



EAC Decision on Request for Interpretation 2009-06 (Temperature and Power Variation Tests)

2002 VSS Volume I, Section 3.4.3

2002 VSS Volume II, Section 4.7.1, 4.7.2, Appendix Sec. C.4

2005 VVSG Volume I, Section 4.3.3

2005 VVSG Volume II, Section 4.7.1, 4.7.3, Appendix Sec. C.4

EAC Decision on Request for Interpretation 2008-1

Date:

April 16, 2010

Questions:

1. The EAC decision in RFI 2008-1 states that the test length per unit could be as short as 64 hours (of which 48 must be in an environmental chamber). Are the systems to remain voting in the test ballot counting cycle of Section 4.7.1 for the entire period?
2. If these 2 tests are combined as stated in EAC RFI 2008-1 and Appendix C, how can the test method incorporate the statement:

For example, a typical system operations scenario for environmental operating hardware tests will consist of approximately 45 hours of equipment operation. Broken down, this time allotment involves 30 hours of equipment setup and readiness testing and 15 hours of elections operations.

3. EAC excerpt from Interpretation: 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.
4. What exact operations can be completed in a counting cycle as stated in the manual or an operational cycle as stated in the EAC interpretation? Are cycles different between Temperature Power and Reliability?

Section of Standards or Guidelines:

2002 VSS Vol. I, Section 3.4.3 & Vol. 2, 4.7.1, Appendix C, Sec. C.4

2005 VVSG Vol. I, Section 4.3.3 & Vol. 2, 4.7.1

VSS/VVSG Volume I

VSS 3.4.3 / VVSG 4.3.3 Reliability

The reliability of voting system devices shall be measured as Mean Time Between Failure (MTBF) for the system submitted for testing. MBTF is defined as the value of the ratio of operating time to the number of failures which have occurred in the specified time interval. A typical system operations scenario consists of approximately 45 hours of equipment operation, consisting of 30 hours of equipment set-up and readiness testing and 15 hours of elections operations. For the purpose of demonstrating compliance with this requirement, a failure is defined as any event which results in either the:

- Loss of one or more functions
- Degradation of performance such that the device is unable to perform its intended function for longer than 10 seconds

The MTBF demonstrated during certification testing shall be at least 163 hours.

VSS/VVSG Volume II

VSS / VVSG 4.7.1 Temperature and Power Variation Tests

This test is similar to the low temperature and high temperature tests of MIL-STD-810-D, 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.

Each operating cycle shall consist of processing the number of ballots indicated above.

Step 1: Arrange the equipment in the test chamber. Connect as required and provide for power, control, and data service through enclosure wall.

Step 2: Set the supply voltage at 117 voltage alternating current.

Step 3: Power the equipment, and perform an operational status check as in Section 4.6.1.5.

Step 4: Set the chamber temperature to 50 degrees F, observing precautions against thermal shock and condensation.

Step 5: Begin 24 hour cycle.

Step 6: At T=4 hrs, lower the supply voltage to 105 vac.

Step 7: At T=8 hrs, raise the supply voltage to 129 vac.

Step 8: At T=11:30 hrs, return the supply voltage to 117 vac and return the chamber temperature to lab ambient, observing precautions against thermal shock and condensation.

Step 9: At T=12:00 hrs, raise the chamber temperature to 95 degrees Fahrenheit.

Step 10: Repeat Steps 5 through 8, with temperature at 95 degrees Fahrenheit, complete at T=24 hrs.

Step 11: Set the chamber temperature at 50 degrees Fahrenheit as in Step 4.

Step 12: Repeat the 24 hour cycle as in Steps 5-10, complete at T=48 hrs.

Step 13: After completing the second 24 hour cycle, disconnect power from the system and remove it from the chamber if needed.

Step 14: Reconnect the system as in Step 2, and continue testing for the remaining period of operating time required until the ACCEPT/REJECT criteria of Subsection 4.7.1.1 have been met.

VSS/VVSG Volume II

VSS 4.7.3 Reliability Test

The ITA shall test for reliability based on the provisions of Volume I, Section 3 for the acceptable mean time between failure (MBTF). The MBTF shall be measured during the conduct of other system performance tests specified in this section, and shall be at least 163 hours. Volume II, Appendix C, Section C.4 provides further details of the calculation for this testing period.

VVSG 4.7.3 Reliability Test

The accredited test lab shall test for reliability based on the provisions of Volume I, Section 4 for the acceptable Mean Time Between Failure (MTBF). The MTBF shall be measured during the conduct of other system performance tests specified in this section, and shall be at least 163 hours. Appendix C provides further details of the calculation for this testing period.

VSS/VVSG Volume II

VSS / VVSG Appendix C.4 Time-based Failure Testing Criteria

The equivalence between a number of events and a time period can be established when the operating scenarios of a system can be determined with precision. Some of the performance test criteria of Volume II, Section 4, use this equivalence.

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 for equipment failure that is not dependent on the time of testing or the previous failures. In that case, 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 4.7.1.

In this case, the null hypothesis is that the Mean Time Between Failure (MTBF), as defined in Volume I, Subsection 4.3.3 is at least as great as some value, here the Nominal Specification Value. The alternate hypothesis is that the MTBF is no better than some value, here the Minimum Acceptable Value.

For example, a typical system operations scenario for environmental operating hardware tests will consist of approximately 45 hours of equipment operation. Broken down, this time allotment involves 30 hours of equipment setup and readiness testing and 15 hours of elections operations. If the Minimum Acceptable Value is defined as 45 hours, and a test discrimination ratio of 3 is used (in order to produce an acceptably short expected time of decision), then the Nominal Specification Value equals 135 hours.

With a value of decision risk equal to 10 percent, there is no more than a 10 percent chance that a system would be rejected when, in fact, with a true MTBF of at least 135 hours, the system would be acceptable. It also means that there is no more than a 10 percent chance that a system would be accepted with a true MTBF lower than 45 hours when it should have been rejected.

Therefore,

H0: MTBF = 135 hours

H1: MTBF = 45 hours

$\alpha = 0.10$

b = 0.10.

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Discussion:

The intention of this RFI is to facilitate testing efficiencies while assuring these specifications are fully meet. To clarify the questions addressed in this RFI the following discussion and conclusions are offered:

1. **Question:**

The EAC decision in RFI 2008-1 states that the test length per unit could be as short as 64 hours (of which 48 must be in an environmental chamber). Are the systems to remain voting in the test ballot counting cycle of Section 4.7.1 for the entire period?

Discussion:

The intention of the requirement is stated to be:

“This procedure tests system operation under various environmental conditions for at least 163 hours.”

Therefore the system must be in the test ballot counting cycle for the entire period of the test. The following discussion is offered to provide further detail but does not modify this conclusion.

VSS/VVSG V1:4.7.1, Temperature and Power Variation Tests, states:

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

*Test Ballots per Counting Cycle
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.

This rate shall be maintained throughout the duration of test 163 hours or subset thereof. If multiple modes of operation are to be tested during this phase additional systems can be utilized for this purpose. (The 163 hour test must be completed on all equipment, including COTS equipment, but the chamber portion is waived for the additional systems. However, the mode most vulnerable to failure shall be subjected to the chamber portion. The test plan shall provide an analysis explaining the rationale used in selecting the mode to be used during the chamber portion of the test).

2. **Question:**

If these 2 tests are combined as stated in EAC RFI 2008-1 and Appendix C, how can the test method incorporate the statement:

For example, a typical system operations scenario for environmental operating hardware tests will consist of approximately 45 hours of equipment operation. Broken down, this time allotment involves 30 hours of equipment setup and readiness testing and 15 hours of elections operations.

Discussion:

The section quotes is part of VSS 3.4.3 / VVSG 4.3.3, Reliability, given as an example of how time is distributed in a typical operation, however the requirement, given subsequently is to demonstrate an MTBF of at least 163 hours. In Annex C additional discussion is given of how to calculate the time required in order to demonstrate a specific MTBF. It should be noted that test efficiencies are only possible when a solid understanding is available to verify that the failure mechanisms are "...a constant hazard rate for equipment failure that is not dependent on the time of testing or the previous failures". Neither of these discussions modifies the requirement of VSS / VVSG 4.7.1:

"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."

3. **Question:**

EAC excerpt from Interpretation: 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.

Discussion:

In the Test Plan the VSTL is to provide an analysis that supports its test strategy for the specific voting system under test. This analysis must demonstrate that it has an understanding of the potential failure modes and their dependencies, e.g. time dependent, event dependent. Where the failure modes or their dependencies are not fully known the test must be designed to reveal both time and event dependent failures.

4. **Question:**

What exact operations can be completed in a counting cycle as stated in the manual or an operational cycle as stated in the EAC interpretation? Are cycles different between Temperature Power and Reliability?

Discussion:

A ballot counting cycle is the period between the input of the voter's selections, through the processing of the ballot, to the final storage of the cast vote record or vote tabulation. The exact beginning and end point will vary by system type but is to reproduce system use during an election. The Temperature and Power Variation Tests specifically calls for ballot counting cycles to be used. The Reliability test allows for VSTL's to design focused tests for particular failure modes. When the tests are combined the ballot counting cycle must be used. If the tests are run separately and the failure modes are well known, more focused operations can be utilized, so long as they can be defended as fully testing for the specified MTBF of the device.

Conclusion:

1. **Question:**

The EAC decision in RFI 2008-1 states that the test length per unit could be as short as 64 hours (of which 48 must be in an environmental chamber). Are the systems to remain voting in the test ballot counting cycle of Section 4.7.1 for the entire period?

Response:

Yes, the system must be in the test ballot counting cycle for the entire period of the test.

2. **Question:**

If these 2 tests are combined as stated in EAC RFI 2008-1 and Appendix C, how can the test method incorporate the statement:

For example, a typical system operations scenario for environmental operating hardware tests will consist of approximately 45 hours of equipment operation. Broken down, this time allotment involves 30 hours of equipment setup and readiness testing and 15 hours of elections operations.

Response:

The section quotes is an example given in a discussion of the reliability test and does not modify the requirement of VSS / VVSG 4.7.1:

“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.”

3. **Question:**

EAC excerpt from Interpretation: 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

Response:

In the Test Plan the VSTL must demonstrate that it has an understanding of the potential failure modes and their dependencies, e.g. time dependent, event dependent. This analysis is used to support the design of test for a specific system. Where the nature of the failure modes is not fully understood, worst case assumptions must be used. The test must be designed to reveal both time and event dependent failures.

4. **Question:**

What exact operations can be completed in a counting cycle as stated in the manual or an operational cycle as stated in the EAC interpretation? Are cycles different between Temperature Power and Reliability?

Response:

The Temperature and Power Variation Tests specifically calls for ballot counting cycles to be used. The Reliability test allows for VSTL's to design focused tests for particular failure modes. When the tests are combined the ballot counting cycle must be used. If the tests are run separately and the failure modes are well known, more focused operations can be utilized, so long as they can be defended and fully testing for the specified MTBF of the device.

Effective Date:

For all systems without an approved test plan.