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Test Plan for EAC 2005 VVSG 1.0 Certification Testing MicroVote EMS 4.4 Voting System

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1.0 INTRODUCTION

The purpose of this Test Plan is to document the procedures that Pro V&V, Inc. will follow to perform certification testing during a system modification campaign for the MicroVote EMS 4.4 Voting System to the requirements set forth for voting systems in the U.S. Election Assistance Commission (EAC) 2005 Voluntary Voting System Guidelines (VVSG), Version 1.0. Prior to submitting the voting system for testing, MicroVote submitted an application package to the EAC for certification of the EMS 4.4 Voting System. The application was accepted by the EAC and the project was assigned the unique Project Number of MVTEMS44.

At test conclusion, the results of all testing performed as part of this test campaign will be submitted to the EAC in the form of a national certification test report.

1.1 Description and Overview of EAC Certified System Being Modified

The MicroVote EMS 4.4 software functionality is divided by activity, based on each stage of the election. These activities are further divided into five modes, all building on each other to complete the election process: Administration, Election Setup, Ballot Setup, Programming & Printing, and Vote Tabulation. These modes combined, working together capture:

- Creating and maintaining default preferences and settings for a specific jurisdiction.
- Creating and maintaining preferences and settings for an election.
- Creating and maintaining security clearances for all users of EMS.
- Creating primary, general or both types of elections or municipal elections.
- Creating offices and filing candidates.
- Creating and maintaining all objects appearing on the ballot.
- Printing ballots.
- Programming voting devices.
- Printing reports of election data.
- Tallying election results.
- Generating reports of election results for state reporting systems, media displays, or printing.
- Creating and restoring backup files of election databases for archival purposes

The Administration mode is the system setup stage. This mode includes: Preferences, Political Parties, Vote Types, Precincts, Ballot Text, Ballot Graphics, Equipment, Equipment Assignment, and Security. Election Setup Reports reflecting each form are also available.

The Election Setup, Ballot Setup, and Programming & Printing modes are all pre-election activities. The Election Setup includes entering offices, filing candidates, creating secondary vote lockouts. In Ballot Setup, users create and edit ballots, build activations, and assign precincts. Programming & Printing includes programming voting machines and Smart Cards, previewing and printing ballots, and assigning voting panels to locations.

Phonetics, text-to-speech, option is built into EMS. All pronunciation of words, names or phrases can be altered for better listening comprehension. Reports are available for Election and Ballot setup for further election setup auditing.

Support has been added for an optional Voter Verifiable Printed Audit Trail (VVPAT) printer to be attached to the MicroVote Infinity voting panel. The EMS user can set the number of allowed voter voids (1-5) during the voting session and optional QR code printed on each ballot which contains ballot header information and ballot selections.

The Vote Tabulation mode is the final mode during which all tabulations and final results are produced. Election Night Reporting mode reports reflect the results as they are tabulated.

The EMS software supports the MicroVote Infinity voting panel with optional VVPAT printer attached. This panel is a direct recording electronic (DRE) device, and is connected to EMS via a serial port. Data/Vote tabulations exchange between the EMS and the Infinity machine is done directly through the serial port or via a Smart Card programmed for each election. OMR Ballot Cards, sometimes referred to as Absentee Cards, are optically scanned by a Chatsworth ACP 2200 reader.

Several COTS hardware items and software are used with the EMS software. EMS is designed to be used with Microsoft Windows 10 Pro X86/X64, and is installed on a Dell computer desktop and/or laptop. The database software is SQL Server 2017 Express. There is a COTS DOUBLETALK LT text-to-speech converter box attached to the Infinity machine. There are also COTS Smart Cards and Smart Card readers/writers. All OMR/Absentee ballot cards are optically scanned by the ACP 2200 reader.

1.1.1 Baseline Certified System

The EAC Certified System that is the baseline for the submitted modification is described in the following subsections. All information presented was derived from the previous Certification Test Report, the EAC Certificate of Conformance and/or the System Overview.

The baseline system for this modification is the EMS 4.2 Voting System. The tables below describe the certified equipment and firmware versions. Detailed descriptions of the EMS 4.2 test campaign are contained in Pro V&V Report No. TR-01-01-MVT-2016-01.01, Rev. C, which is available for viewing on the EAC's website at www.eac.gov.

Table 1-1. EMS 4.2 System Components

EMS 4.2 SYSTEM SOFTWARE	
Firmware/Software	Version
<i>Proprietary</i>	
Election Management Software (EMS)	4.2
<i>COTS</i>	
Microsoft Windows 10 Professional	1709
Microsoft Visual Studio 2017 Professional	15.5
ComponentOne Ultimate 2014	1
EMS 4.2 SYSTEM HARDWARE	
Component	Serial Number
<i>Proprietary</i>	
Infinity Voting Panel (VP-1 Rev: D05) w/Power Supply	11588
Infinity Voting Panel (VP-1 Rev: C) w/Power Supply	04689
<i>COTS</i>	
Dell OptiPlex 3020 w/Power Cord, Keyboard, & Mouse	BSNNK52
Dell OptiPlex 3020 w/Power Cord, Keyboard, & Mouse	FVNNK52
Dell Latitude EMS Computer (Model E5440 or E5570)	---
Dell 15" Monitor (E153FPb)	CN-0D5421-46633-4B8-0GVU T
Seiko Instruments Printer (DPU-3445) w/Power Supply	2008922A
EMS Download Cable	CC06789-06
USB Smart Card Reader (PC USB TR PIV) w/Stand (HWP109380 B)	113101316600170
DoubleTalk LT w/Radio Shack Headphones	[MVT-001]
Gearmo USB to RS-232 Converter (FTDI-LED)	USA000106043

1.1.2 Description of Modification

The submitted modifications for the EMS 4.4 test campaign include modifications to the baseline EMS 4.2 system. These modifications consisted of various enhancements and updates to add support and improve voting functions, replacements of end-of-life components, adding alternate components (Infinity Revision E and UPS), and adding support for optional VVPAT (Voter Verifiable Paper Audit Trail) thermal roll-to-roll printer within an election. Descriptions of the submitted modifications are described below:

Enhancements

1. E-01-(EMS/Infinity) – Added support for optional VVPAT (Voter Verifiable Paper Audit Trail) thermal roll-to-roll printer within an election.

2. E-01-(EMS) – Added support for polling locations.
3. E-02-(EMS) – Added support for equipment tracking.
4. E-03-(Infinity) – Added timing mark for VVPAT barcode.
5. E-04-(Infinity) – Allow Infinity programming through VVPAT port.
6. E-05-(Infinity) – Added date/time stamp printing to VVPAT for testing.
7. E-06-(EMS) – Added auto precinct detect for OMR card reading.
8. E-07-(EMS) – Added search box to lookup windows.
9. E-08-(EMS) – Reporting viewed in full screen window.
10. E-09-(EMS) – Allow independent candidate filings past vote limit.
11. E-10-(EMS) – Autodetect of COM port for panel programming, vote extraction and OMR scanning.
12. E-11-(EMS) – Added popup window to reports when report is blank.
13. E-12-(EMS) – Suppressed straight party results with no votes (used for de-linking contests from straight party selector on Infinity panel).
14. E-13-(Infinity) – Changed “Ready” mode to “Locked” mode on Infinity.

Addition of Alternate Components

1. A-01-(EMS) – Infinity Revision E with color display and optional VVPAT printer.
2. A-02-(EMS) – Dell Latitude 3500 Laptop Computer.
3. A-03-(Infinity) – MV1500AVR Minuteman UPS.

Replacement of End-Of-Life Components

1. R-01-(EMS) – Replaced Advanced Installer 14.8 with Advanced Installer 16.4.1.
2. R-02-(EMS) – Replaced SQL Server 2016 Express with SQL Server 2017 Express.

1.1.3 Initial Assessment

Prior to development of this Test Plan, Pro V&V performed an evaluation of the results from the previous test campaign along with the changes made to the system to determine the scope of testing required for certification of the EMS 4.4. Based on this evaluation, Pro V&V determined that testing from the previous test campaigns would establish the baseline and that the focus of this test campaign would be on the system updates.

It was determined the following tasks would be required to verify compliance of the modifications:

- Technical Data Package (TDP) Review

A limited TDP Review will be performed to ensure that all submitted modifications were accurately documented and that the documents meet the requirements of the EAC 2005 VVSG.

- Physical Configuration Audit (PCA), including Security Testing

A PCA will be performed to compare the voting system submitted for certification testing to the manufacturer's technical documentation.

- Source Code Review, Compliance Build, Trusted Build, and Build Document Review

A source code review will be performed based on the source code changes made since the previous system was certified. To perform the source code review, Pro V&V will review the submitted source code to the EAC VVSG 1.0 and the manufacturer-submitted coding standards. Prior to initiating the software review, Pro V&V shall verify that the submitted documentation is sufficient to enable: (1) a review of the source code and (2) Pro V&V to design and conduct tests at every level of the software structure to verify that design specifications and performance guidelines are met.

- System Level Testing

System Level Testing includes the FCA, Accuracy, and System Integration tests. The FCA for this test campaign includes an assessment of the submitted modifications and tests designed to verify that the modifications were implemented as intended and did not adversely affect system performance. The System Integration tests will be performed to ensure the EMS 4.4 with VVPAT functions as a complete system. The Accuracy Test will be performed to ensure the EMS 4.4 with VVPAT correctly captures, stores, consolidates, and reports the specific ballot selections, and absence of selections, for each ballot position.

- EMS And System Functional Regression Testing

Regression testing will be conducted on the EMS to establish assurance that the modifications had no adverse impact on the compliance, integrity, or performance of the system.

- Hardware Testing (Operational/Non-Operational Environmental and Electrical)

The addition of the Infinity Revision E, UPS, and VVPAT will result in the full suite of environmental and electrical hardware testing being performed to verify the VVPAT meets hardware test requirements set forth in the EAC 2005 VVSG 1.0.

- Usability and Accessibility Testing

Usability and accessibility tests will be performed to evaluate the system to the requirements set forth in the EAC 2005 VVSG 1.0.

- Security Review

Physical security testing will be performed to evaluate the security posture of the system that may have been affected by the changes implemented in this modification.

1.1.4 Regression Test

Regression testing shall be conducted on the EMS to establish assurance that the modifications have no adverse impact on the compliance, integrity, or performance of the system.

1.2 References

- Election Assistance Commission 2005 Voluntary Voting System Guidelines (VVSG) Version 1.0, Volume I, “Voting System Performance Guidelines”
- Election Assistance Commission 2005 Voluntary Voting System Guidelines (VVSG) Version 1.0, Volume II, “National Certification Testing Guidelines”
- Election Assistance Commission Testing and Certification Program Manual, Version 2.0
- Election Assistance Commission Voting System Test Laboratory Program Manual, Version 2.0
- National Voluntary Laboratory Accreditation Program NIST Handbook 150-2016, “NVLAP Procedures and General Requirements (NIST Handbook 150-2016)”, dated July 2016
- National Voluntary Laboratory Accreditation Program NIST Handbook 150-22, 2008 Edition, “Voting System Testing (NIST Handbook 150-22)”, dated May 2008
- United States 107th Congress Help America Vote Act (HAVA) of 2002 (Public Law 107-252), dated October 2002
- Pro V&V, Inc. Quality Assurance Manual, Revision 7.0
- Election Assistance Commission “Approval of Voting System Testing Application Package” letter dated November 14, 2019
- EAC Requests for Interpretation (RFI) (listed on www.eac.gov)
- EAC Notices of Clarification (NOC) (listed on www.eac.gov)
- MicroVote EMS 4.3 Technical Data Package (*A listing of the EMS 4.3 documents submitted for this test campaign is listed in Section 4.6 of this Test Plan*)
- MicroVote TDP Section 2.13 System Change Notes, Election Management System, Version 1.18, dated 11/07/2019

1.3 Terms and Abbreviations

This subsection lists terms and abbreviations relevant to the hardware, the software, or this Test Plan.

“COTS” – Commercial Off-The-Shelf

“DRE” – Direct Record Electronic

“EAC” – United States Election Assistance Commission

“EMS” – Election Management System

“FCA” – Functional Configuration Audit

“HAVA” – Help America Vote Act

“NIST” – National Institute of Standards and Technology

“NOC” – Notice of Clarification

“NVLAP” – National Voluntary Laboratory Accreditation Program

“PCA” – Physical Configuration Audit

“QA” – Quality Assurance

“RFI” – Request for Interpretation

“TDP” – Technical Data Package

“VSTL” – Voting System Test Laboratory

“VVPAT” – Voter Verifiable Paper Audit Trail

“VVSG” – Voluntary Voting System Guidelines

1.4 Project Schedule

The Project Schedule for the test campaign is located in Appendix A. The dates on the schedule are not firm dates but planned estimates based on the anticipated project work flow.

1.5 Scope of Testing

The scope of testing is limited to the modifications made to the previously certified EMS 4.2 Voting System, as described in Section 1.1.2. The scope of testing focused on the modifications made to the baseline system and includes the areas of evaluation detailed in Section 1.1.3.

1.5.1 Block Diagram

The system overview of the submitted voting system is depicted in Figure 1-1.

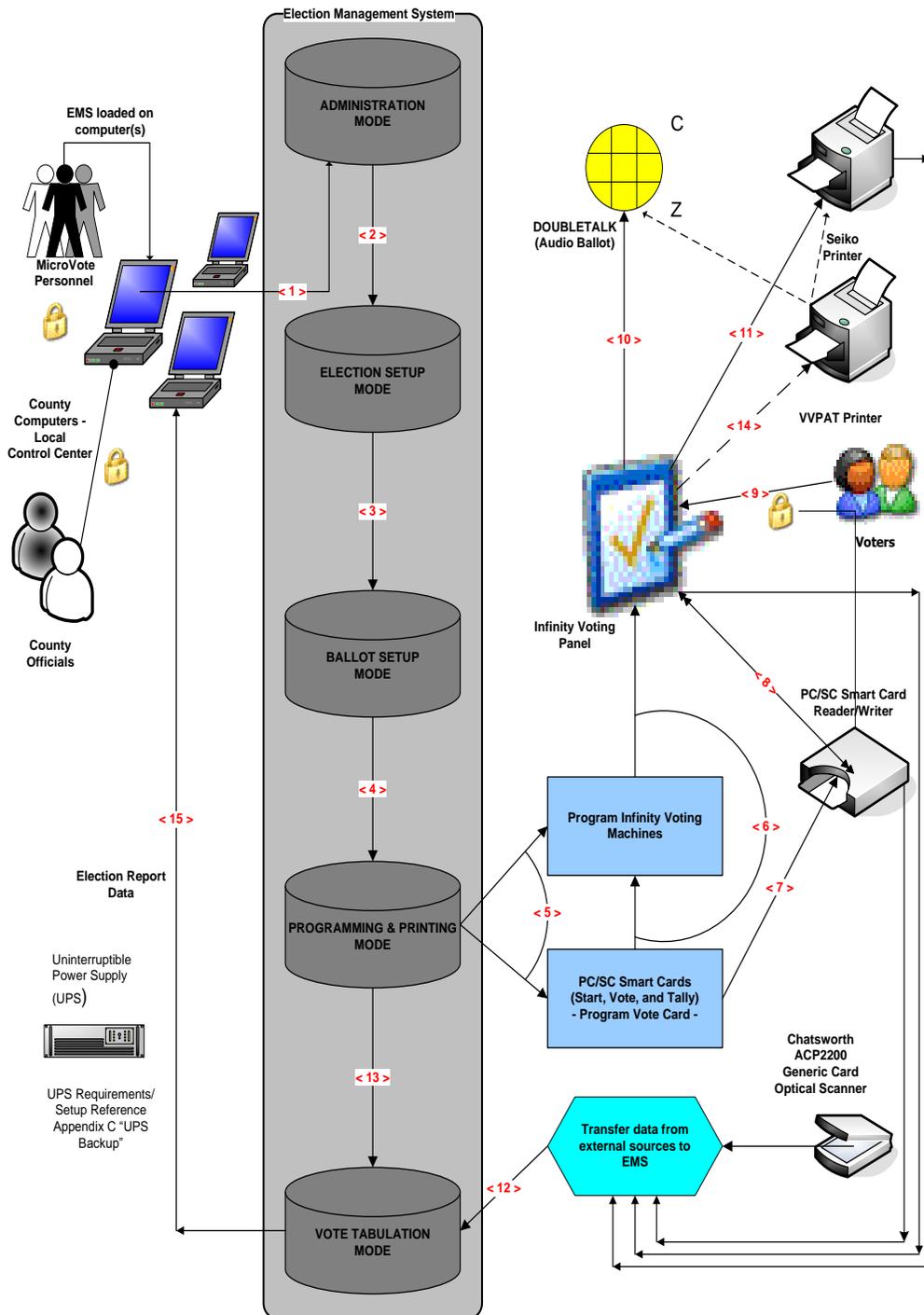


Figure 1-1. EMS 4.4 System Overview

1.5.2 System Limits

There were no changes made to the system limits. The system limitations for the baselined system, as taken from the Certificate of Conformance, are detailed below:

Table 1-2. EMS 4.2 System Limitations

Characteristic	Limiting Component	Evaluated	Manufacturer Calculated		
			EMS	Infinity	ACP 2200
Maximum Ballot Positions	Ballot Design Form	150	600	600	402
Maximum Precincts in Election	Precinct Number	559	9,999	9,999	9,999
Maximum Contests in Election	Contests in Ballot Style * Ballot Styles/Election	100	300,000	2,999,700	2,009,799
Maximum Candidates/ Counters in Election	Precinct Counters * Total Precincts	300	5,989,401	5,989,401	4,019,598
Maximum Candidates/ Counters in Precinct	Ballot Design Form	125	599	599	402
Maximum Candidates/ Counters in Activation	Ballot Design Form	125	599	599	402
Maximum Ballot Styles in Election	Ballot Style Number	270	1000	9999	1000
Maximum Contests in a Ballot Style	Ballot Design Form	50	300	300	201
Maximum Candidates in a Contest	Ballot Design Form	68	599	599	401
Maximum Count for any Precinct Element	Transact-SQL Bigint	600	<i>Note 1</i>	65,000	<i>Note 1</i>
Maximum Ballot Styles in a Precinct	Precinct Style Assignment Form	1	1	1	1
Maximum Activations per Ballot Style	Build Activations Form	15	99	30	99
Maximum Activations per Election	Act/Ballot Style * Ballot Style/Elec	1300	99,000	299,970	299,970
Maximum Number of Parties	Party Code Combinations	8	50,653	598	400
Maximum Vote For in Contest	Office Vote Limit	56	99	64	99

Note 1: 9,223,372,036,854,770,000

1.5.3 Supported Languages

The submitted voting system supports:

- English
- Spanish
- optional third language, including pictographic

Support for each stated languages will be verified. Both English and Spanish language ballots will be cast during the performance of functional testing. Additionally, one character based language (Chinese) will be tested during System Integration Testing.

Testing of the Chinese language will be accomplished through the creation and execution of both a primary and general election verifying the translations can be used by Chinese minority language voters. The translations themselves will be taken from an online translator (Google Translate). The translations will then be copied and pasted into the qualified EMS ballot text fields using Windows Notepad. In order for the Infinity Panel to recognize the Chinese characters, a number of special reserved ballot text objects will need to be activated, as covered in *MicroVote TDP Appendix B: Third Language Support of the EMS User Manual*.

1.5.4 Supported Functionality

There were no changes made to the supported functionality of the voting system. The supported functionality for the submitted voting system remains unchanged from the previously certified version.

1.5.5 VVSG

The EMS 4.4 Voting System shall be evaluated against the relevant requirements contained in the EAC 2005 VVSG, Volumes I and II.

1.5.6 RFIs

There are no RFIs released by the EAC as of the date of this Test Plan that pertain to this test campaign that were not in effect at the time of the baseline system certification.

1.5.7 NOCs

There are no NOCs released by the EAC as of the date of this Test Plan that pertain to this test campaign that were not in effect at the time of the baseline system certification.

2.0 PRE-CERTIFICATION TESTING AND ISSUES

This section describes previous testing performed prior to submitting the voting system to the EAC.

2.1 Evaluation of Prior VSTL Testing

Pro V&V evaluated to the published Final Test Report for the EMS 4.2 System in order to baseline the current system under test.

2.2 Evaluation of Prior Non-VSTL Testing

No prior non-VSTL testing of the EMS 4.2 modifications were considered for this test campaign.

2.3 Known Field Issues

EMS 4.4 is a modification to a previously certified system and has not been fielded. The baseline system (4.2) has been fielded and there are no known field issues reported at the time of this test plan creation.

3.0 MATERIALS REQUIRED FOR TESTING

The following sections list all materials needed to enable the test engagement to occur.

The materials required for testing of the MicroVote EMS 4.4 Voting System include all materials to enable the test campaign to occur. This includes the applicable hardware and software as well as the TDP, test support materials, and deliverable materials, as described in the following subsections.

3.1 Software

This subsection lists the proprietary and COTS software to be provided by the manufacturer as part of the test campaign.

Table 3-1. MicroVote EMS 4.4 Software

Firmware/Software	Version
<i>Proprietary</i>	
EMS	4.4
Infinity Panel Rev. D	4.30
Infinity Panel Rev. E	4.40
<i>COTS</i>	
Microsoft Windows 10 Professional	1909
Microsoft Visual Studio Professional 2017	15.9
ComponentOne Ultimate 2014	1
Advanced Installer	16.4.1
Advanced Installer Extension for Visual Studio 2017	16.5

3.2 Equipment

This subsection lists the proprietary and COTS equipment to be provided by the manufacturer as part of the test campaign.

For COTS equipment, every effort will be made to verify that the COTS equipment has not been modified for use. This will be accomplished by performing research using the COTS equipment manufacturer’s websites based on the serial numbers and service tag numbers for each piece of equipment. Assigned test personnel will evaluate COTS hardware, system software and communications components for proven performance in commercial applications other than voting. For PCs, laptops, and servers, the service tag information will be compared to the system information found on each machine. Physical external and internal examination will also be performed when the equipment is easily accessible without the possibility of damage. Hard drives, RAM memory, and other components will be examined to verify that the components match the information found on the COTS equipment manufacturer’s websites.

Table 3-2. MicroVote EMS 4.4 Hardware

Component	Serial Number
<i>Proprietary Hardware</i>	
Infinity Voting Panel (Rev D) w/Power Supply	11588
Infinity Voting Panel (Rev E) w/Power Supply	14009
Infinity Voting Panel (Rev E) w/Power Supply	14010
VVPAT (Rev A) w/Power Supply	001011
VVPAT (Rev A) w/Power Supply	001100
<i>COTS Hardware</i>	
Tripp Lite Portable Surge Protector (TRAVELCUBE)	[MVT-TC-001]
Tripp Lite Portable Surge Protector (TRAVELCUBE)	[MVT-TC-002]
Minuteman UPS (EP1000LCD)	AK11190890004
APC Back-UPS Pro (BN1100M2)	3B1925X63177
APC Back-UPS Pro (BN1100M2)	3B1925X63227
Dell Latitude 5580 Laptop w/Power Supply	51LG8H2
Dell Latitude 5580 Laptop w/Power Supply	5DL1RN2
USB Smart Card Reader (PC USB TR PIV) w/Stand (HWP109380 B)	113101316600170
EMS Download Cable	CC06789-06
USB-RS232 Converter	USA000106043
Seiko Instruments Printer (DPU-3445) w/Power Supply	2008922A

Table 3-2. MicroVote EMS 4.4 Hardware (continued)

Component	Serial Number
DoubleTalk LT	[MVT-DT-001]
Hamilton Buhl (PRM100B)	[MVT-HB-001]
Chatsworth Data (ACP-2200)	TBD

3.3 Test Materials

This subsection lists the test materials required to execute the required tests throughout the test campaign.

Table 3-3. Required Test Materials

Material	Model/Version	Description
Smart Cards (x6)	Start – 6 Bytes Vote – 11 Bytes Tally – 32,518 Bytes	Smart cards for Start, Vote, and Tally functions
Thermal Printer Paper Rolls (x3)	N/A	Paper rolls for the Seiko Instruments Printer

3.4 Deliverables

This subsection lists the materials identified by the manufacturer as materials deliverable to the end user for the system being tested.

Table 3-4. Voting System Deliverables

Material	Version	Description
EMS Software	4.4	Election Management Software
Infinity Panel	Rev E	DRE precinct count/accessible voting station
Infinity Panel	Rev D	DRE precinct count/accessible voting station
VVPAT	Rev A	Voter Verifiable Paper Audit Trail

3.5 Proprietary Data

All data and documentation considered by the manufacturer to be proprietary will be identified and documented in an independent submission along with a Notice of Protected Information.

4.0 TEST SPECIFICATIONS

Certification testing of the MicroVote EMS 4.4 Voting System submitted for evaluation will be performed to ensure the applicable requirements of the EAC 2005 VVSG and the EAC Testing and Certification Program Manual are met. Additionally, all EAC Request for Interpretations (RFI) and Notices of Clarification (NOC) relevant to the system under test will be incorporated in

the test campaign. A complete listing of the EAC RFIs and NOCs is available on the EAC website.

4.1 Requirements (Strategy of Evaluation)

To evaluate the EMS 4.4 test requirements, the submitted modifications were evaluated against each section of the EAC 2005 VVSG to determine the applicable tests to be performed. Based on this assessment, it was determined the following evaluations would be required to verify compliance of the modifications:

Technical Documentation Package (TDP) Review

A TDP Review will be performed to ensure that all submitted modifications are accurately documented and that the documents meet the requirements of the EAC 2005 VVSG. The TDP Review includes the Initial Review, the Regulatory/Compliance Review, and the Final Review. This review is conducted to determine if the submitted technical documentation meets the regulatory, customer-stated, or end-user requirements and includes reviewing the documents for stated functionality review and verification

Physical Configuration Audit (PCA)

A PCA will be performed to compare the voting system submitted for certification testing to the manufacturer's technical documentation. The purpose of the PCA will be to verify that the submitted hardware is unmodified from the previously certified voting system.

Source Code Review, Compliance Build, Trusted Build, and Build Document Review

Pro V&V will review the submitted source code to the EAC 2005 VVSG and the manufacturer-submitted coding standards. Prior to initiating the software review, Pro V&V shall verify that the submitted documentation is sufficient to enable: (1) a review of the source code and (2) Pro V&V to design and conduct tests at every level of the software structure to verify that design specifications and performance guidelines are met. The source code review will be based on the source code changes made since the previous system was certified.

Functional Configuration Audit

The FCA targets the specific functionality claimed by the manufacturer to ensure the product functions as documented. This testing uses both positive and negative test data to test the robustness of the system. The FCA encompasses an examination of manufacturer tests, and the conduct of additional tests, to verify that the system hardware and software perform all the functions described in the manufacturer's documentation submitted in the TDP (such as system operations, voter manual, maintenance, and diagnostic testing manuals). It includes a test of system operations in the sequence in which they would normally be performed. These system operations and functional capabilities are categorized as follows by the phase of election activity in which they are required:

- Overall System Capabilities: These functional capabilities apply throughout the election process. They include security, accuracy, integrity, system audit ability, election management system, vote tabulation, ballot counters, telecommunications, and data retention.
- Pre-voting Capabilities: These functional capabilities are used to prepare the voting system for voting. They include ballot preparation, the preparation of election-specific software (including firmware), the production of ballots, the installation of ballots and ballot counting software (including firmware), and system and equipment tests.
- Voting System Capabilities: These functional capabilities include all operations conducted at the polling place by voters and officials including the generation of status messages.
- Post-voting Capabilities: These functional capabilities apply after all votes have been cast. They include closing the polling place; obtaining reports by voting machine, polling place, and precinct; obtaining consolidated reports; and obtaining reports of audit trails.
- Maintenance, Transportation and Storage Capabilities: These capabilities are necessary to maintain, transport, and store voting system equipment.

As part of the FCA, three primary and three general elections will be executed to verify the submitted modification has been successfully implemented.

System Integration Test

The system integration tests will be performed to ensure the EMS 4.4 functions as a complete system. The system integration testing addresses the integration of the hardware and software. This testing focuses on the compatibility of the voting system software components and subsystems with one another and with other components of the voting system. During test performance, the system is configured as would be for normal field use.

Accuracy Test

An Accuracy Test will be performed to ensure the EMS 4.4 correctly captures, stores, consolidates, and reports the specific ballot selections, and absence of selections, for each ballot position.

EMS and System Functional Regression Testing

EMS and System Functional Regression Testing will be performed to ensure the submitted modification does not adversely affect the EMS 4.4 system.

Throughout the test campaign, Pro V&V personnel shall maintain a test log identifying the system and equipment under test and any records of deviations to the test plan along with the rationale for performing the deviations. Pro V&V shall also utilize an internal bug tracking system to record and track all issues and/or discrepancies noted during the test campaign.

Hardware Testing (Operational/Non-Operational Environmental and Electrical)

The addition of the Infinity Panel, Rev. E, and the VVPAT will require the full suite of environmental and electrical hardware testing being performed to verify the VVPAT meets hardware test requirements set forth in the EAC 2005 VVSG 1.0. The hardware tests specified in the VVSG are divided into two categories: non-operating and operating. The non-operating tests apply to the elements of the system that are intended for use at poll site locations and are intended to simulate the storage and transport of equipment between the storage facility and the polling location. The Operating tests apply to the entire system, including hardware components that are used as part of the voting system telecommunications capability, and are intended to simulate conditions that the voting system may encounter during operation. Prior to and immediately following each required non-operating and operating test, the system shall be subjected to an operational status check.

The requirements in this section shall be tested and/or evaluated by personnel verified by Pro V&V to be qualified to perform the testing.

Usability and Accessibility

The usability testing focuses on the usability of the system being tested. Usability is defined generally 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. Additional requirements for task performance are independence and privacy: the voter should normally be able to complete the voting task without assistance from others, and the voter selections should be private. Accessibility evaluates the requirements for accessibility. These requirements are intended to address HAVA 301 (a) (3) (B).

Security

The objective of the security testing will be to evaluate the security posture of the system that may have been affected by the changes implemented in this modification. The evaluation of the system will be accomplished by utilizing a combination of documentation review, functional testing, and manual inspection. During the execution of a security penetration evaluation, the system will be inspected to verify that various controls and measure are in place in order to meet the objectives of the security standards which include: protection of the critical elements of the voting system; establishing and maintaining controls to minimize errors; protection from intentional manipulation, fraud and malicious mischief; identifying fraudulent or erroneous changes to the voting system; and protecting the secrecy in the voting process.

4.1.1 Rationale for ‘Not Applicable’ Requirements

All requirements that were excluded from the previous test campaign (EMS 4.2) were also deemed not applicable to this test campaign due to the submitted modifications not impacting the specific requirements. These requirements are listed below:

- Volume I, Section 6.2.6 (Telecommunications Requirements): These requirements are written for use of public networks. The EMS 4.4 does not utilize public networks.
- Volume I, Section 7.52-7.54 (Telecommunications and Data Transmission): These requirements are written for use of public networks. The EMS 4.4 does not utilize public networks.
- Volume I, Section 7.6 (Use of Public Networks): These requirements are written for use of public networks. The EMS 4.4 does not utilize public networks.
- Volume I, Section 7.7 (Wireless Communications): No wireless technology is utilized in this system.

4.2 Hardware Configuration and Design

The hardware configuration and design for the modification has changed from the baseline system. The Infinity Revision E with color display, optional VVPAT printer, and UPS have been added.

4.3 Software System Functions

An update to the previously certified voting system (EMS 4.2) was submitted for this modification campaign.

4.4 Test Case Design

Test cases are designed based on the manufacturer's design specifications and the relevant technical requirements set forth by the VVSG. Test cases shall be examined based on the following aspects of the voting system:

- Hardware qualitative examination design
- Hardware environmental test case design
- Software module test case design and data
- Software functional test case design
- System level test case design

Test cases shall provide information regarding the sequence of actions to be performed for the execution of a test, the requirements being met, the test objective, test configuration, equipment needed, special requirements, assumptions, and pass/fail criteria. Once the test cases are finalized, they will be validated and published for use in the test campaign. The validation of the test case will be accomplished by Technical Review and Approval. This validation will include the following: confirmation of adequate test coverage of all requirements; confirmation that test case results are not ambiguous and gave objective pass/fail criteria; and conformation that any automated test suites will produce valid results.

4.4.1 Hardware Qualitative Design

Previous hardware examinations were performed on the certified baseline system (EMS 4.2). The components added to the modified system will require the full suite of hardware and electrical testing as detailed in the 2005 VVSG. These tests are listed below:

Electrical Tests:

- Electrical Power Disturbance
- Electromagnetic Radiation
- Electrostatic Disruption
- Electromagnetic Susceptibility
- Electrical Fast Transient
- Lightning Surge
- Conducted RF Immunity
- Magnetic Fields Immunity
- Electrical Supply

Environmental Tests:

- Bench Handling
- Vibration
- Low Temperature
- High Temperature
- Humidity
- Temperature Power Variation

4.4.2 Hardware Environmental Test Case Design

The voting system hardware shall be subjected to the tests specified in Section 4.4.1. Testing will be performed by personnel verified by Pro V&V to be qualified to perform the test. Pro V&V will utilize third-party test facilities for performance of the electrical and environmental tests. Environmental and Electrical will be performed at the NTS Longmont facility located in Longmont, Colorado. All pre and post operational status checks shall be conducted by Pro V&V personnel.

4.4.3 Software Module Test Case Design

Pro V&V shall review the manufacturer's program analysis, documentation, and module test case design and shall evaluate the test cases for each module with respect to flow control parameters and entry/exit data. As needed, Pro V&V shall design additional test cases to satisfy the coverage

criteria specified in Volume II, Section 7.2.1. Component Level Testing will be implemented during the FCA for each component and subcomponent. During the Source Code Review, Compliance Builds, and Security Testing, Pro V&V will utilize limited structural-based techniques (white-box testing). Additionally, specification-based techniques (black-box testing) will be utilized for the individual software components.

Pro V&V shall define the expected result for each test and the ACCEPT/REJECT criteria for certification. If the system performs as expected, the results will be accepted. If the system does not perform as expected, an analysis will be performed to determine the cause. The test will be repeated in an attempt to reproduce the results. If the failure can be reproduced and the expected results are not met, the system will have failed the test. If the results cannot be reproduced, the test will continue. All errors encountered will be documented and tracked through resolution.

4.4.4 Software Functional Test Case Design

Pro V&V shall review the manufacturer-submitted test plans and data to verify that the individual performance requirements specified in the EAC 2005 VVSG and the TDP are reflected in the software. As part of this process, Pro V&V shall review the manufacturer's test case design and prepare a detailed matrix of system functions and the test cases that exercise them. Pro V&V shall also prepare a test procedure describing all test ballots, operator procedures, and the data content of output reports. Pro V&V shall define abnormal input data and operator actions and then design test cases to verify that the system is able to handle and recover from these abnormal conditions. During this review, emphasis shall be placed on those functions where the manufacturer data on module development reflects significant debugging problems, and on functional tests that resulted in high error rates.

Pro V&V shall define the expected result for each test and the ACCEPT/REJECT criteria for certification. If the system performs as expected, the results will be accepted. If the system does not perform as expected, an analysis will be performed to determine the cause. The test will be repeated in an attempt to reproduce the results. If the failure can be reproduced and the expected results are not met, the system will have failed the test. If the results cannot be reproduced, the test will continue. All errors encountered will be documented and tracked through resolution.

4.4.5 System-Level Test Case Design

System Level testing will be implemented to evaluate the complete system. This testing will include all proprietary components (software, hardware, and peripherals) and COTS components (software, hardware, and peripherals) in a configuration of the system's intended use. For software system tests, the tests shall be designed according to the stated design objective without consideration of its functional specification. The system level hardware and software test cases shall be prepared independently to assess the response of the hardware and software to a range of conditions.

4.5 Test Specifications

Descriptions of the tests required to evaluate the EMS 4.4 to the scope defined in Section 1.5 are provided in the subsections below.

4.5.1 TDP Evaluation

In order to determine compliance of the modified TDP documents with the EAC 2005 VVSG, a limited TDP review shall be conducted. This review will focus on TDP documents that have been modified since the certification of the baseline system. The review will consist of a compliance review to determine if each regulatory, state, or manufacturer-stated requirement has been met based on the context of each requirement. Results of the review of each document will be entered on the TDP Review Checklist and reported to the manufacturer for disposition of any anomalies. This process will be ongoing until all anomalies are resolved. Any revised documents during the TDP review process will be compared with the previous document revision to determine changes made, and the document will be re-reviewed to determine whether subject requirements have been met. A listing of all documents contained in the EMS 4.4 TDP is provided in Table 4-1.

Table 4-1: EMS 4.4 TDP Documents

Section	Description	Version
---	Technical Data Package (TDP) TABLE OF CONTENTS Election Management System	1.1
2.1	SCOPE Election Management System	1.2
2.2	SYSTEM OVERVIEW Election Management System	1.16
2.3	SYSTEM FUNCTIONALITY DESCRIPTION Election Management System	1.3
2.4	SYSTEM HARDWARE SPECIFICATION Election Management System	1.4
2.5	SOFTWARE DESIGN AND SPECIFICATION Election Management System	2.11
2.6	SYSTEM SECURITY SPECIFICATION Election Management System	1.10
2.7	SYSTEM TEST AND VERIFICATION SPECIFICATION Election Management System	1.3
2.8	SYSTEM OPERATION PROCEDURES Election Management System	1.3
2.9	SYSTEM MAINTENACE PROCEDURES Election Management System	1.4
2.10	PERSONNEL DEPOYMENT AND TRAINING REQUIREMENTS Election Management System	1.1
2.11	CONFIGURATION MANAGEMENT PLAN Election Management System	1.7
2.12	QUALITY ASSURANCE PROGRAM Election Management System	1.4
2.13	SYSTEM CHANGE NOTES Election Management System	1.18
---	Appendices TABLE OF CONTENTS Election Management System	1.9

4.5.2 Source Code Review

Pro V&V will review the submitted source code to the EAC 2005 VVSG and the manufacturer-submitted coding standards. Prior to initiating the software review, Pro V&V shall verify that the submitted documentation is sufficient to enable: (1) a review of the source code and (2) Pro V&V to design and conduct tests at every level of the software structure to verify that design specifications and performance guidelines are met.

4.5.3 Physical Configuration Audit (PCA)

The Physical Configuration Audit (PCA) compares the voting system components submitted for qualification to the manufacturer's technical documentation, and shall include the following activities:

- Establish a configuration baseline of software and hardware to be tested; confirm whether manufacturer's documentation is sufficient for the user to install, validate, operate, and maintain the voting system
- Verify software conforms to the manufacturer's specifications; inspect all records of manufacturer's release control system; if changes have been made to the baseline version, verify manufacturer's engineering and test data are for the software version submitted for certification
- If the hardware is non-COTS, Pro V&V shall review drawings, specifications, technical data, and test data associated with system hardware to establish system hardware baseline associated with software baseline
- Review manufacturer's documents of user acceptance test procedures and data against system's functional specifications; resolve any discrepancy or inadequacy in manufacturer's plan or data prior to beginning system integration functional and performance tests

Subsequent changes to baseline software configuration made during testing, as well as system hardware changes that may produce a change in software operation are subject to re-examination.

4.5.4 System Level Testing

System Level Testing will be implemented to evaluate the complete system. This testing will include all proprietary components and COTS components (software, hardware, and peripherals) in a configuration of the system's intended use. For software system tests, the tests will be designed according to the stated design objective without consideration of its functional specification. The system level hardware and software test cases will be prepared independently to assess the response of the hardware and software to a range of conditions. Pro V&V will review the manufacturer's program analysis, documentation, and module test case design and evaluate the test cases for each module with respect to flow control parameters and entry/exit data.

For this campaign, System Level Testing includes the evaluations of the following test areas: FCA, Accuracy Testing, and System Integration Testing.

Pro V&V defined the expected result for each test and the ACCEPT/REJECT criteria for certification. If the system performs as expected, the results will be accepted. If the system does not perform as expected, an analysis was performed to determine the cause. If needed, the test will be repeated in an attempt to reproduce the results. If the failure can't be reproduced and the expected results are not met, the system will be determined to have failed the test. If the results can't be reproduced, the test will continue. All errors encountered will be documented and tracked through resolution.

4.5.4.1 Functional Configuration Audit (FCA)

The Functional Configuration Audit (FCA) encompasses an examination of manufacturer's tests, and the conduct of additional tests, to verify that the system hardware and software perform all the functions described in the manufacturer's documentation submitted in the TDP.

In addition to functioning according to the manufacturer's documentation, tests will be conducted to ensure all applicable EAC VVSG 1.0 requirements are met.

4.5.4.2 Accuracy

The Accuracy test ensures that each component of the voting system can each process 1,549,703 consecutive ballot positions correctly within the allowable target error rate.

The Accuracy test is designed to test the ability of the system to "capture, record, store, consolidate and report" specific selections and absences of a selection. The required accuracy is defined as an error rate. This rate is the maximum number of errors allowed while processing a specified volume of data. For paper-based voting systems, the ballot positions on a paper ballot must be scanned to detect selections for individual candidates and contests and the conversion of those selections detected on the paper ballot converted into digital data. In an effort to achieve this and to verify the proper functionality of the units under test, the following methods will be used to test components of the voting system:

The accuracy requirements for the MicroVote EMS 4.4 will be accomplished by the execution of the standard accuracy test utilizing a voting script.

4.5.4.3 System Integration

System Integration is a system level test that evaluates the integrated operation of both hardware and software. Compatibility of the voting system software components or subsystems with one another, and with other components of the voting system environment, shall be determined through functional tests integrating the voting system software with the remainder of the system.

Additionally, the system shall be configured exactly as it would for normal field use. This includes connecting all supporting equipment and peripherals including ballot boxes, voting booths (regular and accessible), and any physical security equipment such as locks and ties.

Pro V&V personnel shall properly configure and test the system by following the procedures detailed in the EMS 4.4 technical documentation.

4.5.4.4 Regression Testing

Regression testing will be conducted on the EMS 4.4 to establish assurance that the modification has no adverse impact on the compliance, integrity, or performance of the system.

4.5.5 Usability and Accessibility Testing

EMS 4.4 will be evaluated to the usability and accessibility requirements set forth in the EAC 2005 VVSG 1.0.

4.5.6 Security Review

Physical Security testing will be performed to verify and validate submitted changes are in compliance to the requirements of the EAC 2005 VVSG. Physical Security will be tested by setting up the system as described in the TDP and then examining the effectiveness and comprehensiveness of physical security measures.

5.0 TEST DATA

The following subsections provide information concerning test data recording, criteria, and reduction.

5.1 Test Data Recording

All equipment utilized for test data recording shall be identified in the test data package. The output test data shall be recorded in an appropriate manner as to allow for data analysis. For source code and TDP reviews, results shall be compiled in reports and submitted to MicroVote for resolution.

5.2 Test Data Criteria

The EMS 4.4 Voting System shall be evaluated against all applicable requirements contained in the EAC 2005 VVSG. The acceptable range for system performance and the expected results for each test case shall be derived from the manufacturer-submitted technical documentation and the EAC 2005 VVSG.

6.0 TEST PROCEDURES AND CONDITIONS

The following subsections detail the facility requirements, test setup conditions, and sequence of testing.

6.1 Test Facilities

Unless otherwise annotated, all testing shall be conducted at the Pro V&V test facility located in Huntsville, AL, by personnel verified by Pro V&V to be qualified to perform the test.

Unless otherwise specified herein, testing shall be performed at the following standard ambient conditions and tolerances:

- Temperature: 68-75° F ($\pm 3.6^\circ\text{F}$)
- Relative Humidity: Local Site Humidity
- Atmospheric Pressure: Local Site Pressure
- Time Allowable Tolerance: $\pm 5\%$

.6.2 Test Set-Up

All voting system equipment shall be received and documented using Pro V&V proper QA procedures. Upon receipt of all hardware, an inspection will be performed to verify that the equipment received is free from obvious signs of damage and/or degradation that may have occurred during transit. If present, this damage shall be recorded, photographed, and reported to the MicroVote Representative. Additionally, a comparison shall be made between the recorded serial numbers/part numbers and those listed on shipper's manifest and any discrepancies shall be reported to the MicroVote Representative.

TDP items and all source code received shall be inventoried and maintained by Pro V&V during the test campaign.

During test performance, the system shall be configured as would be for normal field use. This includes connecting all supporting equipment and peripherals.

6.3 Test Sequence

The EMS 4.4 Voting System will be evaluated against all applicable requirements in the EAC 2005 VVSG. There is no required sequence for test performance.

6.4 Test Operations Procedure

Pro V&V will identify PASS/FAIL criteria for each executed test case. The PASS/FAIL criteria will be based on the specific expected results of the system. In the case of an unexpected result that deviates from what is considered standard, normal, or expected, a root cause analysis will be performed.

Pro V&V will evaluate every EAC 2005 VVSG requirement impacted by the submitted modification. Any deficiencies noted will be reported to the EAC and the manufacturer. If it is determined that there is insufficient data to determine compliance, this test plan will be altered and additional testing will be performed.

Appendix A-1 – Project Schedule

Task Name	Start Date	End Date	Assigned To	Duration	Predecessors
EAC Application & TRR	10/31/19	11/11/19		8d	
Application Submitted to EAC	10/31/19	10/31/19	Mancy	1d	
TRR	11/01/19	11/05/19	Mancy	3d	2
Application Approval from EAC	11/06/19	11/11/19	Mancy	4d	3
TDP	10/31/19	03/05/20		86d	
Initial Review	10/31/19	11/06/19	Alan	5d	
Compliance Review	11/07/19	03/02/20	Alan	78d	6
Final review	03/03/20	03/05/20	Alan	3d	7
Test Plan	11/25/19	02/12/20		53d	
Test Plan Creation	11/25/19	12/11/19	Wendy	13d	
Vendor Review & Comments	12/12/19	12/17/19	Wendy	4d	10
EAC Submission and Review	12/18/19	01/21/20	Wendy	20d	11
VSTL Comment Review & Update	01/22/20	01/27/20	Wendy	4d	12
EAC Submission & Review of Revision	01/28/20	02/10/20	Wendy	10d	13
EAC Approved Test Plan	02/11/20	02/12/20	Wendy	2d	14
System Delivery & Setup	12/16/19	01/07/20		12d	
PCA	12/16/19	12/27/19	Mancy	7d	
System Setup	12/30/19	01/02/20	Mancy	2d	17
System Loads & Hardening	01/03/20	01/07/20	Mancy	3d	18
Hardware Testing	11/11/19	01/13/20		41d	
Electrical Testing (2 configurations Rev D & Rev E)	11/11/19	12/04/19	Mancy	18d	
Environmental Testing (Rev E)	11/11/19	12/05/19	Mancy	19d	
Temp Power (85 hours based on 2 Rev D & 2 Rev E units under test)	12/09/19	12/13/19	Mancy	5d	
Electrical Supply	01/08/20	01/09/20	Mancy	2d	19
Maintainability	01/10/20	01/13/20	Mancy	2d	24
System Level Testing	01/14/20	03/09/20		40d	
FCA	01/14/20	02/10/20	Mancy	20d	25
Usability	02/11/20	02/12/20	Mancy	2d	27
Accessibility	02/11/20	02/12/20	Mancy	2d	27
Volume & Stress	02/13/20	02/24/20	Mancy	8d	29
Accuracy	02/25/20	02/28/20	Mancy	4d	30
Regression Testing	03/02/20	03/02/20	Mancy	1d	31
System Integration	03/03/20	03/09/20	Mancy	5d	32
Test Report	03/10/20	05/08/20		44d	
Test Report Creation	03/10/20	03/19/20	Wendy	8d	33
Vendor Review & Comments	03/20/20	03/23/20	Wendy	2d	35
EAC Submission & Review	03/24/20	04/20/20	Wendy	20d	36
VSTL Comment Review & Update	04/21/20	04/22/20	Wendy	2d	37
EAC Submission & Review of Revision	04/23/20	05/06/20	Wendy	10d	38
EAC Approved Test Report	05/07/20	05/08/20	Wendy	2d	39