATION TEST TARGET (MT-3)





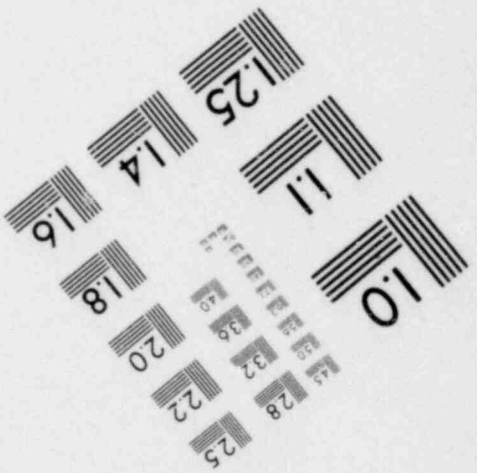


TABLE II

SUMMARY OF TEST RESULTS

Cycle	Time (hrs)	Nominal Temp. (F)	Nominal Humidity(%RH)	Nominal Line Voltage	Nominal Line Frequency
[					] b,c

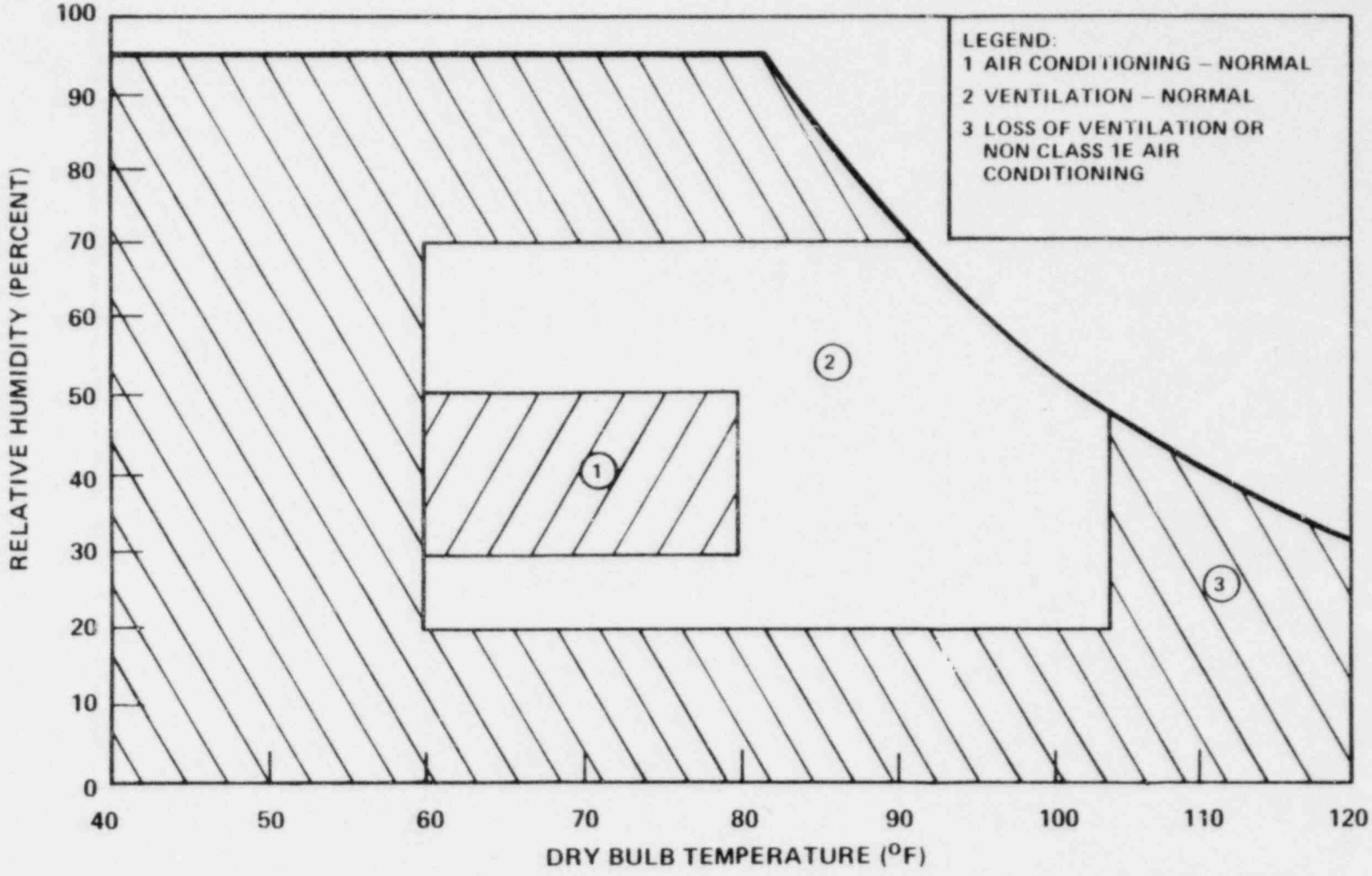


Figure 1 Temperature Versus Humidity - Enclosed Environments Outside Containment

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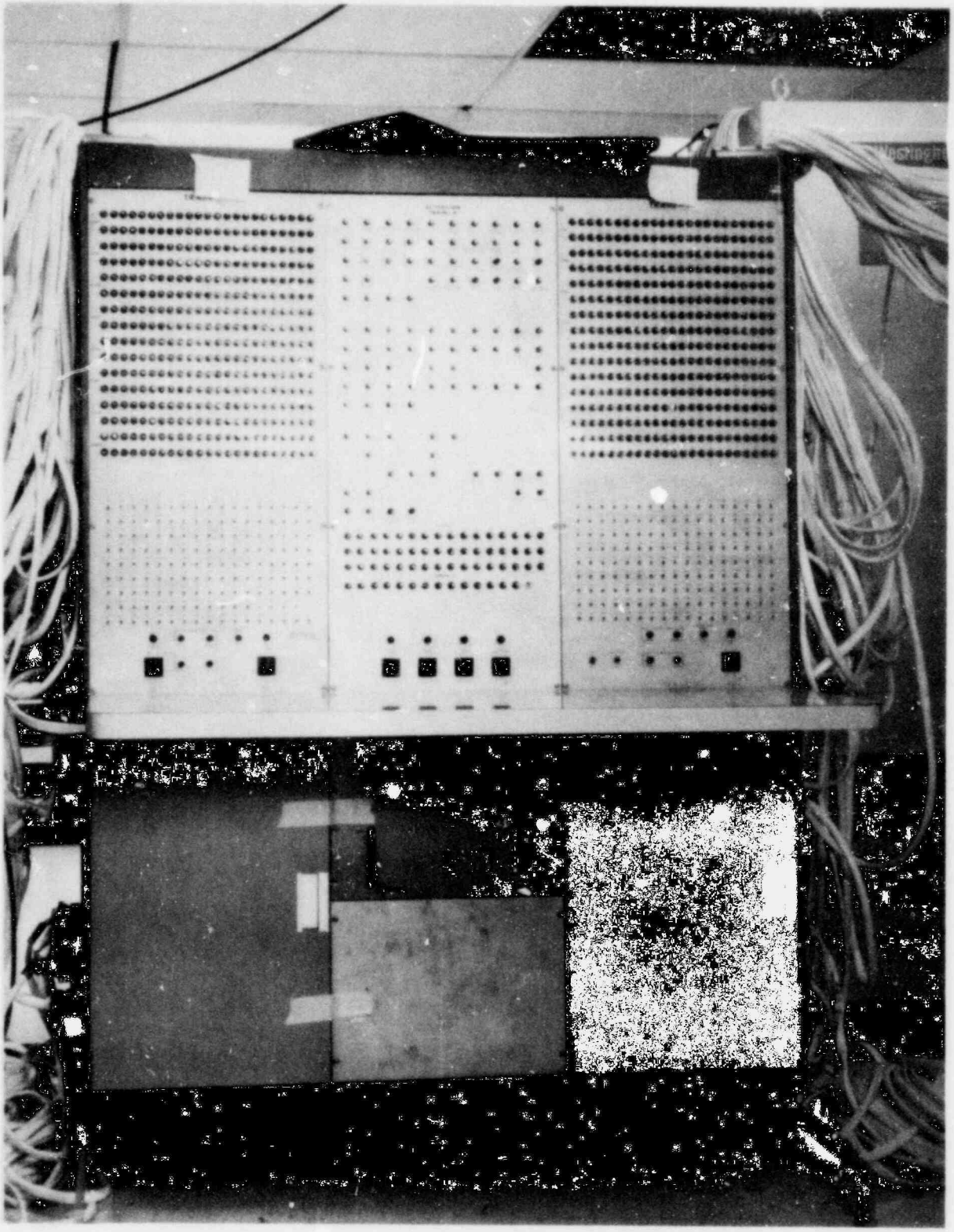

Figure 2 SSPS Test Tool

POOR ORIGINAL

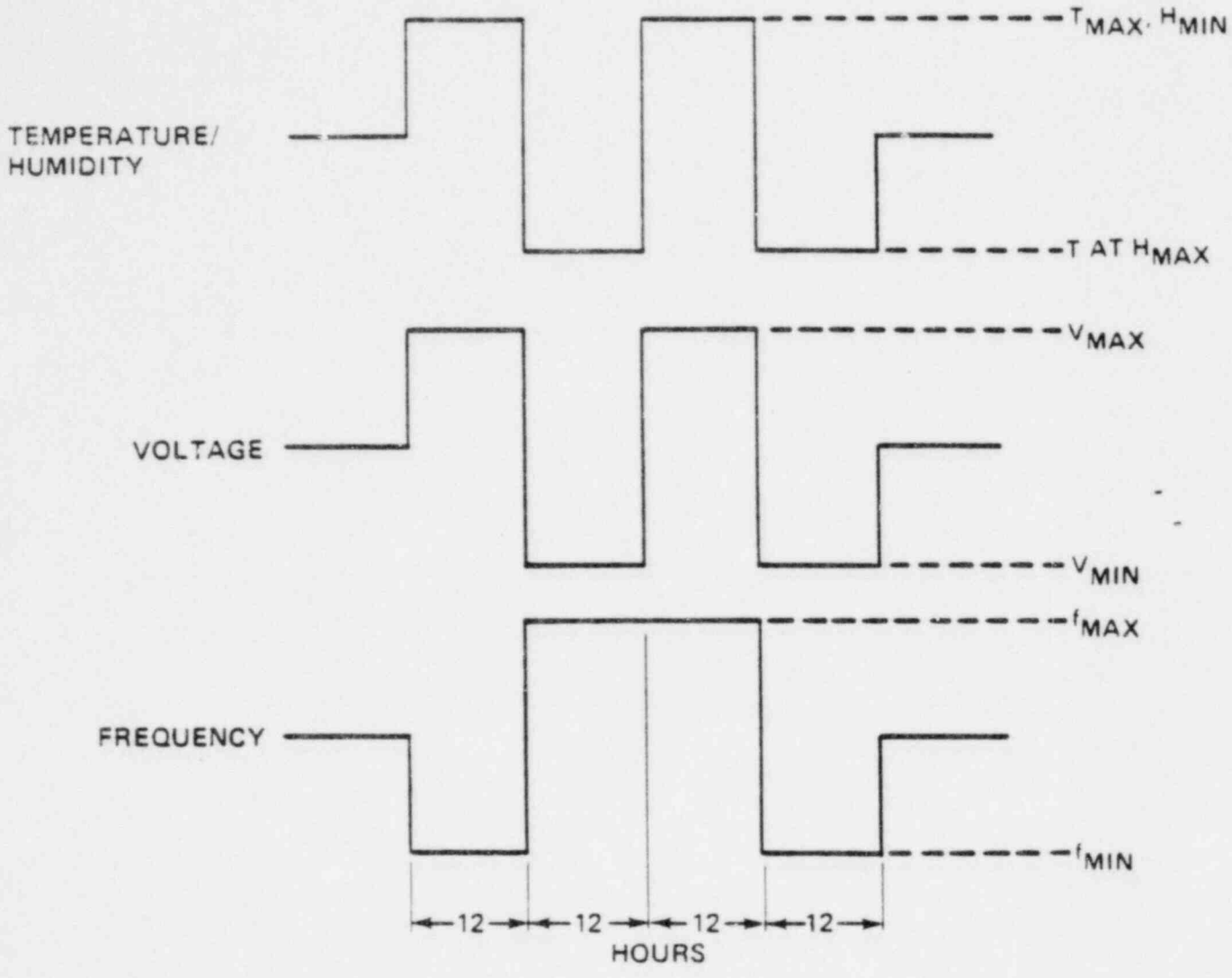

Figure 3 Verification Test Profile

b,c

Figure 4 Environmental Conditions–Cycle 1

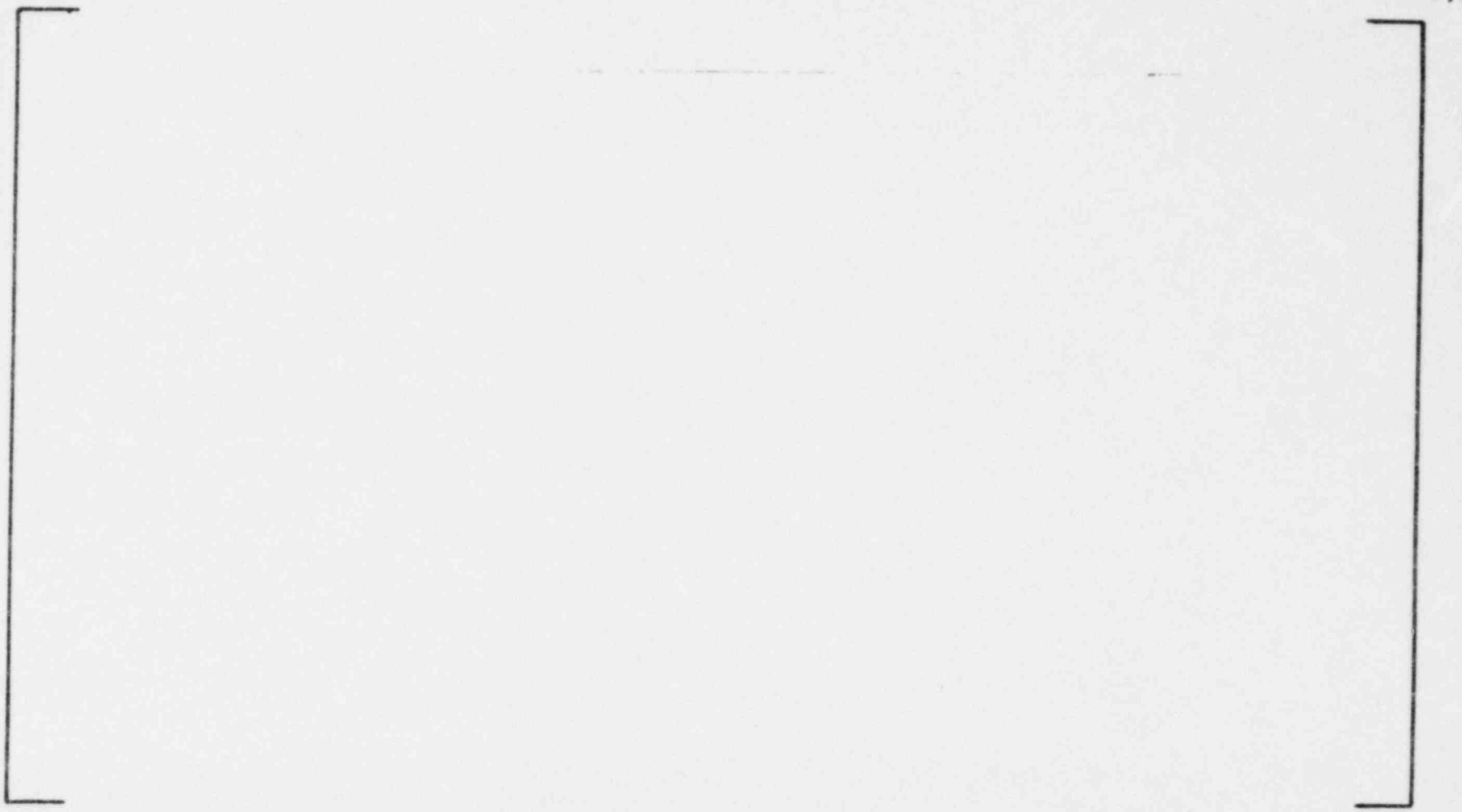

Figure 5 Environmental Conditions–Cycle 2

b,c

Figure 6 Typical SSPS Test Sequence