Certification Test Report

Report Number HRT-3276 CTR 01

Hart InterCivic Verity Voting 2.0

Certification Test Report version 1.1

April 14th 2016

Prepared for:

Vendor Name	*Hart InterCivic Inc.*
Vendor System	*Verity Voting 2.0*
EAC Application No.	HRT1501
Vendor Address	*15500 Wells Port Drive* *Austin, TX 78728*

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Accredited by the National Institute of Standards and Technology (NIST) National Voluntary Lab Accreditation Program (NVLAP), and accredited by the Election Assistance Commission (EAC) for VSTL status.

Revision History

Release	Author	Revisions
v1.0	M. Santos	Initial Release; submitted to EAC for approval
v1.1	M. Santos	Updates for EAC comments
v1.2	M. Santos	Removal of yellow highlights

Disclaimer

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The tests referenced in this document were performed in a controlled environment using specific systems and data sets, and results are related to the specific items tested. Actual results in other environments may vary.

Opinions and Interpretations
There are no SLI opinions or interpretations included in this report beyond the final recommendation.

Other Labs Performing Hardware Testing

SLI Compliance is responsible for all core voting system tests as identified in NIST NVLAP Handbook 150-22 (2008). Regarding non-core hardware testing for this certification test campaign, this report contains data that were produced under subcontract by the following lab(s):

Table 1 – Labs Performing Hardware Testing

Laboratory	Address	Test(s)	Date(s)
NTS Longmont formerly EMC Integrity (NVLAP certified for electromagnetic compatibility and	1736 Vista View Drive Longmont, CO 80504	**EMC / EMI Tests:** Radiated Emissions, Conducted Emissions, ESD, Electromagnetic Susceptibility, Electrical Fast Transient, Lightning Surge, Conducted RF Immunity,	**1/18/2016 - 2/11/2016**

Laboratory	Address	Test(s)	Date(s)
telecommunications)		Magnetic Fields Immunity, Electrical Power Disturbance	
Cascade TEK – Front Range (A2LA certified for mechanical including MIL STD 810)	1530 Vista View Drive Longmont, CO 80504	**MIL-STD-810D Tests:** Bench Handling, Vibration, Low Temperature, High Temperature, Humidity, Temperature/Power Variation, and Reliability	1/18/2016 - 2/1/2016

TABLE OF CONTENTS

List of Tables

1   Introduction

SLI Compliance is submitting this test report as a summary of the certification testing efforts for the **Hart InterCivic Verity 2.0** voting system, a modified system from **Verity 1.0**, as detailed in the section System Identification. The purpose of this document is to provide an overview of the certification testing effort and the findings of the testing effort for the **Hart InterCivic Verity 2.0** voting system.

This effort included documentation review of the Technical Data Package, source code review, and testing of the **Hart InterCivic Verity 2.0** voting system. Testing consisted of the development of a test plan, managing system configurations, executing a subset of test cases based on the Hart testing performed, component and system level tests prepared by SLI, and analysis of results. The review and testing was performed at SLI's Denver, Colorado facility.

1.1   References

1. Election Assistance Commission Voluntary Voting System Guidelines version 1.0 (EAC VVSG 1.0), Volumes I & II
2. NIST NVLAP Handbook 150: 2006.
3. NIST NVLAP Handbook and 150-22: 2008.
4. EAC Voting System Testing and Certification Program Manual, United States Election Assistance Commission, v 2.0, May 2015
5. EAC Voting System Test Laboratory Program Manual, United States Election Assistance Commission, v 2.0, May 2015
6. SLI VSTL Quality System Manual, v 2.0, prepared by SLI, Jan. 8, 2016

1.2   Document Overview

This document contains:

- The Introduction, which discusses the application tested/reviewed
- The Certification Test Background, which discusses the testing process
- The System Identification, which identifies hardware and software for the Hart InterCivic Verity 2.0 voting system
- The System Overview, which discusses the functionality of Hart InterCivic Verity 2.0 voting system software and firmware
- The Certification Tests, which are a summary of the testing effort
- The Recommendations section, which contains the final analysis of the testing effort
- EAC Certification & Voting System Configuration, which summarizes the voting system configuration
- Attachments as follows:
    - o   Attachment A – Warrant of Change Control for Verity 2.0
    - o   Attachment B1 - Record of Trusted Build 02-15-2016 Verity 2.0.0
    - o   Attachment B2 - Record of Trusted Build 03-08-2016 Verity 2.0.1

- o Attachment B3 - Record of Trusted Build 03-22-2016 Verity 2.0.2
- o Attachment B4 - Record of Trusted Build 03-30-2016 Verity 2.0.3
- o Attachment C – List of Source Code Reviewed and Results
- o Attachment D1 - NTS Longmont_200737_CERT_ISO-IEC 17025-2005
- o Attachment D2 - NTS Longmont_Scope_Of_ACCREDIT_ISO-IEC 17025-2005
- o Attachment D3 - CASCADE_ENV_A2LA_Scope_Of_ACCREDIT_ISO-IEC 17025-2005
- o Attachment D4 - TUV audit report of TS3
- o Attachment D5 - Verity 2.0_Safety_Report_TUV NRTL Safety Certificate U8 16 02 90917 002
- o Attachment E1 - PCA Doc - System Security Spec Rev02
- o Attachment E2 - PCA Doc - System Overview Rev01
- o Attachment E3 - PCA Doc - System Operations Procs Rev02
- o Attachment E4 - PCA Doc - System Maintenance Procs Rev01
- o Attachment E5 - PCA Doc - System Hardware Spec Rev02
- o Attachment E6 - PCA Doc - System Functionality Desc Rev02
- o Attachment E7 - PCA Doc - Software Design_Spec Rev02
- o Attachment E8 - PCA Doc - Quality Assurance Rev01
- o Attachment E9 - PCA Doc - Personnel Deployment_Training Reqs Rev03
- o Attachment E10 - PCA Doc - Configuration Management Plan Rev02
- o Attachment E11 - PCA Doc - System Test_Verification Spec Rev03
- o Attachment E12 - PCA Doc - System Change Notes Rev02
- o Attachment F1 - Hart InterCivic Verity 2.0 VVSG EMC EMI Test Plan v2.0
- o Attachment F2 - Hart InterCivic Verity 2.0 VVSG Hardware ENV Test Plan v2.0
- o Attachment F3 – Lonestar EMC Test Plan A02
- o Attachment G1 - Cascade Tek_CTC C1958A_Environmental_Bench Handling_Vibration_Low Temp_High Temp_ Humidity_Temp Power VariationTest Report for Verity 2.0
- o Attachment G2 - NTS Longmont_ETRB60122 revA_Radiated_Conducted_Emissions_Test Report for Verity 2.0
- o Attachment G3 - NTS Longmont_TRB60122 revA_ Electro Susceptibility_EFT_Lightning Surge_CON RF_Magnetic Fields RF_ELEC Power DIST_Immunity Test Report for Verity 2.0

- o Attachment G4 - Verity 2.0_TUV Safety Report PTI-1411085-100_Att1_2_3.

- o Attachment G5 - Verity 2.0_TUV Safety Report PTI-1411085-100_TRF_iec60950

- o Attachment H – Discrepancies

- o Attachment I - Hart Verity 2.0 EAC Modification Test Plan v1.3

- o Attachment J1 - HRT_C#_MSAllInOneStandard_SCRF

- o Attachment J2 - HRT_C_&_C++_MSAllInOneStandard_SCRF

- o Attachment K - PCA System Configuration Checklist

- o Attachment L - FCA Summary Form

- o Attachment M - Verity Voting 2.0 Attestation of Durability

- o Attachment N - Verity Voting 2.0 Attestation of Integrity

- o Attachment O - Verity Voting 2.0 Attestation of Production Hardware and Software

- o Attachment P - Verity 2.0 Hardware and Software General Applicability Form

- o Attachment Q - Modification of Certified System Analysis Summary Form

2 Certification Test Background

This section provides a brief overview of the EAC Certification Program and the activities involved in order for a voting system to be considered for certification against the VVSG 1.0 and the current EAC program manuals.

2.1 PCA - Document and Source Code Reviews

The Physical Configuration Audit (PCA) review of the **Hart InterCivic Verity 2.0** documentation, submitted in the requisite Technical Data Package (TDP), was performed in order to verify conformance with the VVSG 1.0. Source code was reviewed for each software and firmware application declared within the **Verity 2.0** voting system. As this is a modification test campaign, the source code was compared against the final code base of **Verity 1.0**, and changes were subject to review.

All PCA reviews were conducted in accordance with *Volume II Section 2* of the VVSG 1.0, to demonstrate that the system meets the requirements. Results of the PCA documentation review can be found in section 5.2 of this Certification Test Report. Informational issues, which are errors that don't affect a VVSG 1.0 requirement, such as minor typo's or incorrect labeling of a document (draft versus official), and Discrepancies such as formatting or versioning, incorrect processes, functionality descriptions and/or missing functionality or descriptions, in documentation were identified to Hart for resolution or comment. Additional details of the PCA documentation review can be found in Attachments E1-E12.

All PCA source code reviews were conducted in accordance with *Volume I Section 5.2 and Volume II Section 5* of the VVSG 1.0, to demonstrate that the system meets the requirements. Results of the PCA source code reviews can be found in Attachment C – List of Source Code Reviewed and Results. Inconsistencies or errors in the source code were identified to Hart for resolution or comment. Additional details of the source code review criteria can be found in Attachments J1-J2.

2.2 FCA - Functional & System Testing and Sampling

The Functional Configuration Audit (FCA) review of the test documentation submitted by Hart in the TDP was reviewed in order to verify testing of the voting system requirements defined in *Volume I Sections 2, 6, 7,* and *9* of the VVSG 1.0.

SLI's standard Test Suites were customized for the **Hart InterCivic Verity 2.0** voting system and conducted in accordance with *Volume II Section 6 of the VVSG 1.0,* in conjunction with the functional testing. Simulations of elections were conducted to demonstrate a beginning-to-end business use case process for the **Hart InterCivic Verity 2.0** voting system.

2.2.1 Test Methods

All test methods employed are within the scope of SLI's VSTL accreditation.

The following validated test methods were employed during this test campaign:

Table 2 – Test Methods

SLI VSTL Test Method Name	Version Date
TM_Acccessibility v1.0.doc	1/14/2014
TM_Accuracy v1.1.doc	12/16/2014
TM_Audit_Record_Data v1.0.doc	1/13/2014
TM_Ballot_and_Program_Installation_and_Control v1.0.doc	1/13/2014
TM_Ballot_Box v1.1.doc	3/28/2014
TM_Ballot_Counter v1.0.doc	1/13/2014
TM_Ballot_Formatting_and_Production v1.0.doc	1/13/2014
TM_Ballot_Rotation v 1.0.doc	1/13/2014
TM_Basic_Election_Components v1.0.doc	1/13/2014
TM_Blanket_Open_Primary_Creation v 1.0.doc	1/13/2014
TM_Closed_Primary_Election_Creation v 1.0.doc	1/13/2014
TM_Closing_the_Polls v 1.0.doc	2/19/2014
TM_Error Message and Recovery v1.2.doc	12/16/2014
TM_HW_Integrity v1.0.doc	1/13/2014
TM_Maintainability v1.0.doc	1/13/2014

SLI VSTL Test Method Name	Version Date
TM_Non-Partisan v1.0.doc	1/13/2014
TM_Partisan Offices v1.0.doc	1/13/2014
TM_Performance v1.0.doc	2/21/2014
TM_Pre-Voting_Capabilities v1.0.doc	1/13/2014
TM_Provisional or Challenged Ballots v1.0.doc	1/13/2014
TM_Ranked_Order_Voting v1.0.doc	2/7/2014
TM_Readiness v1.0.doc	1/13/2014
TM_Security_Access_Control v1.0.doc	2/19/2014
TM_Security_Access_Control_Measures v1.0.doc	2/19/2014
TM_Security_Physical_Security_Measures v1.0.doc	2/19/2014
TM_Security_Software_Security v1.0.doc	2/19/2014
TM_Split_Precincts v1.0.doc	1/13/2014
TM_Standard Open Primary Creation v1.0.doc	1/13/2014
TM_Straight_Party_Voting v1.0.doc	1/13/2014
TM_Stress v1.0.doc	2/7/2014
TM_System_Audit v1.0.doc	2/7/2014
TM_Tally_and_Reporting v1.0.doc	2/7/2014
TM_Usability v1.1.doc	12/16/2014
TM_Volume v1.0.doc	2/7/2014
TM_Vote_for_N_of_M v1.0.doc	2/7/2014
TM_Voting_Ballot_Rotation v1.0.doc	2/7/2014
TM_Voting_Capabilities v1 1.doc	12/16/2014
TM_Voting_Non-Partisan v1.0.doc	2/10/2014
TM_Voting_Partisan_Offices v1.0.doc	2/10/2014
TM_Voting_Precincts_and_Districts v1.0.doc	2/10/2014
TM_Voting_Straight_Party v1.0.doc	2/10/2014
TM_Voting_Vote_for_N_of_M v1.0.doc	2/19/2014
TM_Voting_Write-In v1.0.doc	2/10/2014
TM_Write-In v1.0.doc	2/10/2014

The above listed test methods are implemented in a complementary fashion: modules are employed from various methods to form suites. Suites include a logical sequence of functionality that is used to validate the requirement addressed by each module within the suite. Please see the Terms and Abbreviations table for additional information about Test Modules and Test Suites.

Deviations from, additions to, or exclusions from the test methods

There were no deviations from, additions to, or exclusions from any of the test methods used in this certification test campaign.

2.2.2 Terms and Abbreviations

This section details pertinent terms applicable within this report.

Table 3 – Terms and Abbreviations

Term	Abbreviation	Description
American Association for Laboratory Accreditation	A2LA	A nonprofit, non-governmental, public service, membership society whose mission is to provide comprehensive services in laboratory accreditation and laboratory-related training.
Ballot Marking Device	BMD	An accessible computer-based voting system that produces a marked ballot (usually paper) that is the result of voter interaction with visual or audio prompts.
Cast Vote Record	CVR	Permanent record of all votes produced by a single voter whether in electronic, paper or other form. Also referred to as ballot image when used to refer to electronic ballots.
Central Count Scanner	CCS	High Speed Digital Scanner is a ballot scanning device typically located at a central count facility and is operated by an automated multi-sheet feeding capability.
Chevron (Arrows at top of current screen)	No Abbreviation	Verity software applications are organized around easy-to-follow workflows, with specific activities associated with "chevrons" or "arrows" in the application user interface.
Compact Flash card	CF	This is a type of flash memory card in a standardized enclosure often used in voting systems to store ballot and/or vote results data.
Compact Flash AST	CFAST	A compact flash media based on the Serial ATA bus rather than the Parallel ATA bus, used by the original Compact Flash
Commercial Off the Shelf	COTS	Commercial, readily available hardware devices (such as card readers, printers or personal computers) or software products (such as operating systems, programming language compilers, or database management systems)

Term	Abbreviation	Description
Election Assistance Commission	EAC	An independent, bipartisan commission created by the Help America Vote Act (HAVA) of 2002 that operates the federal government's voting system certification program.
Election Management System	EMS	Typically a database management system used to enter jurisdiction information (district, precincts, languages, etc.) as well as election specific information (races, candidates, voter groups (parties), etc.). In addition, the EMS is also used to lay out the ballots, download the election data to the voting devices, upload the results and produce the final results reports.
Electromagnetic Compatibility	EMC	The goal of EMC is to validate the correct functioning of different equipment in the same environment and the avoidance of any interference effects between them.
Functional Configuration Audit	FCA	Exhaustive verification of every system function and combination of functions cited in the vendor's documentation. The FCA verifies the accuracy and completeness of the system's Voter Manual, Operations Procedures, Maintenance Procedures, and Diagnostic Testing Procedures.
(Verity) Chevron	No Abbreviation	**Verity** components use workflow chevrons. Workflow chevrons, arranged along the top of the screen, identify the function the user is currently viewing.
Institute of Electrical and Electronics Engineers	IEEE	A non-profit organization, IEEE is the world's leading professional association for the advancement of technology.
National Institute of Standards and Technology	NIST	A non-regulatory federal agency within the U.S. Dept. of Commerce. Its mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.
National Voluntary Laboratory Accreditation Program	NVLAP	A division of NIST that provides third-party accreditation to testing and calibration laboratories.
Physical Configuration Audit	PCA	The testing activities associated with the physical aspects of the system (hardware, documentation, builds, source code, etc.).

| Term	Abbreviation	Description
Primary – Blanket		The Blanket Primary election combines all candidates for a given contest, regardless of political affiliation, into the same contest. This is done with the same presentation as in a general election with the one difference being that there may be multiple candidates from each party listed. From the **Verity 2.0** perspective, this election is treated as if it were a general election.
Primary – Closed		The Closed Primary election segregates each political party onto its own ballot, along with all pertinent non-political contests and referendums.
Primary - Open		The Open Primary election combines all political parties' contests onto a single ballot, along with all pertinent non-political contests and referendums.
Precinct Count Scanner	PCS	A precinct-count optical scanner is a mark sense-based ballot and vote counting device located at a precinct and is typically operated by scanning one ballot at a time.
Request For Information	RFI	A form used by testing laboratories to request, from the EAC, interpretation of a technical issue related to testing of voting systems.
Requirements Matrix	N/A	This is the matrix created by the EAC and maintained by SLI that traces the requirements to the various test modules and test methods.
Standard Lab Procedure	SLP	SLI's quality system documentation is made up of standard lab procedures (SLPs), which are procedures required to ensure a systematic, repeatable and accurate approach to voting systems testing and governing the actual performance of SLI's work.
(Verity) Tab	No Abbreviation	Verity software applications are organized around easy-to-follow workflows and activities; a "Tab" provides specific activities associated with "chevron" workflows in the application user interface.
Voting Center		Typically a convenience voting location that manages multiple ballot styles

Term	Abbreviation	Description
Technical Data Package	TDP	This is the data package that is supplied by the vendor and includes: Functional Requirements, Specifications, End-user documentation, Procedures, System Overview, Configuration Management Plan, Quality Assurance Program, and manuals for each of the required hardware, software, firmware components of each voting system.
Test Method	No Abbreviation	SLI proprietary documents which are designed to group sets of EAC VVSG requirements in a logical manner that can be utilized to efficiently validate where and how requirements, or portions of a requirement, are met.
Test Module	No Abbreviation	An actionable component of a Test Method, that functionally verifies that a requirement is met within a voting system. Test Modules are at a generic level within the Test Method, and are customized for a particular voting system, within a Test Suite.
Test Suite	No Abbreviation	An actionable grouping of test modules designed to test a set of functions of a voting system or component in a specific way.
Validation	No Abbreviation	Confirmation by examination and through provision of objective evidence that the requirements for a specific intended use or application have been fulfilled (ISO 9000)
Verification	No Abbreviation	Confirmation by examination and through provision of objective evidence that specified requirements have been fulfilled (ISO 9000)
Voluntary Voting Systems Guidelines Volumes I & II	VVSG	A set of specifications and requirements against which voting systems can be tested to determine if the systems provide all of the basic functionality, accessibility and security capabilities required of these systems.
Voting System Test Lab	VSTL	The accredited lab where the voting system is being tested.
Voting System Under Test	VSUT	The designation for a voting system that is currently being tested.
Voting Test Specialist	VTS	An SLI Compliance employee who has been qualified to perform EAC voting system certification testing.

3 System Identification

The **Hart InterCivic Verity 2.0** voting system was submitted for certification testing with the documentation, hardware and software listed below. No other Hart product was included in this test effort.

3.1 System Topology Diagram
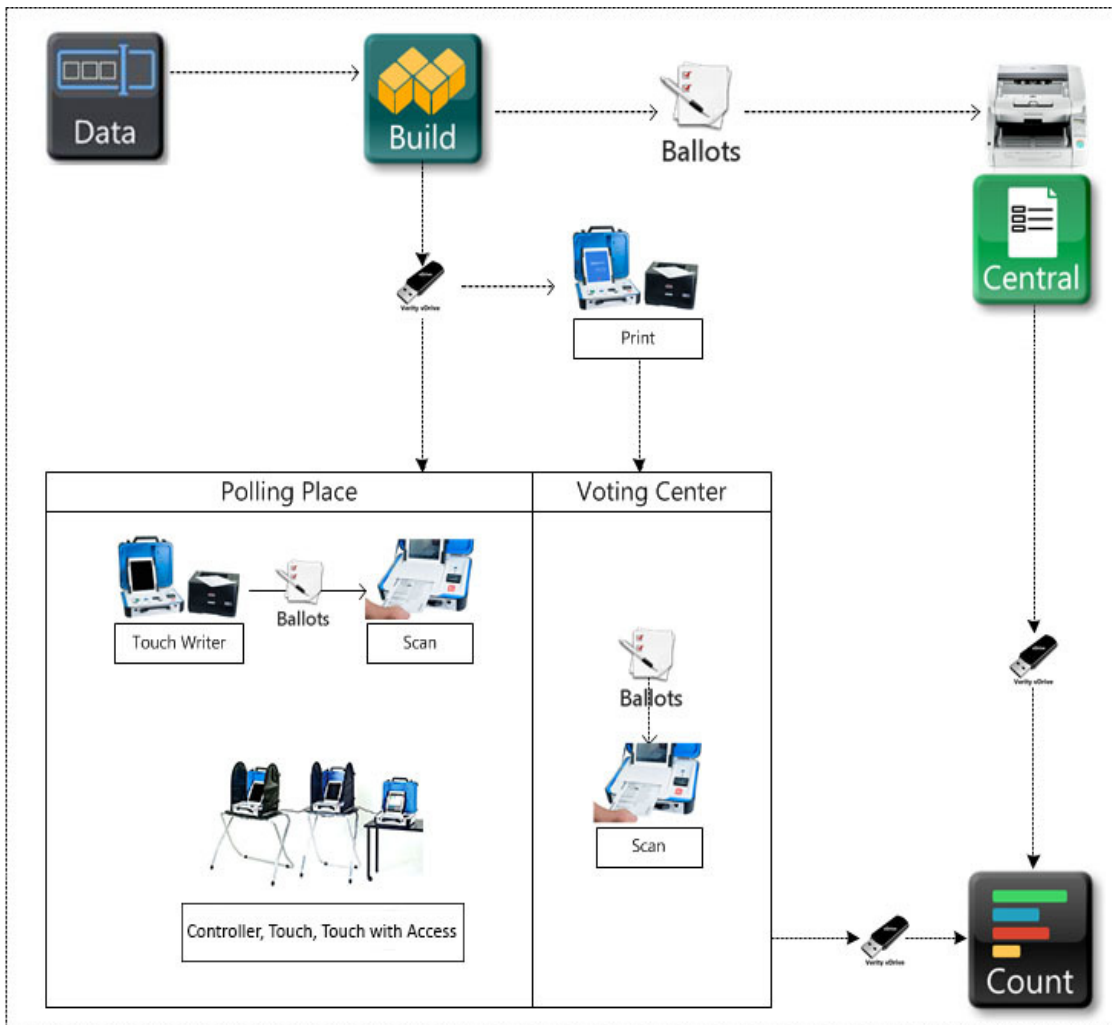
Overview of the diagram:

- The components are displayed as touch points of data access, transfers, and verification.
- Dotted lines show the flow of data and air gaps using Verity vDrives.

- Verity Data and Verity Build are pre-election applications used to create the election
- The Verity Controller, Verity Touch/Verity Touch with Access, Verity Touch Writer and Verity Scan components are part of the Polling Place setup.
- Verity Central is a central count location component that utilizes high speed scanners for high volume scanning of marked ballots.
- Verity Print is part of the voting center setup
- Verity Count tabulates election results and generates reports
- Verity Key (not shown) is required for user access into components to load elections, use features, and generate reports. Feature access depends on the roles applied to user accounts.

3.2 Documentation

The TDP User/Owner manuals that are deliverables of the certified system delivered to a purchaser of the system are as follows:

- Verity Build Quick Reference Manual
- Verity Build Technical Reference Manual
- Verity Central Quick Reference Manual
- Verity Central Technical Reference Manual
- Verity Count Quick Reference Manual
- Verity Count Technical Reference Manual
- Verity Count Quick Reference Manual
- Verity Data Quick Reference Manual
- Verity Data Technical Reference Manual
- Verity Polling Place Operations Technical Reference Manual
- Verity Service and Maintenance Operations Technical Reference Manual
- Verity Operational Guide

3.3 Software and Firmware

Any and all software/firmware that is to be used by the declared voting system whether directly or indirectly, in a production environment, must be validated during the certification process.

The software and firmware employed by **Hart InterCivic Verity 2.0** consists of 2 types, custom and commercial off the shelf (COTS). COTS applications were verified to be pristine, or were subjected to source code review for analysis of any modifications and verification of meeting the pertinent standards. For Software, the software was either obtained directly from the 3rd party manufacturer, or was verified against digital signatures obtained from the 3rd party manufacturer. For Hardware, the hardware was either shipped directly from the 3rd party manufacturer, or the equipment was inspected to verify conformance to the 3rd party manufacturer's specifications.

Tables 4 and 5 below detail each application employed by the Hart InterCivic Verity 2.0 voting system.

Table 4 – Hart Verity 2.0 Software and Firmware

Manufacturer	Application(s)	Version
Verity Data	Ballot setup software	2.0.2
Verity Build	EMS software	2.0.2
Verity Central	High speed digital scanner software	2.0.2
Verity Count	Central count location accumulation and tallying software	2.0.2
Verity Scan	Digital scanner firmware	2.0.3
Verity Touch Writer	BMD firmware	2.0.3
Verity Controller	Polling place device providing management of touch screen voting devices firmware	2.0.3
Verity Touch	DRE firmware	2.0.3
Verity Touch with Access	DRE firmware	2.0.3
Verity Print	Printer firmware	2.0.3
Verity Device Microcontroller	Firmware for Verity Devices	V17

Table 5 – COTS Software

Manufacturer	Application	Version	Verity Voting 2.0 Component
Microsoft	Microsoft Windows Embedded Standard 7 with Service Pack 1 – 64bit	6.1.7601	Data/Build, Data/Build + Count, Central, Count, Print, Scan, Touch Writer, Controller, Touch, Touch with Access
Microsoft	Microsoft SQL Server 2012 for Embedded Systems	11.00.2100	Data/Build, Data/Build + Count, Central, Count
Microsoft	Microsoft SQL Server 2012 Express	11.00.2100	Print, Scan, Touch Writer, Controller, Touch, Touch with Access
McAfee	McAfee Application Control for Devices	6.1.1.369	Data/Build, Data/Build + Count, Central, Count, Print, Scan, Touch Writer, Controller, Touch, Touch with Access

3.4 Equipment (Hardware)

The hardware employed by **Hart InterCivic Verity 2.0** consists of 2 types, custom and commercial off the shelf (COTS). COTS hardware was verified to be unmodified, or was subjected to review for analysis of any modifications and verification of meeting the pertinent standards.

Tables 6 and 7 below detail each device employed by the **Hart InterCivic Verity 2.0** voting system.

Table 6 – Hart Verity 2.0 Custom Voting Equipment

Hardware	Use	Model	Revision
Verity Scan	Precinct polling place digital scanner	2005350	B & B1
Verity Touch Writer	Precinct polling place Ballot Marking Device	2005352	C
Verity Print	Vote Center ballot printer	3005356	B
Verity Controller	Polling place management device for DRE devices	3005351	B
Verity Touch	Polling place DRE device	3005355	B
Verity Touch with Access	Polling place DRE device with disabilities access	3005353	B
Verity Key	Security key used within the voting system	N/A	N/A
Verity vDrive	Media used for transportation of voting system data	N/A	N/A

Table 7 – Hart Verity 2.0 COTS Equipment

Manufacturer	Hardware	Model
OKIDATA (for **Verity Build**, **Verity Central, Verity Touch Writer** and **Verity Count**)	Ballot/Report Printer	B431d
OKIDATA (for **Verity Build**)	Ballot Printer	C911
OKIDATA (for **Verity Build**)	Ballot Printer	C831
Kodak (for **Verity Central**)	Ballot Scanner	i5600
Canon	Ballot Scanner	DR-G1100

Manufacturer	Hardware	Model
(for **Verity Central**)		
Canon (for **Verity Central**)	Ballot Scanner	DR-G1130
Various (for **Verity Build**, **Verity Central** and **Verity Count**)	I**ntel-Windows Workstation (Recommended Requirements)** Processor – x86-compatible, 3.0GHz, Quad Core Memory – 8GB Hard Drive – 2 x 1 TB RAID-Level 1, Removable w/ key lock Ethernet Port – 100Mb/1Gb USB Ports – 4 ports Video Card - Integrated Graphics Keyboard - USB Keyboard Mouse - USB Mouse NO Wireless technologies allowed: WiFi, Bluetooth, Aircard, etc.	
Various (for **Verity Build**, **Verity Central** and **Verity Count**)	**Monitor (Recommended Requirements)** Panel Size - 50.8 cm Aspect Ratio - Widescreen (16:9) Optimal Resolution - 1600 x 900 at 60 Hz Contrast Ratio - 1000: 1 Brightness - 250 cd/m^2 (typical)	

3.5 Materials

The following test materials are required for the performance of testing including, as applicable, test ballot layout and generation materials, test ballot sheets, and any other materials used in testing.

- Ballots & Blank Ballot grade paper
- Thumb Drives
- Ballot marking pens
- Printer paper rolls

3.6 Excluded Requirements

In this section we identify VVSG 1.0 requirements that do not pertain to the declared system being certified. For this certification project Hart has elected not to support their **Verity Relay** *transmission capabilities. As such, the table below enumerates the requirements that will not be subject to verification for this project.*

Requirements Not Under Test	Description	Reason for Exception
2.3.3.1.f	Continue to cast ballots if telecomm failure	Telecomm casting of ballots/data not implemented
2.4.4	Broadcasting results	Broadcasting is not supported
3.1.2.c	Biometric identification and authentication	No biometrics implemented
5.4.2.g	Public Networks	No public networks used
7.5	Telecommunications and Data Transmission	Telecomm and Data Transmission not implemented
7.6	Casting of ballots via telecommunications	Telecomm casting of ballots/data not implemented
7.7	Wireless Communications	Wireless communications not implemented
7.9	Voter Verifiable Paper Audit Trail	VVPAT not implemented

3.7 Additional Functionality/Requirements

A review of the Hart Technical Requirements Documentation (TRDs) resulted in SLI's identification of some Hart functionality/requirements that are considered beyond the scope of the VVSG 1.0, but since they are in the declared system, will require (Volume II section 3.2.2 of the VVSG 1.0) review and verification. Additional functionality/requirements to be audited within the scope of this certification are detailed below.

Verity Security Requirements 4005464 A03

- Verity Desktop Systems that store critical election data shall be connectable to an Uninterruptable Power Supply that will provide sufficient power to allow the user to shut down the system gracefully.
- Verity shall not allow simultaneous access by the same user.
- The secure BIOS shall verify the chain of trust before allowing the system to boot.
- BIOS Verification
- The BIOS shall store a hash computed over the entire BIOS executable stored in persistent memory.
- Electronic keys shall work for one and only one election.
- The user must not be able to open multiple Verity Voting applications at the same time on a single computer.
- The following requirements shall apply to all Verity applications:
   o The user must not be able to start, open, or access any other applications on the computer while the Verity application is open.
   o The user must not be able to access Operating System functionality while the Verity application is open.

Verity Central TRD 4005453 A01

- The application shall NOT allow two users to access an individual ballot simultaneously.
- The application shall support up to 4 simultaneous client workstations per server.
- Each workstation connected to the server shall be required to have a unique Workstation Name.
- Before initiating scanning, the system shall verify that there is sufficient free space available to save and process all ballot images from the scan batch.
- The application shall allow the user to protect a contest, which when protected does not allow manual or automatic resolution actions to be performed on the contest during the adjudication process.
- Protected contests shall not allow manual resolution actions.
- Protected contests shall not be affected by the automatic resolution feature.
- The application shall allow the user to remove protection from a contest.
- The application shall include an interface for creating Recovery Media.

Verity Count TRD 4005454 A02

- Minimum vote threshold.
- *Note: Minimum Vote Threshold is used to notify Election officials of potential privacy issues when there are only a small number of voters in a category.*

Verity Polling Place Device Suite TRD 4005457 A03

- The title of the report shall be "Configuration Readiness Report".
- The report shall include a barcode.
- The barcode shall contain the following data:
  - o The assigned polling place.
  - o The device serial number.
  - o The Election Media Device identifier.

4   System Overview

4.1   Scope of the Hart InterCivic Verity Voting 2.0 Voting System

This section provides a description of the scope of **Hart InterCivic Verity Voting 2.0** voting system components:

- The **Hart Verity Voting 2.0** voting system represents a set of software applications for pre-voting, voting and post-voting election project activities for jurisdictions of various sizes and political division complexities. **Verity Voting 2.0** functions include:
  - o Defining the political divisioning of the jurisdiction and organizing the election with its hierarchical structure, attributes and associations.
  - o Defining the election events with their attributes such as the election name, date and type, as well as contests, candidates, referendum questions, voting locations and their attributes.
  - o Preparing and producing ballots for polling place and absentee voting.
  - o Preparing media for precinct voting devices and central count devices.
  - o Configuring and programming the Verity Scan digital scanners.
  - o Configuring and programming the Verity Touch Writer BMD devices
  - o Producing the election definition and auditing reports.
  - o Providing administrative management functions for user, database, networking and system management.
  - o Import or manual data entry of the Cast Vote Records from Verity Scan devices and Verity Central.
  - o Preview and validation of the election results.
  - o Producing election results tally according to voting variations and election system rules.

o   Producing a variety of reports of the election results in the desired format.

o   Publishing of the official election results.

o   Auditing of election results including ballot images and log files.

- The **Verity Scan** is a digital scan ballot counter (tabulator) that is used in conjunction with an external ballot box. The unit is designed to scan marked paper ballots, interpret and record voter marks on the paper ballot and deposit the ballots into the secure ballot box.

- The **Verity Touch Writer** is a standalone precinct level Ballot Marking Device (BMD) which also includes an Audio Tactile Interface (ATI), which allows voters who cannot complete a paper ballot to generate a machine-readable and human readable paper ballot, based on vote selections made, using the ATI.

- **Verity Controller**, which is a polling place device that is used to activate and accumulate results from a range of 1 to 12 **Verity Touch**/ **Verity Touch with Access** DREs daisy chained to **Verity Controller**.

- **Verity Touch**, which is a Direct Recording Electronic (DRE) device that allows a voter to cast their vote electronically via touch screen.

- **Verity Touch with Access,** which is a Direct Recording Electronic (DRE) device that allows a voter to cast their vote electronically via the **Verity Access** audio-tactile interface.

- **Verity Print**, which is a voting center ballot printing solution for paper ballots.

- **Verity Election Management** allows users with the Administrator role to import and manage election definitions. Imported election definitions are available through the Elections chevron in Build. Users can also delete, archive, and manage the election definitions.

- **Verity User Manager** enables users with the correct role and permissions to create and manage user accounts within the Verity Voting system for the local workstation in a standalone configuration, or for the network in a networked configuration.

- **Verity Election Manager** enables users, with the correct roles, to import election defining import files into the Verity voting system. This application also supports archiving, restoring and deleting elections.

- **Verity Desktop** enables users, with the correct roles, to set the workstations' date and time, gather Verity application hash codes (in order to validate the correctness of the installed applications), and access to Windows desktop.

- **Verity Data**, which provides the user with controls for proofing of data, layout, and audio created. **Verity Data** also performs validation on the exported information to ensure that it will successfully import into **Verity Build**.

- **Verity Build** opens the election to proof data, view reports, and print ballots, and allows for configuring and programming the **Verity Scan** digital scanners, **Verity Touch Writer** BMD devices, **Verity Controller**/**Touch** and **Touch with Access** devices, as well as producing the election definition and auditing reports.

- **Verity Central** is a high-speed, central digital ballot scanning system used for high-volume processing of ballots (such as vote by mail). The unit is based on COTS scanning hardware coupled with the custom **Hart** developed ballot processing application software which resides on attached work-station.

- **Verity Count** is an application that tabulates election results and generates reports. **Verity Count** can be used to collect and store all election logs from every Verity component/device used in the election, allowing for complete election audit log reviews.

4.2   Changes from Verity 1.0 to Verity 2.0

Features new to **Verity 2.0** include:

Verity Data, which provides the user with controls for proofing of data, layout, and audio created. **Verity Data** also performs validation on the exported information to ensure that it will successfully import into **Verity Build**.

Verity Controller, which is a polling place device that is used to activate and accumulate results from a range of 1 to 12 **Verity Touch**/ **Verity Touch with Access** DREs daisy chained to **Verity Controller**.

Verity Touch, which is a Direct Recording Electronic (DRE) device that allows a voter to cast their vote electronically via touch screen.

Verity Touch with Access, which is a Direct Recording Electronic (DRE) device that allows a voter to cast their vote electronically via the **Verity Access** audio-tactile interface.

Verity Print, which is a voting center ballot printing solution for paper ballots.

Updates to features from **Verity Voting 1.0** to **Verity Voting 2.0** include:

Build Changes

1. Verity Controller settings added to Election Settings screen
2. Verity Print settings added to Election Settings screen
3. Cumulative support in:
    a. Contest creation
    b. Ballot layout
    c. Data validation
    d. CSV export
    e. Reports
4. Add export functionality to electronic ballot preview
5. Change number of ranks in Ranked Choice Voting from 5 to 6

Central Changes

1. Cumulative voting mark analysis and adjudication
2. Resolve defect associated with Product Advisory dated 9/30/15 with Central write-in adjudication in a Straight Party contest
3. Change number of ranks in Ranked Choice Voting from 5 to 6

Count Changes

1. Change number of ranks in Ranked Choice Voting from 5 to 6
2. Provisional Ballot Support:
    a. Election Dashboard progress bar
    b. Support Provisional Ballot Retrieval Code in CVR
    c. New Provisional Ballots screen
    d. Help Tab content
    e. Provisional Ballot Status import/export
    f. Provisional Ballot Status report
    g. Provisional Ballot parsing logic
3. Support Touch/Controller on:
    a. Device Log report
    b. Voting Device report
    c. vDrive Status report
    d. Custom report filters
    e. Auditing dashboard filters
    f. Text write-in resolution changes
        i. Display in resolution screen
        ii. Auto-assign if exact match to existing write-in candidate

Verity Scan Changes

1. Cumulative voting mark analysis and second chance voting
2. Change number of ranks in Ranked Choice Voting from 5 to 6

Verity Touch Writer Changes

1. Cumulative Voting:
    a. Contest Display
    b. Vote Capture
    c. Help Screen Content
2. Aesthetic changes to Contest List screen
3. Add number of available choices to the contest audio
4. Add "Your ballot has N sheets" to the ballot printing audio
5. Change number of ranks in Ranked Choice Voting from 5 to 6

4.2.1 Supported Languages

The **Hart Verity Voting 2.0** voting system supports the English and Spanish languages.

4.2.2 Supported Functionality

4.2.2.1 Voting Variations

Verity Voting 2.0 supports the following voting variations:

- Closed primary elections
- Blanket primary elections
- Open primary elections
- General elections
- Partisan offices
- Non-partisan offices
- Write-in voting
- Cumulative voting
- Primary presidential delegation nominations
- Ballot rotation
- Straight party voting
- Split precincts
- Vote for N of M

Note that **Verity Voting 2.0** does not include Ranked Choice Voting as a fully implemented voting variation. **Verity Data** provides functionality to create contests of a Ranked Choice Voting variety. **Verity Build** will build a ballot to Ranked Choice voting, and the voting devices **Verity Scan** and **Verity Touch Writer**, as well as **Verity Central** will allow RCV selections by the voter and record them. **Verity Count** does not perform ranked choice processing; instead it will treat the 1st candidate selected as the candidate chosen. While the full functionality is not in place, SLI tested the implemented functional portions in their respective areas as listed.

4.2.3 Ballot Standards

Verity Build employs and supports the ballot standards as follows:

- Supports the following paper sizes:
  - 8.5" x 11"
  - 8.5" x 11" w/ 3" stub (8.5" x 14")
  - 8.5" x 14"
  - 8.5" x 14" w/ 3" stub (8.5" x 17")
  - 8.5" x 17"

- 8.5" x 17" w/ 2" stub (8.5" x 19")
- 11" x 17"

• Supports ballot layouts in portrait orientation.

• Supports duplex ballot layouts.

• Supports the inclusion of ballot stubs on paper ballots.

• Supports layouts for a variety of ballot types, including Test mode, Official mode, and Sample ballots.

• Compatible with the production of ballots on standard, commercially available white paper stock.

5 Certification Test Results Summary

5.1 Source Code Review Summary

SLI has reviewed the software source code for each application in the **Hart InterCivic Verity 2.0** voting system to determine the code's compliance with Volume I Sections 5, 9 and Volume II Section 5.4 of the VVSG 1.0 and for compliance with **Hart InterCivic**'s internally developed coding standards. **Verity 2.0** is implemented with the C, C++ and C# languages. Results of the source code review are detailed in Attachment C. – List of Source Code Reviewed and Results.

The review was conducted for:

• **Software Integrity:** The module contains no self-modifying code. Software remains unchanged and retains its integrity. The module has defined array dimensions, which are positive constant integers.

• **Modularity:** The modules have a specific testable function; performing a single function; is uniquely named; follows a standard format, has a single entry point; has a single exit point (or deviates in an acceptable manner); has error handling; and acceptable module size

• **Control Constructs:** Logic flow utilizes standard constructs of the development language used; constructs are used consistently throughout the code; logic structure is not overly complex, and acceptable use of error handlers.

• **Naming Conventions:** Variable and Function names that clearly define the purpose of the variable or function. Use of standard notation for variables by type. Use of names that are unique for both global and local variables. Use of names that are unique for functions (except where it deviates in an accepted manner).

- **Coding Conventions:** Use of a standard methodology for the construction of a code module. This includes uniform calling sequences, parameter validation, a single executable statement per line, and status or error messages.

- **Comments Conventions:** Comment Header blocks for the module / function follows a standard format in its layout and content. In code comments are clearly delineated and readable.

Evaluation of Source Code

The source code was reviewed for compliance per the guidelines defined in *Volume II, Section 5.4.* of the VVSG 1.0. As a modification project, the **Verity 2.0** code base was reviewed using the final **Verity 1.0** code base as the initial drop, to which the initial **Verity 2.0** code base was compared. The differences found between those two code bases served as the starting point of the code review. The source code was found to be written adequately in terms of the VVSG 1.0. The code is modular and contains sufficient error handling. Readability is sufficient and supports maintainability.

The reviewer's assessment is based on the following observations:

- Software Integrity

    o There were no unbounded arrays. This follows the VVSG 1.0 requirements for software integrity.

    o No instances of self-modifying or dynamically loaded code were observed.

- Modularity

    o The code is modular and self-contained.

    o Modules perform only the specified functionality.

    o The requirement of single entry and exit points are complied with.

    o Modules are small enough to facilitate ease of reading and understanding.

- Control Constructs

    o Control Constructs used are in accordance with those allowed by the VVSG 1.0.

    o Loop control constructs have been appropriately chosen for the logical tasks to be accomplished. (There are, however, instances of loop constructs written to include early termination logic other than by the normal loop exit condition specification. The interpretation of the currently written VVSG 1.0 requirement is that this early loop termination logic is not disallowed by the VVSG 1.0 but it is a variation of the construct other than that described by the standard and was accepted. As the code is currently written there will be no problems caused by those loop controls; however, future changes to the

code should be performed with some caution to ensure that the system state is stable.)

- o Modules have fewer than 6 levels of indented scope.
- o Array boundaries are checked.

- Naming Conventions

  - o Function and variable names are in accordance with the requirements of the VVSG 1.0.

  - o Names differ by more than a single character and have been chosen as to enhance the readability of the code.

  - o There are no instances of language keywords being used as a name for procedures or variables.

- Coding Conventions

  - o Coding conventions employed are in compliance with the requirements of the VVSG 1.0.

  - o Code is well structured and was written appropriately to the standards.

- Comments

  - o Module headers are in compliance with the requirements of the VVSG 1.0.

  - o In-line comments are sufficient in number and placement to facilitate a reasonable understanding of the code.

  - o Variables have appropriate comments at the point of declaration.

- On the Application level, no more than 50% of the modules can exceed 60 lines, no more than 5% can exceed 120 lines, and none can exceed 240 lines without justification.

  - o Functions/modules were within the VVSG 1.0 tolerances;

5.2 Technical Data Package Review Summary

SLI reviewed the **Hart InterCivic Verity 2.0** TDP, as detailed in sections 3.1 and 3.4, for compliance according to *Volume II Section 2* of the VVSG 1.0.

The review was conducted for the required content and format of:

- **System Security Specification:** (Attachment E1) Access control policy and measures, equipment and data security, software installation, telecommunications and data transmission security, elements of an effective security program.

- **System Overview:** (Attachment E2) System description and performance are adequately described.

- **System Operations Procedures:** (Attachment E3**)** Operation environment, system installation and test specifications, operational features, operating procedures, operations support.

- **System Maintenance Procedures:** (Attachment E4) Preventative and corrective maintenance procedures, maintenance equipment, facilities and support.

- **System Hardware Specification:** (Attachment E5) System Hardware Characteristics, Design and Construction.

- **System Functionality Description:** (Attachment E6) System functional processing capabilities, encompassing capabilities required by the Standards and any additional capabilities provided by the system, including a simple description of each capability.

- **Software Design and Specification:** (Attachment E7) Purpose and scope, applicable documents, software overview, software standards and conventions, software operating environment, software functional specification, programming specifications, system database, interfaces and appendices.

- **Quality Assurance Program:** (Attachment E8) Quality assurance policy, parts and materials special testing and examination, quality conformance inspections.

- **Personnel Deployment and Training Requirements:** (Attachment E9) Personnel resources and training required to operate and maintain the system.

- **Configuration Management:** (Attachment E10) Configuration management policy, configuration identification, procedures for baseline, promotion, demotion and configuration control, release process, configuration audits and management resources.

- **System Test and Verification Specifications:** (Attachment E11) Development and certification test specifications that **Hart** applied to their testing efforts.

- **System Change Notes:** (Attachment E12) Changes to a previously certified system (Verity 1.0).

Evaluation of TDP

Once initially identified, all TDP discrepancies were resolved. The Technical Data Package for the Hart InterCivic Verity 2.0 voting system was found to sufficiently comply with the standards such that a jurisdiction would be able appropriately deploy the Hart InterCivic Verity 2.0 voting system. Results of the PCA documentation review are detailed in Attachments E1-E12.

5.3 Hardware Testing

Hardware testing conducted specifically for this test campaign involved the **Verity Controller, Touch and Touch with Access**. That testing involved verification of the following requirements:

- VVSG 1.0 Vol. 1, Section 4 Hardware Requirements
- VVSG 1.0 Vol. 2, Section 4 Hardware Testing

SLI and their third-party certified hardware test laboratories, NTS Longmont formerly EMC Integrity, and Cascade TEK, performed an analysis and review of the **Verity 2.0** voting system hardware components, namely **Verity Controller, Touch and Touch with Access.**

During execution of testing performed at the labs, an SLI representative was present to oversee the testing.

The test methodologies for all tests are identified in the following hardware test plans and hardware test reports:

- Attachment F1 - Hart InterCivic Verity 2.0 VVSG EMC EMI Test Plan v2.0

- Attachment F2 - Hart InterCivic Verity 2.0 VVSG Hardware ENV Test Plan v2.0

- Attachment F3 - Lonestar EMC Test Plan A02

- Attachment G1 - Cascade Tek_CTC C1958A_Environmental_Bench Handling_ Vibration _Low Temp_High Temp_ Humidity_Temp Power VariationTest Report for Verity 2.0

- Attachment G2 – NTS Longmont_ETRB60122_revA_Radiated_Conducted_ Emissions _Test Report for Verity 2.0

- Attachment G3 - NTS Longmont_TRB60122 revA_ Electro Susceptibility _EFT_Lightning Surge_CON RF_Magnetic Fields RF_ELEC Power DIST_Immunity Test Report for Verity 2.0

Additionally, SLI conducted a review on Safety Reports:

"Attachment G4 - Verity 2.0_TUV Safety Report PTI-1411085-100_Att1_2_3."
"Attachment G5 - Verity 2.0_TUV Safety Report PTI-1411085-100_TRF_iec60950."

Conclusion:All critical components comply with IEC 60950-1: 2005, or relevant component standards.

5.3.1 Operating Mode

Prior to and during testing, proper operation of the equipment was confirmed. An operational status check was successfully performed prior to and after each test, verifying the equipment is within acceptable performance limits. Equipment was inspected for damages after each test. No issues were found.

The Verity software was not used during EMC tests because the hardware is only fully exercised while people are voting and casting their ballots. To exercise some of the features of each new Verity hardware device, test software was run during EMC tests to exercise the model's particular hardware features.

During EMC testing, the hardware was exercised via test software as follows:

Verity Controller:

- Check Status LEDs / Switches (before and after test)
    - Run Platform Configuration Utility (and leave it running)
    - Set poll worker LED to flashing (blue)
    - Set power source LED to amber
    - Check buttons/switches (before and after test)
        - Tablet Lock switch
        - Poll worker push button (on rear I/O panel)
        - Validation push button (in vDrive bay)
- Bar code scanner
    - Run notepad, make sure it is the active app
    - Scan a bar code before and after the test – the text should show up in Notepad
    - The bar code scanner remains plugged in during the test

- Thermal Printer (during test)
    - Run Thermal Printer EMI test – it should print the time/date on a new line about every 15 seconds
- File I/O test (during test)
    - Run the File I/O test – it writes data to the USB flash drive (vDrive) – the USB drive's status LED should flash RED while data is being written
- Network Ping Test – sends 65,500 byte ICMP ping packets over the network to the Touch and Touch with Access (during test)
    - The Controller is IP Address: 192.168.0.100
    - ping 192.168.0.102 (the Touch)
    - ping 192.168.0.104 (the Touch with Access)

Verity Touch:
- Check Status LEDs / Switches (before and after test)
  - Run Platform Configuration Utility (and leave it running)
  - Set poll worker LED to flashing (blue)
  - Set power source LED to amber
  - Check buttons/switches (before and after test)
    - Tablet Lock switch
    - Poll worker push button (on rear I/O panel)
    - Validation push button (in vDrive bay)
- Network Ping Test – sends 65,500 byte ICMP ping packets over the network to the Controller and Touch with Access units (during test)
  - The Touch's IP Address: 192.168.0.102
  - ping 192.168.0.100 (the Controller)
  - ping 192.168.0.104 (the Touch with Access)

Verity Touch with Access:

- Check Status LEDs / Switches (before and after test)
  - Run Platform Configuration Utility (and leave it running)
  - Set poll worker LED to flashing (blue)
  - Set power source LED to amber
  - Check buttons/switches (before and after test)
    - Tablet Lock switch
    - Poll worker push button (on rear I/O panel)
    - Validation push button (in vDrive bay)
- Test ATI functionality (before and after test)
  - Run ATI Test program, verity it's the active window and then test the buttons and rotary on the ATI and also verify the Red Green Jelly Switches are working.
- Audio Test – plays an audio clip repeatedly to the headphones that are attached to the ATI (during test)
- Network Ping Test – sends 65,500 byte ICMP ping packets over the network to the Controller and Touch units (during test)
  - The Touch with Access's IP Address: 192.168.0.104
  - ping 192.168.0.100 (the Controller)
  - ping 192.168.0.102 (the Touch)

5.4 Known Vulnerabilities Testing

Hart Verity Voting 2.0 is a modification of **Verity Voting 1.**0, which has had only limited exposure in the field.

There are no known vulnerabilities to this particular system, the Hart Verity voting system (Verity 1.0 and Verity 2.0), at this time.

Review of the "Known Vulnerabilities" database, maintained by SLI, has provided 14 known vulnerabilities to previous Hart (non-Verity) systems already accounted for in SLI's Test Methods.

Within the declared system, the only public facing components are the **Verity Scan** precinct optical scanner, which processes ballots marked by voters in a public polling place, **Verity Touch Writer**, a precinct place ballot marking device, these devices are included as part of the **Verity Voting 1.0** voting system. New public facing components to **Verity Voting 2.0** are polling place devices **Verity Controller** and **Verity Touch**/**Verity Touch with Access,** which are used in tandem as part of the **Verity Voting 2.0** DRE solution to enable voters to cast ballots electronically. The voting center device **Verity Printer** is not a public facing component.

Verity Central is a central count location device, which is implemented in a secure environment.

5.5 Functional Testing Summary

SLI performed tests on each of the system configurations identified in Sections 3 and 4.2. of this test report. The testing incorporated end-to-end election scenarios testing the functionality supported by Hart.

5.5.1 How each Device was tested

Functionality was tested as identified below. The following functional areas exist for Hart InterCivic Verity 2.0 voting system.

5.5.1.1 Verity Touch Writer

- o **Verity Touch Writer** is a standalone precinct level ballot marking device. It assists voters in marking their ballot and prints it out for them. Once the ballot is printed, **Verity Touch Writer** erases all memory components of that session.
- o **Verity Touch Writer** was tested first as an individual component in order to verify that all declared functionality is present and working as documented, utilizing **Verity Build** produced media and data. All documented features were tested, and all functional features were verified to be documented.
- o **Verity Touch Writer** was then tested as an integrated piece of the voting system, in several different test suites, where it accepted user input

instructions, prior to producing marked ballots that mirror user intent, utilizing all HAVA related options.

o Each function of the **Verity Touch Writer** device was examined in individual component testing to determine whether it functioned as expected. Each screen was inspected and exercised in order to provide full coverage. All supported ballot sizes were exercised on the device as well. **Verity Touch Writer** testing also included all applicable HAVA aspects.

o **Verity Touch Writer** was also tested within multiple system level tests that simulated election day activities.

5.5.1.2 Verity Scan

o **Verity Scan** is a standalone precinct level scanning device. It accepts and records votes from voter hand marked ballots, as well as from **Verity Touch Writer** marked ballots. Data from the votes cast is stored in a **Verity vDrive** and transported to central count locations for accumulation and tallying in **Verity Count**.

o **Verity Scan** was tested first as an individual component in order to verify that all declared functionality is present and working as documented, with **Verity Build** produced media and data. All documented features were tested, and all functional features were verified to be documented.

o As an individual component, each function contained within the **Verity Scan** device was examined to determine that it functioned as expected. Each screen was inspected and exercised in order to provide full coverage. All supported ballot sizes were exercised on the device as well.

o **Verity Scan** was also tested as an integrated piece of the voting system in several different test suites, where it inputs **Verity Build** produced media and data, then accepts user filled out ballots as well as **Verity Touch Writer** produced ballots within the polling place, prior to producing all defined output media.

o **Verity Scan** was also tested within the Accuracy test, Volume test, Stress test, and multiple system level tests that simulated election day activities.

5.5.1.3 Verity Controller/Verity Touch & Verity Touch with Access

o **Verity Touch** is a standalone precinct level DRE. It assists voters in marking their ballot and casts the ballot electronically for them. Once the ballot is cast, **Verity Touch** closes the session.

o **Verity Touch** was tested first as an individual component in order to verify that all declared functionality is present and working as documented, utilizing **Verity Build** produced media and data. All documented features were tested, and all functional features were verified to be documented.

o **Verity Touch** was then tested as an integrated piece of the voting system, in several different test suites, where it accepted user input instructions, prior to producing electronically marked ballots that mirror user intent, utilizing all HAVA related options (**Verity Touch with Access**).

- o As an individual component each function contained within the **Verity Touch** (and **Verity Touch with Access**) device was examined to determine that it functioned as expected. Each screen was inspected and exercised in order to provide full coverage. **Verity Touch** testing also included all applicable HAVA aspects (**Verity Touch with Access**).
- o **Verity Touch** was also tested within the Accuracy test, Volume test, Stress test, and multiple system level tests that simulated election day activities.

5.5.1.4 Verity Print

- o **Verity Print** is a standalone central location ballot printing device. Once the ballot is printed, the voter can cast the ballot through **Verity Scan** or through **Verity Central**.
- o **Verity Print** was tested first as an individual component in order to verify that all declared functionality is present and working as documented, utilizing **Verity Build** produced media and data. All documented features were tested, and all functional features were verified to be documented.
- o **Verity Print** was then tested as an integrated piece of the voting system, in several different test suites, where it accepted user input instructions, prior to producing ballots which were then marked and cast through both **Verity Scan** and **Verity Central**.

5.5.1.5 Verity vDrive

- o **Verity vDrive** is a Verity memory device. It carries information from **Verity Build** to each of the components within the **Verity** system during the pre-voting phase of an election. On election day, data from the votes cast in **Verity Scan** and **Verity Central** is stored in a **Verity vDrive** and transported to central count locations for accumulation and tallying.
- o **Verity vDrive** was tested first as an individual component in order to verify that all declared functionality is present and working as documented, utilizing **Verity Build** produced media and data. All documented features were tested, and all functional features were verified to be documented.
- o **Verity vDrive** was also tested as an integrated piece of the voting system where it inputs **Verity Build** produced media and data, then accepts and transports cast vote record data and ballot images from the polling place to **Verity Count**.

5.5.1.6 Verity Key

- o **Verity Key** is a Verity security device. It carries security information from **Verity Build** to each of the components within the **Verity** system.
- o **Verity Key** was tested first as an individual component in order to verify that all declared functionality is present and working as documented, utilizing **Verity Build** produced data. All documented features were tested, and all functional features were verified to be documented.

- o **Verity Key** was also tested as an integrated piece of the voting system, where it is utilized for authorizing loading election information onto **Verity Touch Writer**, **Scan** and **Central**, as well as accumulating vote data into **Verity Count**.

5.5.2 How each Application was tested

5.5.2.1 Verity Data

- o **Verity Data** accepts imported election data and produces contests, choices, precincts, districts, ballots, and all other data needed to import an election into **Verity Build.**
- o **Verity Data** was tested first as an individual component in order to verify that all declared functionality is present and working as documented. All documented features were tested, and all functional features were verified to be documented.
- o **Verity Data** was also tested as an integrated piece of the voting system where it outputs election data to be used by **Verity Build.**

5.5.2.2 Verity Build

- o **Verity Build** accepts imported election information and produces ballots, election information, **Verity vDrives** and **Verity Keys**.
- o **Verity Build** was tested first as an individual component in order to verify that all declared functionality is present and working as documented. All documented features were tested, and all functional features were verified to be documented.
- o **Verity Build** was also tested as an integrated piece of the voting system where it outputs **Verity Build** produced media and data (via Verity Key and vDrive), which feed into **Verity Touch Writer**, **Verity Scan**, **Verity Central** and **Verity Count**.

5.5.2.3 Verity Central

- o **Verity Central** is a central count location system that utilizes high speed scanners to scan large volumes of voted ballots, which are recorded onto a **Verity vDrive** for transportation to **Verity Count** for accumulation and tallying.
- o **Verity Central** was tested first as an individual component in order to verify that all declared functionality is present and working as documented. All documented features were tested, and all functional features were verified to be documented.
- o **Verity Central** was also tested as an integrated piece of the voting system where it inputs **Verity Build** produced media and data, then accepts user filled out ballots as well as **Verity Touch Writer** produced ballots, prior to producing all defined output medias.

5.5.2.4 Verity Count

- o **Verity Count** is the **Verity** application used for accumulation and tallying of voted ballots, transported via **Verity vDrive**, from **Verity Scan** and **Verity Central**.
- o **Verity Count** was tested first as an individual component in order to verify that all declared functionality is present and working as documented. All documented features were tested, and all functional features were verified to be documented.
- o **Verity Count** was also tested as an integrated piece of the voting system where it inputs **Verity Build** produced media and data, then accepts **Verity vDrive** data from **Verity Scan** and **Verity Central**, prior to tabulating results and producing all defined output reports.

5.5.2.5 Verity Election Manager

- o **Verity Election Manager** is the **Verity** application used for importing, exporting, archiving and restoring elections into and from **Verity Build, Central and Count**.
- o **Verity Election Manager** was tested first as an individual component in order to verify that all declared functionality is present and working as documented.
- o **Verity Election Manager** was also tested as an integrated piece of the larger voting applications where it resides (**Verity Build**, **Central** and **Count**), verifying that it performed the appropriate functions for the parent application.

5.5.2.6 Verity User Manager

- o **Verity User Manager** is the **Verity** application used for creating and managing all user roles and accounts within each of the parent applications, **Verity Build, Central and Count**.
- o **Verity User Manager** was tested first as an individual component in order to verify that all declared functionality is present and working as documented.
- o **Verity User Manager** was also tested as an integrated piece of the larger voting applications where it resides (**Verity Build**, **Central** and **Count**), verifying that it performed the appropriate functions and managed the pertinent roles for the parent application.

5.5.2.7 Verity Desktop

- o **Verity Desktop** is the **Verity** application used for setting workstation date/time, accessing the desktop and gathering hash codes for **Verity Build, Central and Count**.
- o **Verity Desktop** was tested first as an individual component in order to verify that all declared functionality is present and working as documented.
- o **Verity Desktop** was tested as an integrated piece of the larger voting applications where it resides (**Verity Build**, **Central** and **Count**), verifying that it performed the appropriate functions for the parent application.

5.5.3 How different System Level Configurations were tested

Verity Data/Build, **Verity Central** and **Verity Count** are each capable of being run as standalone instantiations or networked with a central database. Additionally, **Verity Data/Build** and **Verity Count** are able to be run on the same physical device as **Verity Data/Build/Count** workstations. **Verity Data/Build/Count** can also be utilized in either a stand-alone implementation or a networked configuration. Given these possible configurations, the following configurations were exercised:

- **Verity Data/Build** was tested in standalone mode with accompanying database

- **Verity Count** was tested in standalone mode with accompanying database

- **Verity Data/Build/Count** was tested in standalone mode with accompanying database

- **Verity Central** was tested in standalone mode with accompanying database

- **Verity Data/Build** server was tested in a networked mode with accompanying database and 3 client workstations (total of 4 workstations).

- **Verity Count** server was tested in a networked mode with accompanying database and 3 client workstations (total of 4 workstations).

- **Verity Data/Build/Count** server was tested in a networked mode with accompanying database and 3 client workstations (total of 4 workstations).

- **Verity Central** server was tested in a networked mode with accompanying database and 3 client workstations (total of 4 workstations).

5.5.4 Test Suites Utilized

The following test suites were executed:

5.5.4.1 Verity Election Manager test suite

All functionality present in **Verity Election Manager** was verified to work as documented, providing the appropriate functionality for each main application/workstation type, and that all functionality is appropriately documented.

This test covered **Verity Build, Verity Central** and **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.2 Verity User Manager test suite

All functionality present in **Verity User Manager** was verified to work as documented, providing the appropriate functionality for each main application/workstation type, and all functionality is appropriately documented.

This test covered **Verity Build, Verity Central** and **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.3 Verity Desktop test suite

All functionality present in **Verity Desktop** was verified to work as documented, providing the appropriate functionality for each main application/workstation type, and all functionality is appropriately documented.

This test covered **Verity Build, Verity Central** and **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.4 Verity Data – standalone workstation test suite

All functionality present in **Verity Data** was verified to work as documented, and all functionality is appropriately documented.

This test covered **Verity Data** in a stand-alone configuration and focused on all functionality within the application.

Initial test resulted in Discrepancy HV-11, data import failed when import precincts with splits .

This discrepancy can be seen in further detail in "Attachment H – Discrepancies".

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.5 Verity Data – Client/Server configuration, Networked test suite

Testing of the client/server configuration for **Verity Data** was the focus of this testing, such that reliability of data consistency was verified in a networked setting. **Verity Data** networked supports a Server/Client workstation and up to 3 additional Client workstations, and was tested in its maximum configuration of 4 total workstations. The focus of the testing for the networked configuration was to verify that no concurrency issues existed. Updates to common functionalities were handled in a logical manner and as intended. No database issues were introduced, nor any data corruption. Audit logs correctly recorded the transactions performed by each user. No escalation of privileges occurred when multiple levels of role access were involved.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.6 Verity Build – standalone workstation test suite

All functionality present in **Verity Build** was verified to work as documented, and all functionality is appropriately documented.

This test covered **Verity Build** in a stand-alone configuration and focused on all functionality within the application.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.7 Verity Build – Client/Server configuration, Networked test suite

Testing of the client/server configuration for **Verity Build** was the focus of this testing, such that reliability of data consistency was verified in a networked setting. **Verity Build** networked supports a Server/Client workstation and up to 3 additional Client workstations, and was tested in its maximum configuration of 4 total workstations. The focus of the testing for the networked configuration was to verify that no concurrency issues existed. Updates to common functionalities were handled in a logical manner and as intended. No database issues were introduced, nor any data corruption. Audit logs correctly recorded the transactions performed by each user. No escalation of privileges occurred when multiple levels of role access were involved.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.8 Verity Central– standalone workstation test suite

All functionality present in **Verity Central** was verified to work as documented, and all functionality is appropriately documented.

This test covered **Verity Central** in a stand-alone configuration and focused on all functionality within the application.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.9 Verity Central – Client/Server configuration, Networked test suite

Testing of the client/server configuration for **Verity Central** was the focus of this testing, such that reliability of data consistency was verified in a networked setting. **Verity Central** networked supports a Server/Client workstation and up to 3 additional Client workstations, and was tested in its maximum configuration of 4 total workstations. The focus of the testing for the networked configuration was to verify that no concurrency issues existed. Updates to common functionalities were handled in a logical manner and as intended. No database issues were introduced, nor any data corruption. Audit logs correctly recorded the transactions performed by each user. No escalation of privileges occurred when multiple levels of role access were involved.

This test was without issue, and each device and application passed the tests in this suite.

5.5.4.10 Verity Count– standalone workstation test suite

All functionality present in **Verity Count** was verified to work as documented, and all functionality is appropriately documented.

This test covered **Verity Count** in a stand-alone configuration and focused on all functionality within the application.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.11 Verity Count – Client/Server configuration, Networked test suite

Testing of the client/server configuration for **Verity Count** was the focus of this testing, such that reliability of data consistency was verified in a networked setting. **Verity Count** networked supports a Server/Client workstation and up to 3 additional Client workstations, and was tested in its maximum configuration of 4 total workstations. The focus of the testing for the networked configuration was to verify that no concurrency issues existed. Updates to common functionalities were handled in a logical manner and as intended. No database issues were introduced, nor any data corruption. Audit logs correctly recorded the transactions performed by each user. No escalation of privileges occurred when multiple levels of role access were involved.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.12 Verity Data/Build/Count– standalone workstation test suite

This test covered **Verity Data/Build/Count** in a stand-alone configuration. The test focused on all functionality within the three applications and verified that the applications did not interfere with each other, nor produce unexpected behavior.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.13 Verity Data/Build/Count – Client/Server configuration, Networked test suite

Testing of the client/server configuration for **Verity Data/Build/Count** was the focus of this testing, such that reliability of data consistency was verified in a networked setting. **Verity Data/Build/Count** networked supports a Server/Client workstation and up to 3 additional Client workstations, and was tested in its maximum configuration of 4 total workstations. The focus of the testing for the networked configuration was to verify that no concurrency issues existed. No database issues were introduced, nor any data corruption. Audit logs correctly recorded the transactions performed by each user. No escalation of privileges occurred when multiple levels of role access were involved.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.14 Verity Print test suite

All functionality, including administrative, maintenance as well as election day functionality, present in **Verity Print** was verified to work as documented, and all functionality is appropriately documented.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.15 Verity Scan test suite

All functionality, including administrative, maintenance as well as election day poll worker functionality, present in **Verity Scan** was verified to work as documented, and all functionality is appropriately documented.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.16 Verity Touch Writer test suite

All functionality, including administrative, maintenance as well as election day poll worker functionality, present in **Verity Touch Writer** was verified to work as documented, and all functionality is appropriately documented.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.17 Verity Controller/Touch and Touch with Access test suite

All functionality, including administrative, maintenance as well as election day poll worker functionality, present in **Verity Controller/Touch and Touch with Access** was verified to work as documented, and all functionality is appropriately documented.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.18 Verity Controller/Touch and Touch with Access Chain test suite

Verity Controller can be chained to as many as 12 **Verity Touch** and/or **Verity Touch with Access** devices. A full chain of devices was tested. **Verity Controller/Touch and Touch with Access** was verified to work as documented and as expected, and all functionality is appropriately documented.

This test was completed without issue, and the configuration passed the tests in this suite.

5.5.4.19 GenVariation1 test suite

The focus of this suite was validating N of M voting, Partisan offices, Non-Partisan Offices, Ballot Rotations, Write-Ins, Ballot Formatting, precincts and split precincts, as well as Tally and Reporting functionality.

This test covered **Verity User Manager, Verity Election Manager, Verity Desktop**, **Verity Data, Verity Build**, **Verity Print, Verity Controller/Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan** into **Verity Count**.

Languages implemented in the suite included English, Spanish and (English/Spanish).

Initial test resulted in Discrepancies HV-12, error message when saving empty added write-in candidate, and HV-13, error when trying to assign write-in vote to candidate already voted for.

These discrepancies can be seen in further detail in "Attachment H – Discrepancies".

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.20 GenVariation2 test suite

This suite built upon the GenVariation1 Test. Additional definition was added, with a focus on validating N of M voting, Straight Party voting, Cumulative voting, Partisan offices, Non-Partisan Offices, Write-Ins, ADA/HAVA, as well as Tally and Reporting functionality.

This test covered **Verity User Manager, Verity Election Manager, Verity Desktop**, **Verity Data, Verity Build**, **Verity Print, Verity Controller**/**Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan** into **Verity Count**.

Languages implemented in the suite included English, Spanish and (English/Spanish). ADA devices utilized included headphones, paddles, and sip and puff.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.21 PriOpen test suite

The focus of this suite was an election designed to conform to an Open Primary election with focus on validating primary presidential delegation nominations, N of M voting, Partisan offices, Non-Partisan Offices, Ballot Rotations, Ballot Formatting, ADA/HAVA, precincts and split precincts, as well as Tally and Reporting functionality.

This test covered **Verity User Manager, Verity Election Manager, Verity Desktop**, **Verity Data, Verity Build**, **Verity Print, Verity Controller**/**Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan** into **Verity Count**.

Languages implemented in the suite included English, Spanish and (English/Spanish).

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.22 PriClosed test suite

The focus of this suite was an election designed to conform to a Closed Primary election with N of M voting, Partisan offices, Non-Partisan Offices, Ballot Formatting, ADA/HAVA, precincts and split precincts, as well as Tally and Reporting functionality

Languages implemented in the suite included English, Spanish and (English/Spanish).

This test covered **Verity User Manager, Verity Election Manager, Verity Desktop**, **Verity Data, Verity Build**, **Verity Print, Verity Controller**/**Touch** and **Touch with Access, Verity**

Touch Writer, **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan** into **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.23 Error Messaging and Recovery test suite

Testing in this suite focused on Error Messaging and Recovery in key areas of the system identified from researching previous testing and voting system documentation to help identify potential failure points. Voting systems can be subject to various conditions and when the system exceeds limitations, errors are typically found. Testing of Error messaging focused on the appropriate error messages being generated in response to specific errors, and content of the message. Methods employed to generate errors included attempting to access functions out of order or without authorization, erroneous responses to error messages, and use of invalid USB blank drives as well as invalid inputs. Testing of the voting system Error Recovery capability was also incorporated into Stress testing in order to leverage the necessary range of performance impacts needed to generate system errors and force recoveries. The test suite verified that the recoveries were adequate, the system and audit log's validity of content, and that any downstream process were not negatively affected by errors.

This test covered **Verity User Manager, Verity Election Manager, Verity Desktop**, **Verity Data**, **Verity Build**, **Verity Controller/Touch and Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.24 Audit test suite

Audit records are used to track what system functions have been executed, what data has been modified, as well as by whom and when. Election audit trails provide the supporting documentation for verifying the accuracy of reported election results. They present a concrete, indestructible archival record of all system activity related to the vote tally, and are essential for public confidence in the accuracy of the tally, for recounts, and for evidence in the event of criminal or civil litigation. Additionally, audit record data content can be a key factor in identifying system anomalies and provide assistance in troubleshooting system errors.

Analysis of the **Verity 2.0** voting system was performed to determine the content needed to accurately depict the machinations of the system for the given situation was properly captured. This test suite looks at the overall coverage of auditing of events within the **Verity 2.0** system as well as the content of the audit record in order to ensure sufficient information is captured. The **Verity 2.0** applications utilize both an audit log and a system log to track workstation occurrences at two different levels. Tests were incorporated into Election Validation suites as well as specific Audit validation suites, such that all related requirements were explicitly validated.

This test covered **Verity User Manager, Verity Election Manager, Verity Desktop**, **Verity Data**, **Verity Build**, **Verity Controller/Touch and Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.25 Accuracy test suite

Testing the ability of the system to capture, record, store, consolidate and report the specific selections and absence of selections, made by the voter for each ballot position without error.

Required accuracy is defined in terms of an error rate that for testing purposes represents the maximum number of errors allowed while processing a specified volume of data. For the Accuracy test, the defined volume is no errors in 1.55 million ballot marking positions, or no more than 1 error in 3.1 million ballot marking positions.

Accuracy testing was conducted at both the device level and the system level.

Each device was subjected to scrutiny that verified that the requirements for accuracy are met. Additionally, the system was reviewed and exercised to validate that the accumulation, tallying and reporting mechanisms at the system level are able to accurately perform their functions.

This test covered, **Verity Scan**, **Verity Touch Writer, Verity Controller/Touch and Touch with Access, Verity Central** as well as **Verity Count**. Vote counts were accumulated from **Verity Controller/Touch and Touch with Access, Verity Central** and **Verity Scan**. Note that **Verity Central** was tested with all supported scanners.

Verity Scan supports 3 base ballot sizes

- 8.5" x 11"
- 8.5" x 14"
- 8.5" x 17"

Each ballot size was exercised in the **Verity Scan**. Each size contained 2600 ballots with 600 ballot marking positions. This totaled 7800 ballots and 4.8 million marking positions read by **Verity Scan**.

Verity Touch Writer supports 3 base ballot sizes

- 8.5" x 11"
- 8.5" x 14"
- 8.5" x 17"

Each ballot size was exercised in the **Verity Touch Writer**. Each size contained 50 ballots with 600 ballot marking positions. This totaled 150 ballots and 90,000 marking positions, which were then read by **Verity Scan**.

Verity Central supports 3 scanner types and 4 base ballot sizes

- 8.5" x 11"
- 8.5" x 14"

- 8.5" x 17"
- 11" x 17"

Each ballot size was exercised in **Verity Central** through each scanner type. Each size contained 2600 ballots with 600 ballot marking positions. This totaled 7800 ballots and 4.8 million marking positions through each scanner type, for a total of 23,400 ballots and 14.4 million ballot marking positions.

Voting positions were distributed on each ballot size so as to exercise the entire ballot. This was done by eliminating contest headers which maximized the area for distribution of the ballot marking positions.

Verity Controller/Touch and **Touch with Access** were exercised with the electronic version of the ballots.

All ballot sizes and ballots exercised as described above, were inputted into **Verity Count**. This accumulated to 32,350 ballots and 20.1 million ballot marking positions.

All Accuracy tests were completed without issue, and each device and application passed the tests in this suite.

5.5.4.26 Mark Sensitivity test suite

The purpose of Ballot Mark Sensitivity testing was to determine that the system under test is able to accurately determine when a mark has been made within a ballot marking position. For this test, various marks were made within the ballot marking positions, using Verity supported colors of ink.

Marks include fully filled boxes, left and right oriented slashes, "X" markings, check marks, horizontal single line marks, and circles of various sizes. Marks also included vertical lines within the marking position that fill approximately five percent of the designated space. Small dots down to approximately two percent of the ballot marking position are also included.

The **Verity** specifications specify that only blue or black ink is to be utilized in the marking of ballot positions. These ink colors had no issues. Additional inks were also tested, as well as #2 pencil lead. The colors purple and green and the pencil lead were read without issue on both **Verity Scan** and **Verity Central.** The ink colors red, orange and pink were tested and were able to be read on **Verity Central**, but were not detected on **Verity Scan**. The results on **Verity Scan** were not unexpected as the scanner employs an LED light source. As **Verity Scan** is a polling place device, the governance of marking utensils should be able to prevent issues with these ink colors. This test covered **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan** into **Verity Count**.

This test was completed as described above and each device and application passed the tests in this suite.

5.5.4.27 Volume and Stress test suite

Volume Testing consists of a system's response when subjected to large quantities of data, "more than the expected", as called out in the standards. Volume testing is typically considered a type of non-functional testing. However, as a voting system's primary function is to accumulate, tally, and pass a volume of data (votes) the VSTL approaches volume testing as a functional test. Experience has shown that large amounts of data can slow a system, or even cause failures and loss of data due to architectural limitations. The testing focused on not only passing large amounts of data but how the system operates and handles the data in key areas of functionality within the voting system. Vote gathering components (**Verity Controller/Touch and Touch with Access, Verity Scan** and **Verity Central**) were subjected to volumes of data that met the upper limits of expected performance.

Verity Scan is a standalone device that processes ballots one at a time. Anticipated expected usage in an election environment is 1,000 ballots per device. The test was conducted in a 12 hour time period and 2,500 ballots.

Verity Central is designed to run either in standalone or in networked configurations of up to 4 workstations (1 Server/Client and 3 Clients). The Server/Client workstation maintains the database for all 4 workstations. This configuration was exercised in order to create a significant volume on **Verity Central**. The Kodak i5600 ballot scanner has an expected usage of 20,000 ballots in an 8 hour period. The Cannon DR-G1100 ballot scanner has an expected usage of 14,000 ballots in an 8 hour period. The Cannon DR-G1130 ballot scanner has an expected usage of 14,500 ballots in an 8 hour period. 1 Kodak i5600, 2 Cannon DR-G1100's and 1 CannonDR-G1130 were utilized in this volume/stress configuration. The expected usage was 62,500 ballots in an 8 hour period. The test was conducted in a 12 hour period and processed 85,000 ballots.

Verity Controller/Touch and Touch with Access is designed to run with up to 12 **Verity Touch/Touch with Access** devices. This configuration was exercised in order to create a significant volume for the chained DRE's. Each Touch/Touch with Access would be expected usage of 120 ballots in an 8 hour period. A full chain implementation had an expected 1440 ballots in an 8 hour period. The test was conducted in a 8 hour period and processed 2100 ballots.

This test covered **Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan**.

Stress testing consists of a "system's response to transient overload conditions." Experience has shown that when passing a dataset through a system that eclipses the system architectural limitations, failures can occur and result in the loss of critical data. The testing focused on the system's ability to operate after the limitations have been exceeded and if failures occur, how the data is maintained or recovered in key areas of functionality within the voting system. Vote gathering components (**Verity Controller/Touch and Touch with Access, Verity Scan** and **Verity Central**) were subjected to volumes of data that surpassed the upper limits of expected performance.

As this test is the "next step" from the Volume test, it was performed at the conclusion of the Volume test, utilizing the implementation setup as described for the Volume test.

Verity Scan. The test was conducted in an additional 8 hour time period and processed an additional 3500 ballots on the same device. The number of ballots for the device totaled 6,000.

Verity Central. The test was conducted in an additional 8 hour time period and processed an additional 65,000 ballots on the same configuration. The number of ballots for the component totaled 150,000.

Verity Controller/Touch and Touch with Access The test was conducted in an additional 16 hour time period and processed an additional 3947 ballots on the same configuration. The number of ballots for the component totaled 6047.

This test covered **Verity Build**, **Verity Touch Writer**, **Verity Scan**, **Verity Controller/Touch and Touch with Access, Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.28 Language testing

Testing was conducted to ensure the voting system is capable of implementing and presenting the ballot, ballot selections, review screens and instructions in the required languages, English and Spanish, both visually as well as aurally. This testing is incorporated in the General and Primary test suites detailed within this section.

This testing covers **Verity Data, Verity Build**, **Verity Controller/Touch and Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**. Vote counts were accumulated from both **Verity Central** and **Verity Scan**.

This testing was completed without issue, and each device and application passed the tests in this suite.

5.5.4.29 Data Retention and Hardware Integrity testing

Integrity requirements ensure the physical stability and function of the vote recording and counting processes, such that the system is not prone to a single point of failure that would prevent voting at a polling place. Testing verified prevention of failure of data input or storage, in terms of data retention, as well as confirming that appropriate audit records are maintained and cannot be modified.

The requirements related to this testing were incorporated into other test suites for validation. A review of all testing performed and notation of any pertinent issues encountered also factored into the requirements validation consideration.

This testing covers **Verity Data, Verity Build**, **Verity Print, Verity Controller/Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**.

This testing was completed without issue, and each device and application passed the tests in this suite.

5.5.4.30 Security Access Control test suite

Access control testing verifies procedures and system capabilities that detect or limit access to system components in order to guard against loss of system integrity, availability, confidentiality, and accountability. This testing verified that system resources such as data files, application programs and computer-related facilities and equipment are protected against unauthorized operation, modification, disclosure, loss or impairment. Unauthorized operations include modification of compiled or interpreted code, run-time alteration of flow control logic or of data, and abstraction of raw or processed voting data in any form other than a standard output report by an authorized operator.

This testing covers **Verity Data, Verity Build**, **Verity Print, Verity Controller/Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.31 Security Software test suite

Software security testing was conducted to verify the installation procedures and ongoing foreign software detection, prevention of unauthorized updates and mitigation abilities of the voting system in order to protect against the modification of the software and/or the insertion of malicious software during the installation and during ongoing operations.

Hart's Devices and Desktop systems rely upon a security in depth posture that includes Whitelisting, utilizing McAfee Solidifier, implementing a kiosk mode for all devices and workstations, restricted operating system access, utilization of MS EWF, checksum checks, secured BIOS, prevention of boot to external devices, encrypted transmissions, proprietary USB components, digital signatures and pared down operating systems with only required features and services.

This testing covers **Verity Data, Verity Build**, **Verity Print, Verity Controller/Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.32 Physical Security Measures test suite

Physical security testing verified monitoring and control of the environment of the work place and computing facilities. It also verified control of access to and from such facilities. Controls separating the network and work place into functional areas are also physical controls. Some portions of physical security are functional while other portions are procedural. Functional portions were tested as appropriate while procedural portions were verified to be documented as prescribed by the VVSG 1.0. For polling place devices, **Verity Scan** and the accompanying ballot box, were inspected for the **Hart** prescribed locks and

seals, as well as confirming that the physical device and accompanying ballot box were resistant to unauthorized access and provided for detection of tampering. For **Verity Touch Writer**, the device was inspected for **Hart** prescribed locks, resistance to unauthorized access, as well as providing for detection of tampering. Note that no telecommunications are implemented in the polling place.

This testing covers **Verity Data, Verity Build**, **Verity Print, Verity Controller**/**Touch** and **Touch with Access, Verity Touch Writer**, **Verity Scan**, **Verity Central** as well as **Verity Count**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.33 Audio test suite

Audio testing was performed in order to verify that the polling place ballot marking device, **Verity Touch Writer**, as well as **Verity Controller**/**Touch** and **Touch with Access** fell within the acceptable parameters of hearing as defined in the VVSG 1.0.

This test covered **Verity Controller**/**Touch** and **Touch with Access, Verity Touch Writer**.

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.34 Accessibility and Usability test suite

Testing accessibility requirements for a voting system generally consists of both objective and observable requirements. In combination, the two types of requirements verify that the voting system components are accessible to all eligible voters, including those that may have a type of challenge that creates a need for ATI peripherals of some type. The voting systems should be self contained to allow a voter to cast their vote without assistance from another person. Accessibility calls for the voting system to take into account degrees of vision, dexterity, mobility, aural issues, and speech and language proficiency.

Usability is defined as a measure of the effectiveness, efficiency, and satisfaction achieved by a specified set of users with a given product in the performance of specified tasks. In the context of voting, the primary user is the voter, the product is the voting system, and the task is the correct recording of the voter ballot selections. Testing is conducted to ensure voters are able to negotiate the process effectively, efficiently and comfortably according to the requirements dictated, including HAVA requirements.

This test's focus was as described above, as well as a review of the report of mandated usability study performed by Hart, as per VVSG 1.0 requirements.

This test covered **Verity Touch Writer, Verity Controller**/**Touch** and **Touch with Access** and **Verity Scan**

This test was completed without issue, and each device and application passed the tests in this suite.

5.5.4.35 Maintainability test suite

Maintainability encompasses a range of maintenance actions that examine all scheduled and unscheduled events in place for preventing failures on all hardware devices. Testing verifies the ease with which maintenance actions can be performed based on the design characteristics of the equipment and software. Non-technical election workers are to be able to be made aware of the problem through the equipment and software's ability to correctly self-diagnose problems.

This test included review of Hart documentation for maintenance actions as well as performance of those maintenance actions for ease of use and understandability.

This test covered **Verity Touch Writer, Verity Controller**/**Touch** and **Touch with Access** and **Verity Scan**

This test was completed without issue, and each device and application passed the tests in this suite.

5.6 Evaluation of Testing

The above tests were successfully conducted using the executables delivered in the final Trusted Build, in association with the appropriate hardware versions as declared in this Test Report for the **Hart InterCivic Verity 2.0** voting system.

Issues were found during functional testing as described in section "5.9 – Deficiencies Found During Testing". This resulted in a total of 4 Trusted Builds. The number of issues was reduced in number in each Trusted Build, with the final issues being resolved in Trusted Build #4.

After the initial Trusted Build, each subsequent round of testing consisted of discrepancy fix verification and additional regression testing. Analysis of each individual discrepancy determined the level of retesting required to verify the issue was resolved and did not result in any new issues occurring downstream within the system workflow. Often, the issue being addressed was isolated in its effect, but occasionally resulted in the test suite where the issue was first found, to be re-run in its entirety.

5.7 Environmental Hardware Test Summary

Based upon an examination of the equipment listed in Table 8 – COTS Equipment, and **Hart's** Hardware Specification, SLI concluded that the hardware listed is COTS (Commercial off the Shelf). As such, it is not subject to Environmental Hardware Testing.

SLI and its third-party certified hardware test laboratories, NTS Longmont formerly EMC Integrity, and Cascade TEK, executed Environmental Hardware testing on the non-COTS hardware listed in Table 7 – Hart Verity 2.0 Voting Equipment, and Table 4 – Hart Verity 2.0 Software and Firmware.

The testing consisted of:

- Electromagnetic Emissions / Immunity Tests:

  - Radiated Emissions – FCC, Part 15 Class B ANSI C63.4.
  - Conducted Emissions – FCC, Part 15 Class B ANSI C63.4.
  - ESD – IEC 61000-4-2 (2008) Ed. 2.0.
  - Electromagnetic Susceptibility – IEC 61000-4-3 (1996).
  - Electrical Fast Transient – IEC 61000-4-4 (2004-07) Ed. 2.0.
  - Lightning Surge – IEC 61000-4-5 (1995-02).
  - Conducted RF Immunity – IEC 61000-4-6 (1996-04).
  - Magnetic Fields Immunity – IEC 61000-4-8 (1993-06).
  - Electrical Power Disturbance – IEC 61000-4-11 (1996-06).

- Non-Operating Environmental Tests:

  - Bench Handling - MIL-STD-810D, Method 516.3, Procedure VI
  - Vibration - MIL-STD-810D, Method 514.3, Category 1- Basic Transportation, Common Carrier.
  - Low Temperature - MIL-STD-810D, Methods 502.2, Procedure I- Storage.
  - High Temperature - MIL-STD-810D, Methods 501.2, Procedure I- Storage.
  - Humidity (85%) Soak - MIL-STD-810D, Method 507.2, Procedure I- Natural Hot-Humid.

- Operating Environmental Tests:

  - Temperature/Power Variation - similar to the low temperature and high temperature tests of MIL-STD-810-D, Method 502.2 and Method 501.2.

  - Reliability – Vol. 1, Section 4 for the acceptable Mean Time Between Failure (MBTF).

5.7.1 Evaluation of Environmental Hardware Testing

No issues were found. Attachments G contain the hardware environmental reports from SLI's EAC approved Hardware Environmental Test Subcontractor(s), NTS Longmont formerly EMC Integrity, and Cascade TEK. These reports detail specific information on the environmental hardware testing. As of the writing of this report, all devices subjected to hardware testing, as listed above, have successfully passed all tests.

5.8 Quality Assurance and Configuration Management Audits

The review processes employed verified that the manufacturer not only has written processes and procedures in both the Quality Assurance and Configuration Management arenas, but that those processes and procedures were actually implemented within the software development life cycle that is used to produce the **Hart Verity Voting 2.0** version that is submitted for certification.

The QA portion of the review focused on the testing performed by **Hart InterCivic**. The scope of the testing performed was reviewed in order to verify that **Hart InterCivic** verified that all VVSG 1.0 requirements were met in **Verity 2.0**. SLI reviewed the test case design documents and data as provided by **Hart InterCivic**.

Coverage of tests employed by **Hart** was deemed satisfactory for appropriate robustness of **Verity 2.0** in meeting the requirements of the VVSG 1.0.

The CM portion of the review focused on the organization's understanding and implementation of the declared configuration management processes, procedures and policies. Deliverables were reviewed against all pertinent CM processes employed by **Hart InterCivic**. Interviews of pertinent staff, with regard to configuration management were conducted to verify that processes, procedures and policies are known, understood and implemented within the organization.

Implementation of the **Hart** configuration processes was adequately documented and followed throughout the course of the **Verity 2.0** project, and no issues were encountered.

5.9 Deficiencies Found During Testing

Discrepancies found fall into 4 major categories, Hardware, Documentation, Source Code, and Functional. Hardware discrepancies are issues that occur specifically in the hardware arena, and are usually found during the hardware testing phase. Documentation discrepancies are issues that occur during the PCA documentation review phase and are issues that are resolved by updates to the documentation. Source Code discrepancies are issues that occur during source code review and are issues that must be fixed in the source code prior to the Trusted Build. Functional discrepancies are issues that occur during functional testing and can be related to any software or firmware within the system. Functional discrepancies often lead to source code modifications, additional source code review and an additional Trusted Build.

5.9.1 Hardware Discrepancies

No hardware discrepancies were written during this campaign.

5.9.2 Documentation Discrepancies and Informationals

Discrepancy issues included:

- System change notes did not encompass documentation changes (#1&2)

- Requirement coverage not found (#16,17,18,19,20,25)

- Development comments left in (#21)

- Missing features (#23)

- Outdated information included (#24)

Informational issues included:

- Documents that were labeled as "Draft". (#3,4,5)

- Typo's (#6,7,8,9,10,11,12,13,14,15)

- Files in TDP but not listed in Overview (#22)

5.9.3 Source Code Discrepancies

Source code review generated 766 discrepancies during the review process.

Basic formatting and naming convention issues accounted for 710 of the issues.

Basic programming construct issues were addressed in 54 of the discrepancies.

Issues of a logic nature accounted for 2 of the discrepancies.

All issues were addressed prior to performing the initial Trusted Build

5.9.4 Functional Discrepancies

Functional testing generated 3 discrepancies. 2 additional discrepancies were reported by Hart Intercivic (HV-14 and HV-15).

System functionality issues accounted for 5 discrepancies.

- HV-11, data import failed when import precincts with splits, Verity Data

- HV-12, error message when saving empty added write-in candidate, Verity Central

- HV-13, error when trying to assign write-in vote to candidate already voted for, Verity Count

- HV-14, invalid "Cancel" button when booting, following a suspend polls action, Verity Scan

- HV-15, error generating write-in report after a reboot, after closing polls, Verity Controller

These issues can be seen in further detail in "Attachment H – Discrepancies".

All issues were resolved prior to the final Trusted Build.

5.9.5 Anomalies

Hardware Anomalies

During hardware testing at NTS Longmont formerly EMC Integrity, SLI personnel observed the following anomalies.

Lighting Surge IEC 61000-4-5 (1995-02)
Note: The File I/O test is part of Hart's test software to fully exercise all the features of each Verity model, test software was run during EMC/EMI tests to exercise the model's particular hardware features.

Controller:
- At + 2kV (common mode) line to earth (Line 1) caused the controller's thermal printer to stop printing. The test was stopped because Verity Controller's thermal printer stopped printing though the file I/O was still running.
  - Mitigation performed by Hart and observed by SLI personnel: stop and restart print test application.
- Following test protocol the test was restarted from the beginning, no problems occurred. Unable to reproduce the issue.

ESD IEC 61000-4-2 (2008) Ed.2.0
Controller:
- At +8kV vertical cause the controller's thermal printer to stop printing and lockup.
  - Power cycle controller and restarted ESD test.
- At -15kV, air discharge on the red power after 3 pulse cause the screen to freeze with distorted PIXS.

- Following ESD protocol the test was restarted, no problems occurred. Unable to reproduce the issue.

Touch with Access:
- At -15kV, air discharge to the ATI main cord connected to the Touch with Access cause the tablet to reset twice. This complied with ESD exit criteria (B) Self-Recovering.
    - Mitigation performed by Hart and observed by SLI personnel: stop and restart test applications on the Touch with Access.
- Following ESD protocol the test was restarted, no problems occurred. Unable to reproduce the issue.

1 anomaly was encountered during functional testing. This issue occurred once and was not able to be reproduced despite multiple retries on various environments, including the original environment.

When an invalid vDrive was attempted to be used, to write results to, the Verity Central application froze up instead of informing the user that the vDrive was invalid.

> This issue can be seen in further detail in "Attachment H – Discrepancies", Item #: HV-10.

5.10 Deficiencies

SLI has determined that there are no remaining unresolved deficiencies against the requirements tested.

6 Recommendations

SLI has successfully completed the testing of the Hart InterCivic Verity 2.0 voting system. It has been determined that the Verity 2.0 voting system meets the required acceptance criteria of the Election Assistance Commission Voluntary Voting System Guidelines 2005.

This recommendation reflects the opinion of SLI Compliance based on testing scope and results. It is SLI's recommendation based on this testing effort that the EAC grant certification of Hart InterCivic Verity 2.0 voting system.

SLI:

Traci Mapps
VSTL Director/Director of Operations
April 14th, 2016

7 EAC Certification & Voting System Configuration

This report has been submitted to the Election Assistance Commission on April 14th, 2016. Upon acceptance of this report by the EAC technical committee, a certification number will be issued for this modification.

This certification is for the Hart InterCivic Verity 2.0 voting system, configured as detailed in section 3 of this document.

End of Certification Test Report