Environmental Hardware Test Plan

EAC VVSG 1.0

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Prepared for:

Vendor Name	*Hart InterCivic*
Vendor System	*Verity 2.3*
EAC Application No.	*HRT-Verity-2.3*
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Accredited by the Election Assistance Commission (EAC) for Selected Voting System Test Methods or Services

Revision History

Date	Release	Author	Revision Summary
October 27, 2018	1.0	*Darrick Forester*	Initial Release
January 29, 2019	2.0	*Darrick Forester*	Update Sections 2.7, and 3.4.3.1

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1 INTRODUCTION

This test plan covers the environmental test requirements and methods for the Hart InterCivic 2.3 voting system, Verity Scan, Controller / Touch Writer Duo, hereafter known as the Unit Under Test (UUT), to the requirements as stated in Election Assistance Commission 2005 Voluntary Voting System Guidelines Version 1.0.

1.1 Qualifications

The UUT supplied by Hart InterCivic is representative of product produced in their volume manufacturing process.

1.2 Hardware Test Lab Facility

NTS Environmental/Dynamic
1601 Dry Creek Drive, Suite 2000
Longmont, Colorado 80503

1.3 Reference Documents

- Election Assistance Commission: 2005 Voluntary Voting System Guidelines (EAC VVSG), 2005, Version 1.0, Volumes I and II.
- EAC Voting System Testing and Certification Program Manual, United States Election Assistance, v 2.0, May 2015.
- NIST Handbook 150-2016.
- NIST Handbook 150-22-2017.
- EAC Notice of Clarification 07-05: Voting System Test Laboratory (VSTL) responsibilities in the management and oversight of third party testing.
- EAC Decision on Request for Interpretation 2007-05 (COTS).
- EAC Decision on Request for Interpretation 2008-01 FINAL (temp and power variation tests).
- EAC Decision on Request for Interpretation 2009-06 (Temperature Power Variation) FINAL.041610.
- SLI VSTL Quality System Manual, v 2.6, prepared by SLI, March 28, 2018.

2 Product Description

2.1 Unit Under Test

Product / Model	Serial Number	Description	Qty
Verity Scan 3005800 Two devices used for Temp / Power Testing	S1801828010 S1801828210	**Verity Scan** - Precinct ballot scanner device.	2
Verity Controller (3005825), Touch Writer Duo daisy chain configuration. (3005700) 1x Controller 2x Touch Writer Duo *** 2 Daisy Chain configurations used for Temp / Power Testing**	Daisy Chain 1: C1801827710 B1801825210 B1801825110 Daisy Chain 2: C1801827310 B1801826910 B1801825610	**Verity Controller** - is a poll worker device use for management of voting devices. **Verity Touch Writer Duo** - is a voting device that prints to ab 8.5”x11” or 8.5”x14” thermal paper ballot. They are networked together via a daisy-chain network cable (100Mbit Ethernet over a proprietary cable). An optional accessibility controller (ATI) may be equipped.	2 sets

2.2 Product Information

Product / Model	Dimensions	Weight
Verity Scan	Storage Dimensions (approx.) 19” wide x 18” deep x 8” high	28lbs
Verity Controller Touch Writer Duo	Storage Dimensions (approx.) 19” wide x 18” deep x 8” high	28lbs

2.3 AC Power Adapter

Manufacturer	Model	Input Voltage Rating	Input Current
SL Power Electronics	TE60B2449F02	100-240VAC, 50-60Hz, 1.5A	100-240VAC, 50-60Hz, 1.5A

2.4 Support Equipment (SE)

Product / Model	Serial Number	Description	Qty
Ballot Box	N/A	For Scan	2

Accessible Booth with ATI Tray	N/A	For Touch Writer Duo	2
Standard Booth	N/A	For Touch Writer Duo	2

2.5 Accessories

Type	Model	Function
Test Ballots	N/A	View Ballots
Verity Key - Security Key	N/A	User authentication and configuration of election security.
Verity vDrive	N/A	Load election definitions, record CVRs and audit logs.
COTS Jelly Switches	N/A	Enable voters with limited body mobility to vote independently and privately.
COTS headphones	Hart 2005230	For visually impaired voters and voters having trouble reading the ballot.
Hart Verity ATI Module	2005018	Audio-Tactile Interface (ATI) intended for voters that cannot, or prefer not to, use the touch screen.

2.6 Software / Firmware

Type	Version	Description
Test Software	2.3.0 / 2.3.1	Election software for operational status check.
Firmware	V17	Verity Device Microcontroller.
Firmware	V1	Verity Touch Writer Duo Microcontroller

2.7 Engineering Changes

Hardware changes include the following:

- New tablet board due to the end-of-life of the current Intel chip. Same plastics, same look. Selectively phased-in to the following only:
    A. Verity Scan
    B. Verity Controller
    C. Verity Touch Writer Duo (will only be tested with the new board)
- Verity Scan: new tablet motherboard and scanner head due to obsolescence and cost. Same manufacturer. Going from PageScanIV to PageScanV.

3 Environmental Test Requirements

3.1 Test Procedures

3.1.1 Operating Environmental

Equipment used for election management activities or vote counting (including both precinct and central count systems) shall be capable of operation in temperatures ranging from 50 to 95 degrees Fahrenheit.

3.1.2 Environmental Control – Transit and Storage

Equipment used for vote casting or for counting votes in a precinct count system, **shall** meet these specific minimum performance standards that simulate exposure to physical shock and vibration associated with handling and transportation by surface and air common carriers, and to temperature conditions associated with delivery and storage in an uncontrolled warehouse environment:

- High and low storage temperatures ranging from -4 to +140 degrees Fahrenheit, equivalent to MIL-STD-810D, Methods 501.2 and 502.2, Procedure I-Storage;
- Bench handling equivalent to the procedure of MIL-STD-810D, Method 516.3, Procedure VI;
- Vibration equivalent to the procedure of MIL-STD-810D, Method 514.3, Category 1- Basic Transportation, Common Carrier; and
- Uncontrolled humidity equivalent to the procedure of MIL-STD-810D, Method 507.2, Procedure I-Natural Hot-Humid.

3.2 Design, Construction and Maintenance

This covers voting system materials, construction workmanship, and specific design characteristics important to the successful operation and efficient maintenance of the voting system.

3.2.1 Physical Attributes

The following physical attributes will be examined to assess reliability:

a. Presence of labels and the identification of test points
b. Provision of built-in test and diagnostic circuitry or physical indicators of condition
c. Presence of labels and alarms related to failures
d. Presence of features that allow non-technicians to perform routine maintenance tasks (such as update of the system database)

3.2.2 Additional Attributes

The following additional attributes will be considered to assess system maintainability:

a. Ease of detecting that equipment has failed by a non-technician
b. Ease of diagnosing problems by a trained technician
c. Low false alarm rates (i.e., indications of problems that do not exist)
d. Ease of access to components for replacement
e. Ease with which adjustment and alignment can be performed
f. Ease with which database updates can be performed by a non-technician
g. Adjust, align, tune or service components

3.3 Non-Operating Environmental Test

3.3.1 Operational Status Check

When all tests, inspections, repairs, and adjustments have been completed, normal operation **shall** be verified by conducting an operational status check.

During this process, all equipment shall be operated in a manner and under environmental conditions that simulate election use to verify the functional status of the system. Prior to the conduct of each of the environmental hardware non-operating tests, a supplemental test shall be made to determine that the operational state of the equipment is within acceptable performance limits.

The following procedures **shall** be followed to verify the equipment status:

Step 1: Arrange the system for normal operation.

Step 2: Turn on power, and allow the system to reach recommended operating temperature.

Step 3: Perform any servicing, and make any adjustments necessary, to achieve operational status.

Step 4: Operate the equipment in all modes, demonstrating all functions and features that would be used during election operations.

Step 5: Verify that all system functions have been correctly executed.

3.3.1.1 Failure Criteria

Upon completion of each non-operating test, the system hardware shall be subject to functional testing to verify continued operability. If any portion of the voting machine or precinct counter hardware fails to remain fully functional, the testing will be suspended until the failure is identified and corrected by the manufacturer. The system will then be subject to a retest.

3.3.2 Bench Handling Test

The bench handling test simulates stresses faced during maintenance and repair of voting machines and ballot counters. All systems and components, regardless of type, **shall** meet the requirements of this test. This test is equivalent to the procedure of MIL-STD-810D, Method 516.3, and Procedure VI.

3.3.2.1 Procedure

Step 1: Place each piece of equipment on a level floor or table, as for normal operation or servicing.

Step 2: Make provision, if necessary, to restrain lateral movement of the equipment or its supports at one edge of the device. Vertical rotation about that edge shall not be restrained.

Step 3: Using that edge as a pivot, raise the opposite edge to an angle of 45 degrees, to a height of four inches above the surface, or until the point of balance has been reached, whichever occurs first.

Step 4: Release the elevated edge so that it may drop to the test surface without restraint.

Step 5: Repeat steps 3 and 4 for a total of six events.

Step 6: Repeat steps 2, 3, and 4 for the other base edges, for a total of 24 drops for each device.

Step 7: Perform an **Operational Status Check** verifying continued operability of the UUT.

3.3.3 Vibration Test

The vibration test simulates stresses faced during transport of voting machines and ballot counters between storage locations and polling places. All systems and components, regardless of type, **shall** meet the requirements of this test. This test is equivalent to the procedure of MIL-STD-810D, Method 514.3, Category 1- Basic Transportation, and Common Carrier.

3.3.3.1 Procedure

Step 1: Install the test item in its transit or combination case as prepared for transport.

Step 2: Attach instrumentation as required to measure the applied excitation.

Step 3: Mount the equipment on a vibration table with the axis of excitation along the vertical axis of the equipment.

Step 4: Apply excitation as shown in MIL-STD-810D, Method 514.3-1, “Basic transportation, common carrier, vertical axis”, with low frequency excitation cutoff at 10 Hz, for a period of 30 minutes.

Step 5: Repeat steps 2 and 3 for the transverse and longitudinal axes of the equipment with the excitation profiles shown in Figures 514.3-2 and 514.3-3,

respectively. (Note: The total excitation period equals 90 minutes, with 30 minutes excitation along each axis.)

Step 6: Remove the test item from its transit or combination case and perform an **Operational Status Check** verifying continued operability of the UUT.

3.3.4 Low Temperature Test

The low temperature test simulates stresses faced during storage of voting machines and ballot counters. All systems and components, regardless of type, **shall** meet the requirements of this test. This test is equivalent to the procedure of MIL-STD-810D, Method 502.2, and Procedure I-Storage. The minimum temperature shall be -4 degrees F.

3.3.4.1 Procedure

Step 1: Arrange the equipment as for storage. Install it in the test chamber.

Step 2: Lower the internal temperature of the chamber at any convenient rate, but not so rapidly as to cause condensation in the chamber, and in any case no more rapidly than 10 degrees F per minute, until an internal temperature of -4 degrees F has been reached.

Step 3: Allow the chamber temperature to stabilize. Maintain this temperature for a period of 4 hours after stabilization.

Step 4: Allow the internal temperature of the chamber to return to standard laboratory conditions, at a rate not exceeding 10 degrees F per minute.

Step 5: Allow the internal temperature of the equipment to stabilize at laboratory conditions before removing it from the chamber.

Step 6: Remove the equipment from the chamber and from its containers, and inspect the equipment for evidence of damage.

Step 7: Perform an **Operational Status Check** verifying continued operability of the UUT.

3.3.5 High Temperature Test

The high temperature test simulates stresses faced during storage of voting machines and ballot counters. All systems and components, regardless of type, **shall** meet the requirements of this test. This test is equivalent to the procedure of MIL-STD-810D, Method 501.2, and Procedure I-Storage. The maximum temperature shall be 140 degrees F.

3.3.5.1 Procedure

Step 1: Arrange the equipment as for storage. Install it in the test chamber.

Step 2: Raise the internal temperature of the chamber at any convenient rate, but in any case, no more rapidly than 10 degrees F per minute, until an internal temperature of 140 degrees F has been reached.

Step 3: Allow the chamber temperature to stabilize. Maintain this temperature for a period of 4 hours after stabilization.

Step 4: Allow the internal temperature of the chamber to return to standard laboratory conditions, at a rate not exceeding 10 degrees F per minute.

Step 5: Allow the internal temperature of the equipment to stabilize at laboratory conditions before removing it from the chamber.

Step 6: Remove the equipment from the chamber and from its containers, and inspect the equipment for evidence of damage.

Step 7: Perform an **Operational Status Check** verifying continued operability of the UUT.

3.3.6 Humidity Test

The humidity test simulates stresses faced during storage of voting machines and ballot counters. All systems and components regardless of type **shall** meet the requirements of this test. This test is similar to the procedure of MIL-STD-810D, Method 507.2, Procedure I-Natural Hot-Humid. It is intended to evaluate the ability of the equipment to survive exposure to an uncontrolled temperature and humidity environment during storage. This test lasts for ten days.

3.3.6.1 Procedure

Step 1: Arrange the equipment as for storage. Install it in the test chamber.

Step 2: Adjust the chamber conditions to those given in MIL-STD-810D Table 507.2-I, for the time 0000 of the Hot Humid cycle (Cycle 1).

Step 3: Perform a 24-hour cycle with the time and temperature-humidity values specified in Figure 507.2-1, Cycle 1.

Step 4: Repeat Step 2 until 5, 24-hour cycles have been completed.

Step 5: Continue with the test commencing with the conditions specified for time = 0000 hours.

Step 6: At any convenient time in the interval between time = 120 hours and time = 124 hours, place the equipment in an operational configuration, and perform a complete operational status check.

Step 7: If the equipment satisfactorily completes the status check, continue with the sixth 24-hour cycle.

Step 8: Perform 4 additional 24-hour cycles, terminating the test at time = 240 hours.

Step 9: Remove the equipment from the test chamber and inspect it for any evidence of damage.

Step 10: Perform an **Operational Status Check** verifying continued operability of the UUT.

3.4 Operating Environmental Tests

This section addresses a range of tests for all voting system equipment, including equipment for both precinct count systems.

3.4.1 Simulated Operation Diagnostic

A diagnostic test routine is performed to exercise and diagnose failures from internal subsystems in the UUT. The test performs various operations including writing and reading to storage devices and printing to internal printers. The diagnostic can be looped continuously and will halt if an error is detected while performing an operation.

For DRE equipment, each loop may be very short. For paper ballot scanning devices, a recirculation ballot operation is typically used where the ballot is read, reversed to the input position and then read again. The test will loop continuously until manually interrupted.

3.4.2 Integrity

The UUT is subject to integrity verification based on the provisions of Volume I, Section 2.1.4 (d) to ensure system integrity, all system shall protect against ambient temperature and humidity fluctuations. The ambient temperature fluctuations are verified during the temperature and power variation test. The MILSTD-810D, Method 507.2, Procedure I-Natural Hot-Humid is considered to be industry standard and is selected to verify humidity fluctuations.

3.4.3 Temperature and Power Variation

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 85 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.

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.

Note: Requires 24-hr continuous coverage / support from the hardware test lab for the duration of Temperature / Power Variation Test. Support from the hardware test lab includes monitoring and setting voltage meter when required based off test plan requirements.

3.4.3.1 Test Approach

2 – Verity Controller Touch Writer Duo daisy chain configuration = 85 hours for each unit under test. Per test ballots counting cycle requirement, test will be conducted as such:

- Each Verity Controller will issue 16 Access Codes every hour.
    - 8 voting and printing cycles will be performed on each Touch Writer Duo every hour, for a total of 16 voting and printing cycles on each daisy chain every hour.
        - 16 voted ballots will be scan by Verity Scan located outside of the chamber. Polls will close every 4 hours to get the tally reports.

2 – Verity Scan, duration = 85 hours for each unit under test. Per test ballots counting cycle requirement, test will be conducted as such:

- Each Verity Scan will scan 100 pre-marked ballots every hour.

The test will be conducted to run in 4 hour cycles, such that each cycle is concluded with the generation of a report that details the vote data cast during that period.

When required SLI personnel will audit ballots once per hour until testing is completed.

3.4.4 Reliability

The accredited test lab shall test for reliability based on the provisions of Volume I, Section 4 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. Appendix C of VVSG Vol. II provides further details of the calculation for this testing period.

The “cause for failure” is only limited by the functions being performed by the scanner while in use, as partially denoted by the criteria “Loss of one or more functions“, while this list attempts to cover all potential points of failure, if an issue occurs outside of this list will still be reviewed. For this test, the criteria will be defined as any function observed to have failed from its intended purpose, during the conduction of the test. E.g., for the scanner, scanning ballots (physically moving them in and out of the scanner), the screen remains on and active, counters are active, printer continues to function.

A failure is defined as any event which results in either:

1. Loss of one or more functions.
    a. Scanner not scanning ballots, ballot jam etc.
    b. Scanner sensors read inconsistently.
    c. USB ports not writing to the vDrive.
    d. Thermal printer not printing.
    e. Tablet display goes away.
    f. Tablet display does not function.
    g. USB printer not printing.
    h. USB printer not functioning.
    i. Static Audio not playing.
    j. Device does not power on or off properly.
    k. Loss of ADA functionality.
    l. Guide lights fail USB printer not printing.
    m. Loss of guide lights for feeding ballots.
    n. vDrive fails.
    o. Audit / Error logging is incorrect.
    p. Battery becomes damaged.
    q. Loss of ATI functionality.
    r. Loss of LED functionality.
    s. Operational Status check registers a failure.

t. Any other unexpected action that deviates from device documentation – Scan / Touch Writer / COTS Scanner / COTS Workstation.

2. Loss of functionality – COTS Workstation / COTS Scanner
3. Degradation of performance such that the device is unable to perform its intended function for longer than 10 seconds; will look for degradation of performance of the device, as opposed to actual functionality failure of the first failure criteria.
4. **Criteria C**: COTS and support equipment may have temporary loss of function or degradation of performance, the correction of which requires operator intervention or system reset.

4 Environmental Test Summary

The following Table shows the tests to be performed on the UUT.

Test	Test Specification	VVSG 1.0
Non-Operating Environmental Tests		
Bench Handling	MIL-STD-810D, Method 516.3, Procedure VI	**V1**: 4.1.7.1, **V2**: 4.6.2
Vibration	MIL-STD-810D, Method 514.3, Category 1-Basic Transportation, Common Carrier	**V1**: 4.1.7.1, **V2**: 4.6.3
Low Temperature	MIL-STD-810D, Method 502.2, Procedure I-Storage	**V1**: 4.1.7.1, **V2**: 4.6.4
High Temperature	MIL-STD-810D, Method 501.2, Procedure I-Storage	**V1**: 4.1.7.1, **V2**: 4.6.5
Humidity	MIL-STD-810D, Method 507.2, Procedure I-Natural Hot-Humid	**V1**: 4.1.7.1, **V2**: 4.6.6
Operating Environmental Tests		
Temp / Power Variation	This test is similar to the low temperature and high temperature tests of MIL-STD-810-D, Method 502.2 and Method 501.2. See RFI 2009-06; See note below.	**V1:** 4.1.7.1, **V2:** 4.7.1
Reliability Assessment	See V1 4.3.3 for additional information.	**V1:** 4.3.3, **V2:** 4.7.3
Integrity	Protect against ambient temperature and humidity fluctuations.	**V1:** 2.1.4 (d)

Note: V1 4.1.7.1 Removable Storage Media; In voting systems that use storage media that can be removed from the system and transported to another location for readout and report generation, these media **shall** use devices with demonstrated error-free retention for a period of 22 months under the environmental conditions for operation and non-

operation contained in Subsection 4.1.2. Examples of removable storage media include: programmable read-only memory (PROM), random access memory (RAM) with battery backup, magnetic media or optical media.

5 Handling Hardware Anomalies and Incidents

5.1 Hardware Test Anomalies

An anomaly with the subcontractor's test equipment or a procedural misstep can cause a test to fail. For any suspected test equipment issue or procedural error, analysis will be performed and the decision whether to continue testing based on the severity of the anomaly will be appropriately tracked. The subcontractor test lab will issue a corrective action to address any test equipment and/or procedure errors. This is part of the hardware test subcontractor's quality system process that allows the hardware test lab to train all personnel, repair/calibrate equipment, and prevent any recurrence.

5.2 Hardware Incident Process

For every test failure of any voting system component at the hardware test lab, the lab completes a data sheet (per their laboratory procedures and templates) and immediately informs the SLI Hardware Specialist or designated SLI personnel. This can be communicated in the daily status update, with the data sheet attached.

- Failure Analysis: Once a failure has occurred, the SLI Hardware Specialist or designated SLI personnel will be involved with the subcontractor test lab(s) to identify the hardware discrepancy in the device. The results of the analysis will be documented and tracked in the discrepancy reporting tool used for the test campaign. The analysis will focus on the failure, what caused the failure, the severity (minor or major), and possible impacts to other testing.
- Mitigation: The SLI Hardware Specialist or designated SLI personnel monitors any work done by the manufacturer, with the full understanding of what is occurring and why.
    - The Manufacturer will document what work is done and the SLI Hardware Specialist or designated SLI personnel will sign off on or can stop the work at any time.
    - The Hardware Specialist or designated SLI personnel will determine the number of "minor" fixes the manufacturer can incorporate without a re-start of the test.
    - Any modification to the equipment is followed up with the related manufacturer EC(s). All related ECs must be entered into the hardware test report and the certification test report.

When issues are identified during hardware environmental testing, they result in discrepancies. Discrepancies are tracked in the discrepancy reporting tool.

End of ENV Hardware Test Plan