EAC Decision on Request for Interpretation 2008-01,
2002 VSS Vol. II, Section 4.7.1 & Appendix C
2005 VVSG Vol. II, Section 4.7.1 & Appendix C

Date:

February 6, 2008

Question(s):

1. How many devices can be utilized to meet these requirements of this test?
2. How many ballots are required to be cast per hour?
3. Should the audio interface be tested also during this timeframe if the system is capable?

Section of Standards or Guidelines:

2002 VVSS Volume II, Section 4.7.1, Appendix C, Section C.4, and 2005 VVSG Volume II, Version 1.0, Section 4.7.1, Appendix C, Section C.4

Background:

These sections of the Standards and Guidelines deal generally with temperature and power variation tests.

The test in Section 4.7.1 is similar to the low temperature and high temperature tests of MIL-STD-810D, Method 502.2 and Method 501.2, with test conditions that correspond to the requirements of the performance standards. This procedure tests system operation under various environmental conditions for at least 163 hours. During 48 hours of this operating time, the device shall be in a test chamber. For the remaining hours, the equipment shall be operated at room temperature. The system shall be powered for the entire period of this test; the power may be disconnected only if necessary for removal of the system from the test chamber.
Operation shall consist of ballot-counting cycles, which vary with system type. An output report need not be generated after each counting cycle; the interval between reports, however, should be no more than 4 hours to keep to a practical minimum the

time between the occurrence of a failure or data error and its detection.

Test Ballots per Counting Cycle:
Precinct count systems 100 ballots/hour
Central count systems 300 ballots/hour

The recommended pattern of votes is one chosen to facilitate visual recognition of the reported totals; this pattern shall exercise all possible voting locations. System features such as data quality tests, error logging, and audit reports shall be enabled during the test. (*Specific language contained in the Standard.)*

(Appendix C, Section C.4)
System acceptance or rejection can be determined by observing the number of relevant failures that occur during equipment operation. The probability ratio for this test is derived from the Exponential probability distribution. This distribution implies a constant hazard rate. Therefore, two or more systems may be tested simultaneously to accumulate the required number of test hours, and the validity of the data is not affected by the number of operating hours on a particular unit of equipment. However, for environmental operating hardware tests, no unit shall be subjected to less than two complete 24 hour test cycles in a test chamber as required by Volume II, Subsection 4.7.2. of the Standards

Conclusion:

Question 1. "How many devices can be utilized to meet these requirements of this test?"

Discussion and Interpretation

Volume II Appendix C is a general discussion of the application of statistical principles to testing under the VSS and VVSG. The proper application of statistical methods must be solidly defensible and based upon the science governing each test.

In the specific paragraph cited it is very helpful to compare the VVS 2002 and the VVSG 2005 for a critical sentence:

VSS 2002 Volume II Appendix C.4

> *This distribution implies a constant hazard rate.*

VVSG 2005 Volume II Appendix C.4

> *This distribution implies a constant hazard rate for equipment failure that is not dependent on the time of testing or the previous failures.*

In this case the expanded wording in the VVSG 2005 is intended to give additional insight into what is meant by a 'constant hazard rate.'

The question to be answered is whether the test in 2002 VSS Volume II, Section 4.7.1 is looking to reveal constant hazard failures or alternately failures that are time dependent? Mil Std.810D Method 501.2 Section I states:

I-1 PURPOSE. High-temperature chamber tests are performed to determine if material can be stored and operated under hot climatic conditions without experiencing physical damage or deterioration in performance.

I-2 ENVIRONMENTAL EFFECTS. High temperatures may temporarily or permanently impair the performance of the test item by changing the physical properties or dimensions of the material(s) composing it. Examples of some other problems that can occur as the result of high-temperature exposure are:

a. Parts binding from differential expansion of dissimilar materials.

b. Lubricants becoming less viscous; joints losing lubrication by outward flow of lubricants.

c. Materials changing in dimension, either totally or selectively.

d. Packing, gaskets, seals, bearings and shafts becoming distorted, binding, and failing causing mechanical or integrity failures.

e. Gaskets displaying permanent set.

f. Closure and sealing strips deteriorating.

g. Fixed-resistance resistors changing values.

h. Electronic circuit stability varying with differences in temperature gradients and differential expansion of dissimilar materials.

i. Transformers and eletromechanical components overheating.

j. Altering of operating/release margins of relays and magnetic or thermally activated devices.

k. Shortened operating lifetime.

l. Solid pellets or gains separating.

m. High internal pressures created within sealed cases of projectiles, bombs, etc.

n. Burning of explosives or propellants accelerated.

o. Cast explosives expanded within their cases.

p. Explosives melting and exuding.

q. Organic materials tending to discolor, crack, or craze.

Clearly the temperature and power variation test of 4.7.1 is intended to reveal multiple types of failures, some of which are time dependent, such as aging effects. Time dependent failure mechanisms such as aging effects may not be revealed by multiple units being tested for a shorter duration. The extended duration going beyond 48 hours, indicated by the provision that the units under test are to remain powered up except for the option of removing from the test chamber, provides greater confidence that such effects may be detected. This is especially true where there may be a delay or aging from the conditions causing a change leading to a failure and the actual failure.

The Reliability test (Section 4.7.2) and the Accuracy (Section 4.7.1.1) criteria are constant hazard or time independent test criteria (The Accuracy criteria for failures are event based but the same logic applies). These are tests where the test criteria are valid for any number of devices provided the test represents a full operational cycle of all operating modes over the specified total hours. The simultaneous test design supports the concept, however, that the longer durations can also provide a benefit in detecting time dependent failures as well as the constant hazard failures where prior functional, operational, and modular software tests are too short in duration to sufficiently detect such issues.

Therefore, the following criteria are to be used:
For *N* test units:

N = 1, duration = 163 hours (minimum total hours for the statistical model)
N = 2, duration = 85 hours for each unit under test
N = 3, duration = 64 hours (48 hrs + 16 hrs) for each unit under test
N over 3, *duration* = 64 hours (48 hrs + 16 hrs) for each unit under test

where the 48 hours applies to both non-COTS systems requiring the operational environmental test and COTS systems excused from the environmental testing. This minimum is subject to change pending further engineering reviews of these tests and actual test experience.

Question 2. “How many ballots are required to be cast per hour?”

Discussion and Interpretation

When the voting unit under test is capable of meeting the minimum counting rate the minimum ballot counting rate shall be:

<u>Test Ballots per Counting Cycle</u>

Precinct count systems 100 ballots/hour

Central count systems 300 ballots/hour

For system that are not capable of meeting these rates the system shall be tested casting ballots on a continuous basis at a rate determined by the ability of the system being tested. The rate to be used shall be determined and included in the test plan for the system.

Question 3. "Should the audio interface be tested also during this timeframe if the system is capable?"

Discussion and Interpretation

An engineering analysis of potential failure modes is necessary to determine how an audio interface should be tested. If the possibility of a specific failure mechanism affecting audio interface is not identified then it is sufficient to test the audio interface periodically during the test. The audio interface should be checked at each extreme of a stress being applied in addition to period checks during the course of the test. Results of the engineering analysis as well as the test results shall be included in the final voting system test report.

If the engineering analysis identifies a specific failure mechanism that could affect the audio interface then checks shall be performed in a way that has the highest probability of identifying the failure, should it exist.