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Test Report for EAC VVSG 1.0 Certification Testing
Election Systems & Software (ES&S)
Voting System (EVS) 5.2.4.0

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SIGNATURES

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REVISIONS

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| A | Updates per EAC comments | 5/24/2018 |
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1.0 INTRODUCTION

The purpose of this Test Report is to document the procedures that Pro V&V, Inc. followed to perform certification testing during a system modification campaign for the Election Systems and Software (ES&S) Voting System (EVS) 5.2.4.0 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. Certification testing of EVS 5.2.4.0 was performed to ensure the applicable requirements of the EAC VVSG 1.0 and the EAC Testing and Certification Program Manual, Version 2.0 were met. Additionally, all EAC Request for Interpretations (RFI) and Notices of Clarification (NOC) relevant to the system under test were incorporated in the test campaign.

Prior to submitting the voting system for testing, ES&S submitted an application package to the EAC for certification of the EVS 5.2.4.0. The application was accepted by the EAC and the project was assigned the unique Project Number of ESSEVS5240.

1.1 Description and Overview of EAC Certified System Being Modified

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 following subsections describe the baselined EVS 5.2.3.0.

ES&S EVS 5.2.3.0 is comprised of the following components: ExpressVote Universal Voting System hardware version 1.0 (ExpressVote HW 1.0); AutoMARK Voter Assist Terminal (AutoMARK) versions A100, A200, and A300; DS450 scanner and tabulator (DS450); DS200 precinct-based scanner and tabulator (DS200); DS850 scanner and tabulator (DS850); Electionware Election Management System (Electionware); Election Reporting Manager (ERM); ES&S Event Log Service (ELS); and Removable Media Service (RMS).

- The ExpressVote HW 1.0 is a universal vote capture device designed for all voters, with independent voter-verifiable paper record that is digitally scanned for tabulation. This system combines paper-based voting with touch screen technology. It includes a mandatory vote summary screen that requires voters to confirm or revise selections prior to printing the summary of ballot selections using the internal thermal printer. Once printed, ES&S tabulators process the vote summary card. The ExpressVote HW 1.0 can serve all voters, including those with special needs, allowing voters to cast ballots autonomously. ES&S has fully integrated the ExpressVote HW 1.0 with the existing suite of ES&S voting system products.
- AutoMARK Voter Assist Terminal enables voters who are visually or physically impaired and voters more comfortable reading or hearing instructions and choices in an alternative language to privately mark optical scan ballots. The AutoMARK supports navigation through touchscreen, physical keypad or ADA support peripheral such as a sip and puff device or other binary tactile device.

- DS200 digital scanner and tabulator is a paper ballot tabulator designed for use as a polling place scanner. After the voter makes their selections on their paper ballot, their ballot and/or vote summary card is inserted into the unit for immediate tabulation.

Both sides of the ballot are scanned at the same time using a high-resolution image-scanning device that produces ballot images.

- The DS850 is a digital scan central ballot tabulator that uses cameras and imaging algorithms to capture voter selections on the front and back of a ballot, evaluate results and then sort ballots into discrete bins without interrupting scanning. A dedicated audit printer generates a continuous event log. Machine level reports are produced from a second, laser printer. The scanner saves voter selections and ballot images to an internal hard disk and exports results to a USB flash drive for processing with ERM. Optionally, this device may be configured to transmit tabulation results to the results server through a closed network connection rather than using physically transported USB flash drives.
- The DS450 is a scanner and tabulator that simultaneously scans the front and back of a paper ballot and/or vote summary card. It can also handle folded ballots and can read ballots in any of four orientations. The DS450 sorts tabulated ballots into discrete output bins without interrupting scanning. Optionally, this device may be configured to transmit tabulation results to the results server through a closed network connection rather than using physically transported USB flash drives.
- Electionware integrates the election administration functionality into a unified application. Its intended use is to define an election and create the resultant media files used by the ExpressVote HW 1.0, DS200, AutoMARK, DS450, DS850, and ERM. An integrated ballot viewer allows election officials to view the scanned ballot and captured ballot data side-by-side and produce ballot reports.
- ES&S Event Log Service (ELS) is a Windows Service that runs in the background of any active ES&S Election Management software application to monitor the proper functioning of the Windows Event Viewer. The ELS closes any active ES&S software application if the system detects the improper deactivation of the Windows Event Viewer.
- Removable Media Service (RMS) is an application that runs in the background of the EMS client workstation and supports the installation and removal of election and results media.
- Election Reporting Manager (ERM) generates paper and electronic reports for election workers, candidates, and the media. Jurisdictions can use a separate ERM installation to display updated election totals on a monitor as ballot data is tabulated, and send the results' reports directly to the media outlets. ERM supports accumulation and combination of ballot results data from all ES&S tabulators. Printers are configured as part of the system accumulation/reporting stations PC and related software.

1.1.1 Baseline Certified System

The baseline system for this modification is the EVS 5.2.3.0. The tables below describe the certified equipment and firmware versions.

Detailed descriptions of the EVS 5.2.3.0 test campaign are contained in SLI Report No. ESY-009-CTR-01, Rev. 3.0, which is available for viewing on the EAC's website at www.eac.gov.

Table 1-1. EVS 5.2.3.0 EAC Certified System Components

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|---------------------------------|-------------------------------------|---|--------------------------------|
| ExpressVote | 1.4.1.6 | 1.0 | Universal Voting System. |
| ExpressVote Rolling Kiosk | --- | 98-00049 | Kiosk for use with ExpressVote |
| DS200 | 2.12.2.0 | 1.2.1, 1.2.3, 1.3 | Precinct Count Tabulator |
| DS200 Ballot Box | --- | 1.2, 1.3 | Plastic Ballot Box |
| DS200 Ballot Box | --- | 1.0, 1.1, 1.2 | Metal Ballot Box |
| Auto MARK A100 | 1.8.6.1 | 1.0 | ADA Ballot Marking Device |
| AutoMARK A200 (SBC 2.0 and 2.5) | 1.8.6.1 | 1.1 | ADA Ballot Marking Device |
| AutoMARK A300 (SBC 2.0 and 2.5) | 1.8.6.1 | 1.3 | ADA Ballot Marking Device |
| DS850 | 2.10.2.0 | 1.0 | Central Count Tabulator |
| DS450 | 3.0.0.0 | 1.0 | Central Count Tabulator |
| EMS Client Workstation | --- | Dell OptiPlex 980 or 5040 | Workstation For EMS Reporting |
| EMS Server | --- | Dell PowerEdge T710 | Server For EMS |
| EMS Client Workstation | --- | Dell Latitude E6410 | Laptop For EMS Reporting |
| EMS Standalone Workstation | --- | Dell Latitude E6410 | Laptop For EMS Reporting |
| DS850 Report Printer | --- | Oki B431dn & Oki B431d | Laser Report Printer |
| DS850 Audit Printer | --- | Oki Microline 420 | Dot Matrix Audit Printer |
| DS450 Report Printer | --- | Dell S2810dn | Laser Report Printer |
| DS450 Audit Printer | --- | Oki Microline 420 | Dot Matrix Audit Printer |
| DS450 UPS | --- | APC Back-UPS Pro 1500 | UPS For DS450 |
| DS850 UPS | --- | APC Back-UPS RS 1500 or APC Back-UPS Pro 1500 | UPS For DS850 |
| DS450 Surge Protector | | Tripp Lite Spike Cube | Surge Protector for DS450 |

Table 1-1. EVS 5.2.3.0 System Components (continued)

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|---|-------------------------------------|---|--|
| USB Flash Drive | --- | Delkin 512MB, 1GB, 2GB, 4GB, 8GB | Storage for election and ballot definition |
| USB Flash Drive | --- | Delkin 16 GB | Validation purposes only |
| Compact Flash | --- | Delkin Devices 1.0 GB capacity | Storage for election and ballot definition |
| CF Card Reader | --- | 6381 | Delkin Compact Flash Reader |
| CF Card Reader | --- | 018-6305 | Sandisk Compact Flash Reader |
| USB Flash Drive | --- | SanDisk 512MB, 1GB, 2GB | Storage for election and ballot definition |
| Barcode Scanner | --- | DS457- SR20009 | Barcode scanner manufactured by Zebra integrated with rolling kiosk |
| QR Code Scanner | --- | DS9208 | Barcode scanner manufactured by Symbol |
| Headphones | --- | 86002 | COTS headphones manufactured by Avid |
| Electionware | 4.7.1.1 | --- | Election management software that provides end-to-end election management activities |
| Election Reporting Manager (ERM) | 8.12.1.1 | --- | Election results reporting program |
| Event Log Service (ELS) | 1.5.5.0 | --- | Service supporting election media programming |
| Removable Media Service (RMS) | 1.4.5.0 | --- | Service supporting election media programming |
| ExpressVote Previewer | 1.4.1.6 | --- | Ballot preview for accessible voting equipment |
| AutoMARK VAT Preview | 1.8.6.1 | --- | Ballot preview for accessible voting equipment |
| Adobe Acrobat Standard | 11 | --- | Desktop Publishing Software |
| Cerberus FTP | 8.0.6 (x64) | --- | File transfer server for or precinct results network |
| Microsoft Server 2008 | R2 w/SP1 | --- | Operating System for EMS and results servers |
| Microsoft Windows 7 | 64-bit/SP1 | --- | Operating System for standalone and client workstations |
| WSUS Microsoft Windows Offline Update Utility | 10.7.4 | --- | Software Updates (Update utility) |

Table 1-1. EVS 5.2.3.0 System Components *(continued)*

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|--|-------------------------------------|----------------------------|--------------------|
| Micro Focus RM/COBOL Runtime | 12.06 | --- | COBOL Runtime |
| Symantec Endpoint Protection | 12.1.6 | --- | Anti-Virus |
| Symantec Endpoint Protection Intelligent Updater | 20160829-002-v5i64 | --- | Anti-Virus |

1.2 References

- Election Assistance Commission 2005 Voluntary Voting System Guidelines (VVSG) Version 1.0, Volume I, “Voting System Performance Guidelines”, and 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 Edition, “NVLAP Procedures and General Requirements (NIST HB 150-2016)”, dated July 2016
- National Voluntary Laboratory Accreditation Program NIST Handbook 150-22, 2017 Edition, “Voting System Testing (NIST Handbook 150-22-)”, dated July 2017
- 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 1.0
- Election Assistance Commission “Approval of Voting System Testing Application Package” letter dated May 6, 2016
- EAC Requests for Interpretation (RFI) (listed on www.eac.gov)
- EAC Notices of Clarification (NOC) (listed on www.eac.gov)
- SLI Report No. ESY-009-CTR-01, Rev. 3.0, “Certification Test Report – Modification ES&S EVS 5.2.3.0”
- EAC Certificate of Conformance ES&S EVS 5.2.3.0, dated February 8, 2018

- Pro V&V Document No. TP-01-01-ESS-2018-02.01, Rev. B, “Test Plan for EAC VVSG 1.0 Certification Testing Election Systems & Software (ES&S) Voting System (EVS) 5.2.4.0”
- ES&S Technical Data Package (*A listing of the EVS 5.2.4.0 documents submitted for this test campaign is listed in Section 3.1 of this Test Report*)

1.3 Terms and Abbreviations

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

“ADA” – Americans with Disabilities Act 1990

“BMD” – Ballot Marking Device

“CM” – Configuration Management

“COTS” – Commercial Off-The-Shelf

“EAC” – United States Election Assistance Commission

“EMS” – Election Management System

“ERM” – Election Reporting Manager

“ES&S” – Election Systems and Software

“FCA” – Functional Configuration Audit

“HAVA” – Help America Vote Act

“ISO” – International Organization for Standardization

“NOC” – Notice of Clarification

“PCA” – Physical Configuration Audit

“QA” – Quality Assurance

“RFI” – Request for Interpretation

“RMS” – Removable Media Service

“TDP” – Technical Data Package

“VAT” – Voting Assist Terminal

“VSTL” – Voting System Test Laboratory

“VVSG” – Voluntary Voting System Guidelines

2.0 CERTIFICATION TEST BACKGROUND

2.1 Revision History

Pro V&V evaluated to the published Final Test Report for the EVS 5.2.3.0 in order to baseline the current system under test.

2.2 Scope of Testing

The scope of testing focused on evaluating the modifications detailed in Section 1.1.2 of this Test Report. Primarily, these modifications focused on upgrades to the components of the previously certified EVS 5.2.3.0 and the introduction of two new hardware versions for the ExpressVote (version 2.1.0.0 and 2.1.2.0). EVS 5.2.4.0 includes the following hardware:

- ExpressVote Universal Voting System hardware version 1.0 (ExpressVote HW 1.0)
- ExpressVote Universal Voting System hardware versions 2.1.0.0 and 2.1.2.0 (ExpressVote HW 2.1)
- AutoMARK Voter Assist Terminal (AutoMARK)
- DS200 precinct-based scanner and tabulator (DS200)
- DS450 central scanner and tabulator (DS450)
- DS850 central scanner and tabulator (DS850)

ExpressVote HW 1.0 was previously certified with EVS 5.2.3.0 and will remain certified with this system. ExpressVote HW 2.1 (hardware versions 2.1.0.0 and 2.1.2.0) are being incorporated in the EVS 5.2.4.0 as a modification and will be subjected to testing as part of this test campaign; however, previous results for Hardware Testing and Usability and Accessibility Testing will be utilized to satisfy those requirements. For ExpressVote HW 2.1, hardware version 2.1.0.0, previous certification testing performed as part of the EVS 5.4.0.0 will be used. For ExpressVote HW 2.1, hardware version 2.1.2.0, testing performed as part of the EVS 5.4.1.0 test campaign will be used. *Note: Hardware testing on the ExpressVote 2.1.2.0 was performed as part of the EVS 5.4.1.0 test campaign, which is still in process; however, testing was performed pursuant to the EVS 5.2.4.0 EAC Testing and Certification Test Campaign.*

To evaluate the EVS 5.2.4.0 test requirements, the submitted modifications were reviewed against each section of the EAC VVSG 1.0 to determine the applicable tests to be performed. Based on this assessment, the following tests were required:

- System Level Testing
 - System Integration Testing (*performed as part of Regression Testing*)
 - Functional Configuration Audit (FCA)
 - Accuracy Testing (*performed as part of Regression Testing*)

- Physical Configuration Audit (PCA), including System Loads & Hardening
- Technical Documentation Package (TDP) Review
- Hardware Testing
 - Non-Operating Environmental Testing
 - Operating Environmental Testing
 - Electrical Hardware Testing
- Source Code Review, Compliance Build, Trusted Build, and Build Document Review
- Usability & Accessibility Testing
- Regression Testing

2.2.1 Modification Overview

The EVS 5.2.4.0 is a modified voting system configuration that includes upgrades to the components of the EVS 5.2.3.0 and introduces two new hardware versions of the ExpressVote (version 2.1.0.0 and 2.1.2.0). EVS 5.2.4.0 adds four new ExpressVote configuration options: Quad Express Cart, MXB ExpressVote Voting Booth, ExpressVote Single Table and ExpressVote Double Table. EVS 5.2.4.0 also: adds a new ADA table configuration for the AutoMARK; provides security upgrades to third-party EMS COTS products; and contains minor enhancements to Electionware and ExpressVote.

2.2.1.1 Detailed List of Changes

The list below includes specific changes between EVS 5.2.4.0 and the baseline of the EVS 5.2.3.0:

General

- Security upgrades to third-party EMS COTS products

ExpressVote Universal Voting System

- Introduced two new hardware versions of the ExpressVote (2.1.0.0 and 2.1.2.0). Hardware 2.1.2.0 includes displays 6.4 and 6.8.
 - The new hardware version for the ExpressVote addresses end-of-life components as well as improved manufacturability.
- Introduced new configuration options for the ExpressVote
 - ExpressVote Single Table: Holds one ExpressVote in place while providing privacy for the voter. The table features a hole for cord management and a privacy screen. With side approach, this table accommodates voters in wheelchairs as well as standing voters.

- ExpressVote Double Table: Holds two ExpressVote units in place while providing privacy for each voter. The table features a hole for cord management and a double privacy screen.
- MXB ExpressVote Voting Booth: A configurable voting booth solution that accommodates seated voters on one side and standing voters on the other. Each side of this voting booth includes privacy screens.
- Quad Express Cart: A rolling cart with four locking caster wheels. It is capable of holding up to four ExpressVote units in place. Three of the units are positioned for standing voters while the fourth accommodates a seated voter. Each of the four stations on this cart include deployable privacy screens.
- Resolved an issue with write-in entries using a binary tactile device in multi-language elections.
- Resolved an issue where very long candidate text can truncate instead of displaying the entire text string.

AutoMARK

- Introduced a new configuration option
 - AutoMARK Table: Holds one AutoMARK in place while providing privacy for the voter. The table features a hole for cord management. With side approach, this table accommodates voters in wheelchairs as well as standing voters.

Electionware

- Updated audio prompts for enhanced support of ADA voting with a binary tactile device
- Updated Users xml export filename
- Updated User Guide

DS200

- Introduced the collapsible ballot box as a new configuration option

2.2.2 Block Diagram

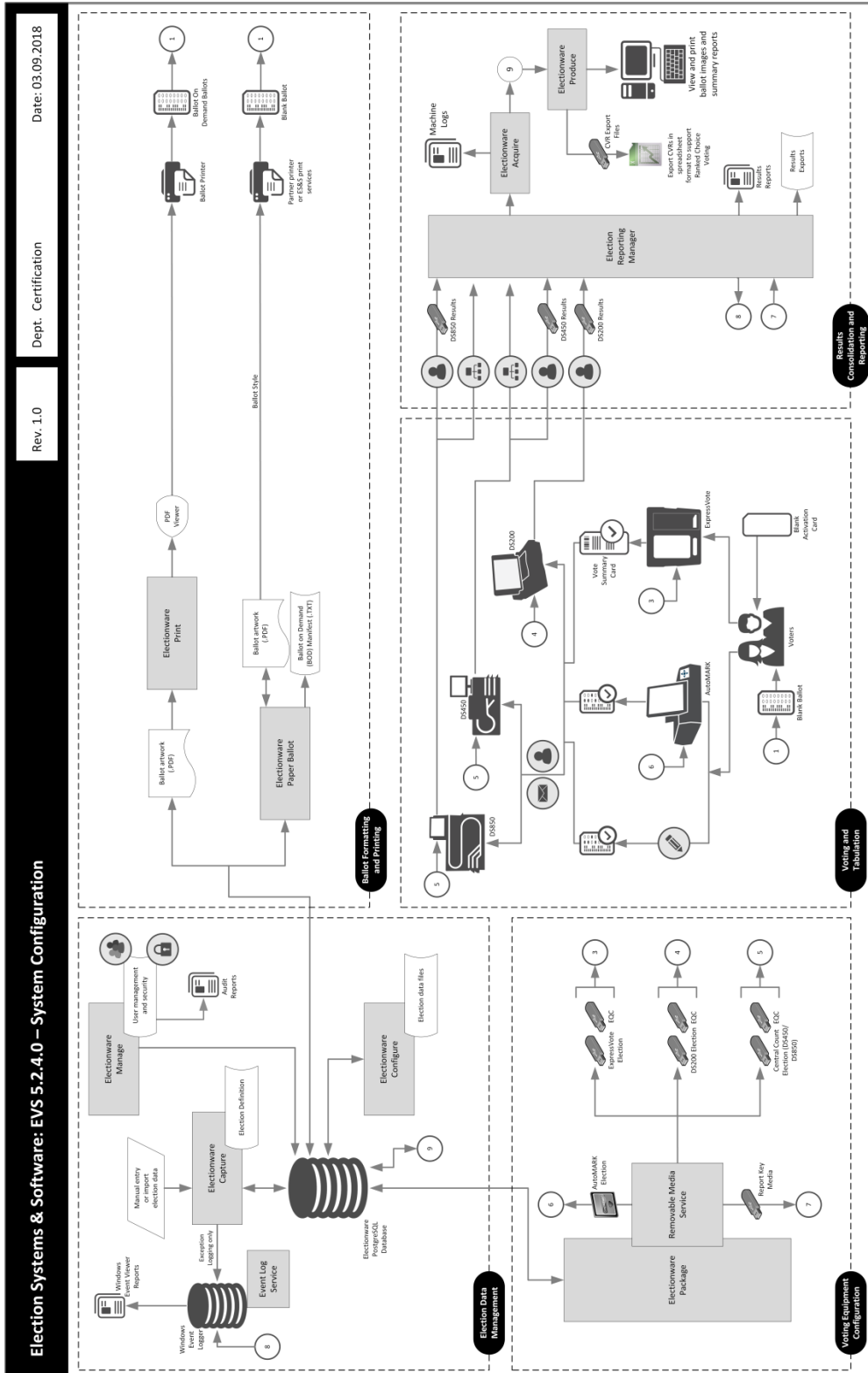


Figure 1-1. EVS 5.2.4.0 System Overview

2.2.3 Supported Functionality

The EVS 5.2.4.0 supports the following voting variations:

- General Election
- Closed Primary
- Open Primary
- Early Voting
- Partisan/Non-Partisan Offices
- Write-In Voting
- Split Precincts
- Vote for N of M
- Ballot Rotation
- Provisional or Challenged Ballots
- Straight Party Voting
- Cross-party Endorsement

2.2.4 Supported Languages

The following languages are supported by EVS 5.2.4.0:

- English
- Spanish
- Chinese
- Korean
- Japanese
- Bengali

Support for all stated languages was verified; however, only English and Spanish language ballots were cast during the performance of functional testing. Additionally, one character based language (Chinese) was tested during System Integration Testing.

For the character based language, the ballot was created by Pro V&V and voted utilizing both paper ballots and ADA voting devices along with all applicable peripherals.

2.2.5 System Limits

The system limits that were verified during testing to be supported by the EVS 5.2.4.0 are provided in the table below.

Table 2-1. EVS 5.2.4.0 System Limits

| System Characteristic | Boundary or Limitation | Limiting System Component |
|--|---|---------------------------------|
| Max. precincts allowed in an election | 9,900 | ERM |
| Max. count for any precinct element | 500,000 (99,990 from any tabulator media) | ERM report (ERM results import) |
| Max. candidates allowed per election | Depends on election content (limited by 21,000 maximum counters) | ERM |
| Max. contests allowed in an election | Depends on election content (limited by 21,000 maximum counters) | ERM |
| Max. counters allowed per precinct | Limits candidates and contests assigned to a precinct to 1,000 | ERM |
| Max. contests allowed per ballot style | 200 or # of positions on ballot | N/A |
| Max. candidates (ballot choices) allowed per contest | 175 | ERM (database create) |
| Max. number of parties allowed | General election: 75 Primary election: 20 (including nonpartisan party) | ERM (database create) |
| Max. 'vote for' per contest | 98 | ERM (database create) |
| Ballot formats | All paper ballots used in an election must be the same size. Votable paper ballots must contain the same number of rows | Ballot scanning equipment |
| Max. Ballot Styles | 9,900 | ERM |
| Max. District Types/Groups | 20 | ERM |
| Max. districts of a given type | 40 | --- |

Additionally, the following EVS 5.2.4.0 product limitations have been identified:

Paper Ballot Limitations

1. The paper ballot code channel, which is the series of black boxes that appear between the timing track and ballot contents, limits the number of available ballot variations depending on how a jurisdiction uses this code to differentiate ballots. The code can be used to differentiate ballots using three different fields defined as: Sequence (available codes 1-26,839), Type (available codes 1-30) or Split (available codes 1-40).
2. For paper ballots, if Sequence is used as a ballot style ID, it must be unique election-wide and the Split code will always be 1. In this case the practical style limit would be 26,000.

DS200

1. The DS200 configured for an early vote station does not support precinct level results reporting. An election summary report of tabulated vote totals is supported.
2. The DS200 storage limitation for write-in ballot images is 3,600 images. Each ballot image includes a single ballot face, or one side of one page.
3. Write-in image review requires a minimum 1GB of onboard RAM.
4. To successfully use the write-in report, ballots must span at least three vertical columns. Using two columns or fewer results in the write-in area being too large to print on the report tape.

AutoMARK Voter Assist Terminal

1. AutoMARK capacities exceed all documented limitations for the ES&S election management, vote tabulation and reporting system. For this reason, Election Management System and ballot tabulator limitations define the boundaries and capabilities of the AutoMARK system as the maximum capacities of the ES&S AutoMARK are never approached during testing.

Electionware

1. Electionware capacities exceed the boundaries and limitations documented for ES&S voting equipment and election reporting software. For this reason, ERM and ballot tabulator limitations define the boundaries and capabilities of the Electionware system.
2. Limits were calculated using default text sizes for ballot and report elements. Some uses and conditions, such as magnified ballot views or combining elements on printed media or ballot displays, may result in limits lower than those listed. Check printed media and displays before finalizing the election.
3. Electionware Export Ballot Images function is limited to 250 districts per export.
4. Special characters are not supported and may not appear properly when viewed on equipment displays or reports.
5. Electionware cannot display more than 30,000 images when filtering ballot images for display. Employ one or more filters to ensure that the number of ballots viewed is less than 30,000.

ExpressVote

1. ExpressVote capacities exceed all documented limitations for the ES&S election management, vote tabulation and reporting system. For this reason, Election Management System and ballot tabulator limitations define the boundaries and capabilities of the ExpressVote system as the maximum capacities of the ES&S ExpressVote are never approached during testing.

Election Reporting Manager (ERM)

1. ERM requires a minimum monitor screen resolution of 800x600.

2. ERM Database Create allows 1,600 Precincts per Ballot Style.
3. There is a limit of 3,510 precincts in the precincts counted/not counted display.
4. There is a limit of 3,000 precincts in the precincts counted/not counted scrolling display.
5. Contest/Precinct selection pop up display limited to 3,000 contests/precincts.
6. Non-English characters are not supported in ERM. This has to do with the creation of the XML results file out of ERM.
7. ERM's maximum page size for reports is 5,000 pages.

2.2.6 VVSG

The EVS 5.2.4.0 was evaluated against the relevant requirements contained in the EAC VVSG 1.0.

2.2.7 RFIs

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

2.2.8 NOCs

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

3.0 TEST FINDINGS AND RECOMMENDATIONS

The EVS 5.2.4.0 was evaluated against the relevant requirements contained in the EAC 2005 VVSG, Volumes I and II. The focus of this test campaign was on the modifications to the voting system configuration that included upgrades to the components of the baselined system and the introduction of the new hardware versions for the ExpressVote (version 2.1.0.0 and 2.1.2.0). The summary findings and recommendations for each area of testing are provided in the following sections.

3.1 Summary Findings and Recommendation

Summary findings for the System Level Testing (System Integration Testing, Accuracy, and Limited FCA), PCA, Hardware Testing, and Source Code Review are detailed in the relevant sections of this report. In addition to these areas of testing, a TDP Review was performed, as described below.

Technical Documentation Package (TDP) Review

In order to determine compliance of the modified TDP documents with the EAC VVSG 1.0, a limited TDP review was conducted. This review focused on TDP documents that have been modified since the certification of the baseline system. The review consisted of a compliance review to verify that each regulatory, state, or manufacturer-stated requirement had been met based on the context of each requirement.

Results of the review of each document were entered on the TDP Review Checklist and reported to the manufacturer for disposition of any anomalies. This process was ongoing until all anomalies were resolved. Any revised documents during the TDP review process were compared with the previous document revision to determine changes made, and the document was re-reviewed to determine whether subject requirements had been met. A listing of all documents contained in the EVS 5.2.4.0 TDP is provided in Table 3-1.

Table 3-1. EVS 5.2.4.0 TDP Documents

| Document ID | Description | Document Revision |
|--|---|--------------------------|
| <i>Preface</i> | | |
| EVS5240_C_L_Requirements Matrix | Requirements of the 2005 VVSG Trace to Vendor Testing | 1.0 |
| <i>System Overview</i> | | |
| EVS5240_C_D_0100_SYSOVR | ES&S Voting System 5.2.4.0 System Overview | 1.3 |
| <i>System Functionality Description</i> | | |
| EVS5240_C_D_0200_SFD | ES&S Voting System 5.2.4.0 System Functionality Description | 1.0 |
| <i>System Hardware Specification</i> | | |
| AQS-18-5000-001-F | AutoMARK System Hardware Specification | 6 |
| AQS-18-5002-000-S | AutoMARK System Hardware Overview | 9 |
| DS200HW_M_SPC_0312_HW SPEC | DS200 Hardware Specification, Hardware Revision 1.2 | 3.4 |
| DS200HW_M_SPC_0313_HW SPEC | DS200 Hardware Specification, Hardware Revision 1.3 | 4.5 |
| DS450_1'0_SPC_HWSPEC | DS450 Hardware Specification, Hardware Revision 1.0 | 1.6 |
| DS850HW_M_SPC_0310_HW SPEC | DS850 Hardware Specification, Hardware Revision 1.0 | 1.6 |
| EVOTEHW_M_SPC_0310_H WSPEC | ExpressVote Hardware Specification, Hardware Revision 1.0 | 3.10 |
| EVOTEHW_M_SPC_0321_H WSPEC | ExpressVote Hardware Specification, Hardware Revision 2.1 | 1.3 |
| AutoMARKHW_M_SPC_A100_BOM | AutoMARK A100 Approved Parts List | 2.0 |
| AutoMARKHW_M_SPC_A200_BOM | AutoMARK A200 Approved Parts List | 2.0 |
| AutoMARKHW_M_SPC_A300_BOM | AutoMARK A300 Approved Parts List | 2.0 |
| DS200HW_M_SPC_0312_APL | DS200 Approved Parts List | 1.2 |
| DS200HW_M_SPC_0313_APL | Approved Parts List: DS200 HW Rev 1.3 | 1.1 |
| DS450HW_M_SPC_0310_APL | Approved Parts List: DS450 HW Rev 1.0 | 1.1 |
| DS850HW_M_SPC_0310_APL | Approved Parts List: DS850 HW Rev 1.0 | 1.1 |

Table 3-1. EVS 5.2.4.0 TDP Documents (continued)

| Document ID | Description | Document Revision |
|--|---|-------------------|
| ExpressVoteHW_M_SPC_0310_APL | Approved Parts List: ExpressVote HW Rev 1.0 | 1.1 |
| ExpressVoteHW_M_SPC_0321_APL | Approved Parts List: ExpressVote HW 2.1 | 2.3 |
| <i>Software Design and Specification</i> | | |
| EVS5240_D_SDS00_DS200 | DS200 - Software Design Specification | 1.0 |
| EVS5240_D_SDS00_DS450 | DS450 - Software Design Specification | 1.0 |
| EVS5240_D_SDS00_DS850 | DS850 – Software Design Specification | 1.0 |
| EVS5240_D_SDS00_ELS | ES&S Software Design Specifications Event Log Service ES&S Voting System | 1.0 |
| EVS5240_D_SDS00_ERM | ES&S Software Design Specifications Election Reporting Manager (ERM) ES&S Voting System | 1.0 |
| EVS5240_D_SDS00_ExpressVote_HW1'0 | ExpressVote Software Design and Specification | 1.1 |
| EVS5240_D_SDS00_ExpressVote_HW2'1 | ExpressVote (Hardware Version 2.1) Software Design Specification | 1.2 |
| ESSSYS_D_P_0400_CODING STANDARDS | Coding Standards | 1.2 |
| ESSSYS_1'0_P_SYSDEVPROGRAM | System Development Program | 1.5 |
| ESSSYS_1'0_SPC_LicenseAgreements | License Agreements for Procured Software | 1.3 |
| EVS5240_D_SDS00_ELECTIONWARE | Electionware – Software Design Specification | 1.0 |
| AQS-18-5002-003-S | AutoMARK Ballot Image Processing Specifications | 6 |
| AQS-18-5002-007-S | AutoMARK Ballot Scanning and Printing Specification | 5 |
| AQS-18-5000-002-F | AutoMARK Driver API Specification | 5 |
| AQS-18-5002-005-S | AutoMARK ESS Embedded Database Interface Specifications | 6 |
| AQS-18-5001-005-R | AutoMARK Graphical User Interface Design Specifications | 6 |
| AQS-18-5001-002-R | AutoMARK Operating Software (AMOS) Design Specifications | 5 |
| AQS-18-5002-004-S | AutoMARK Operations and Diagnostic Log Specifications | 5 |
| AQS-18-5001-011-R | AutoMARK Programming Specifications Details | 6 |
| AQS-18-5001-004-S | AutoMARK Software Design Specifications | 7 |
| --- | Software Design and Specifications Overview AutoMARK Voter Assist Terminal (VAT) | N/A |
| AQS-18-5001-006-R | AutoMARK Software Development Environment Specifications | 5 |

Table 3-1. EVS 5.2.4.0 TDP Documents (continued)

| Document ID | Description | Document Revision |
|--|--|--------------------------|
| AQS-18-5000-004-F | AutoMARK Software Diagnostics Specification | 5 |
| AQS-18-4000-000-S | AutoMARK ESS Software Standards Specification | 5 |
| System Test and Verification | | |
| EVS5240_QA_D_0500_SYST ESTPLAN | ES&S Voting System 5.2.4.0 System Test Plan | 1.0 |
| AMVATHW_P_D_0510_CIFR ptAMVAT | Usability Test Report ES&S AutoMARK Voter Assist Terminal (VAT) Version 1.X | --- |
| DS200HW_P_D_0512_CIFRpt DS200 | Usability Test Report DS200 Precinct Ballot Scanner Version 1.2.1 | --- |
| ExpressVoteHW_P_D_0509_C IFRptExpressVote | ExpressVote Usability Report ES&S Voting System 5.2.0.0 | --- |
| System Security Specification | | |
| AQS-18-5002-001-S | AutoMARK System Security Specifications | 7 |
| EVS5240_CM_SPC00_SysSec uritySpec | ES&S Voting System Security Specification | 1.0 |
| EVS5240_CM_SPC_CLIENT WORKSTATIONSETUPCON FIGGUIDE | ES&S Voting System 5.2.4.0 EMS Client Workstation Secure Setup & Configuration Guide | 1.1 |
| EVS5240_CM_SPC_EMSSER VERSETUPCONFIGGUIDE | ES&S Voting System 5.2.4.0 EMS Server Secure Setup & Configuration Guide | 1.1 |
| EVS5240_CM_SPC02_SECSC RIPTDESC | ES&S Voting System 5.2.4.0 Security Script Description | 1.0 |
| EVS5240_CM_SPC_STANDA LONEWORKSTATIONSETU PCONFIGGUIDE | ES&S Voting System 5.2.4.0 Standalone EMS Workstation Secure Setup & Configuration Guide | 1.1 |
| EVS5240_CM_D_1000_VERP ROC_VERIFICATIONPC | Verification Procedure: Verification PC Setup | 1.0 |
| EVS5240_CM_D_2010_EMSV ERIFICATIONPROCEDURE | Verification Procedure: Election Management System | 1.2 |
| EVS5240_CM_D_2021_Auto MARKVerificationProcedure | Verification Procedure: AutoMARK Ballot Marking Device | 1.2 |
| EVS5240_CM_D_2050_DS850 VERIFICATIONPROCEDURE | Verification Procedure: DS850 Central Scanner & Tabulator | 1.2 |
| EVS5240_CM_D_2060_DS450 VERIFICATIONPROCEDURE | Verification Procedure: DS450 Central Scanner & Tabulator | 1.2 |
| EVS5240_CM_D_2070_DS200 VERIFICATIONPROCEDURE | Verification Procedure: DS200 Precinct Scanner & Tabulator | 1.2 |
| EVS5240_CM_D_2081_Expres sVoteHW10VerificationProced ure | Verification Procedure: ExpressVote Universal Voting System | 1.0 |

Table 3-1. EVS 5.2.4.0 TDP Documents (continued)

| Document ID | Description | Document Revision |
|--|--|--------------------------|
| EVS5240_CM_D_2081_ExpressVoteHW2'1VerificationProcedure | Verification Procedure: ExpressVote Hardware 2.1 | 1.0 |
| EVS5240_D_L01_StaticDynamicFileList_Electionware | Validation File List: Electionware | 1.0 |
| EVS5240_D_L02_StaticDynamicFileList_ExpressVote_HW1'0 | Validation File List: ExpressVote HW1.0 | 1.0 |
| EVS5240_D_L02_StaticDynamicFileList_ExpressVote_HW2'1 | Validation File List: ExpressVote HW 2.1 | 1.3 |
| EVS5240_D_L03_StaticDynamicFileList_DS450 | Validation File List: DS450 | 1.0 |
| EVS5240_D_L04_StaticDynamicFileList_DS200 | Validation File List: DS200 | 1.0 |
| EVS5240_D_L05_StaticDynamicFileList_DS850 | Validation File List: DS850 | 1.0 |
| EVS5240_D_L06_StaticDynamicFileList_AutoMARK | Validation File List: AutoMARK | 1.0 |
| EVS5240_D_L08_StaticDynamicFileList_ERM | Validation File List: ERM | 1.0 |
| EVS5240_D_L11_StaticDynamicFileList_ExpressVotePreviewer_HW1'0 | Validation File List: ExpressVote HW1.0 Previewer | 1.0 |
| EVS5240_D_L11_StaticDynamicFileList_ExpressVotePreviewer_HW2'1 | Validation File List: ExpressVote HW 2.1 Previewer | 1.1 |
| EVS5240_D_L15_StaticDynamicFileList_ELS | Validation File List: ELS | 1.0 |
| EVS5240_D_L16_StaticDynamicFileList_RMS | Validation File List: RMS | 1.0 |
| EVS5240_D_L19_StaticDynamicFileList_VATPreviewer | Validation File List: VAT Previewer | 1.0 |
| ESSSYS_EVS5230_BP_EMSEMBUILDENVIRONMENT | Build Environment Construction, Election Management System | 1.4 |
| ESSSYS_EVS5230_BP_EXPR ESSVOTEUVS-V1VMTRUSTEDBUILD1 | Build Procedure: ExpressVoteUVS-v1 and ExpressVoteUVS-v1 Previewer Trusted Build 1 | 2.0 |
| ESSSYS_5'2'4'0_BP_EMSTrust edBuild1 | Build Procedure, Election Management System Trusted Build 1 | 1.0 |
| ESSSYS_5'2'4'0_BP_ExpressVoteUVS-v1VMTrustedBuild1 | Build Procedure: ExpressVoteUVS-v1 and ExpressVoteUVS-v1 Previewer Trusted Build 1 | 1.0 |
| ESSSYS_5'2'4'0_BP_EXPRES SVOTEUVS-V2TRUSTEDBUILD1 | Build Procedure: ExpressVoteUVS-v2 and ExpressVoteUVS-v2 Previewer Trusted Build 1 | 1.0 |
| System Operations Procedures | | |

Table 3-1. EVS 5.2.4.0 TDP Documents (continued)

| Document ID | Description | Document Revision |
|---|---|--------------------------|
| EVS5240_DOC_SOP_AMVAT | AutoMARK Operator's Guide, Firmware Version 1.8 | 1.1 |
| EVS5240_DOC_SOP_DS200 | DS200 Operator's Guide, Firmware Version 2.12 | 1.0 |
| EVS5240_DOC_SOP_DS200_APPX | DS200 Operator's Guide Appendices, Firmware Version 2.12 | 1.0 |
| EVS5240_DOC_SOP_DS450 | DS450 Operator's Guide, Firmware Version 3.0 | 1.0 |
| EVS5240_DOC_SOP_DS450_APPX | DS450 Operator's Guide Appendices, Firmware Version 3.0 | 1.0 |
| EVS5240_DOC_SOP_DS850 | DS850 Operator's Guide, Firmware Version 2.10 | 1.1 |
| EVS5240_DOC_SOP_DS850_APPX | DS850 Operator's Guide Appendices, Firmware Version 2.10 | 1.0 |
| EVS5240_DOC_SOP_ELS | EVS Event Logging Service User's Guide, Software Version 1.5 | 1.0 |
| EVS5240_DOC_SOP_ERM | Election Reporting Manager User's Guide, Software Version 8.12 | 1.0 |
| EVS5240_DOC_SOP_ERM_APPX | Election Reporting Manager User's Guide Appendices, Software Version 8.12 | 1.0 |
| EVS5240_DOC_SOP_Express Vote_HW1'0 | ExpressVote Operator's Guide, Firmware Version 1.4 | 1.1 |
| EVS5240_DOC_SOP_Express Vote_HW1'0_APPX | ExpressVote Operator's Guide Appendices, Firmware Version 1.4 | 1.0 |
| EVS5240_DOC_SOP_EW01Admin | Electionware Vol. I: Administrator Guide, Software Version 4.7 | 1.0 |
| EVS5240_DOC_SOP_EW02Define | Electionware Vol. II: Define User Guide, Software Version 4.7 | 1.0 |
| EVS5240_DOC_SOP_EW03Design | Electionware Vol. III: Design User Guide, Software Version 4.7 | 1.0 |
| EVS5240_DOC_SOP_EW04Deliver | Electionware Vol. IV: Deliver User Guide, Software Version 4.7 | 1.0 |
| EVS5240_DOC_SOP_EW05Results | Electionware Vol. V: Results User Guide, Firmware Version 4.7 | 1.0 |
| EVS5240_DOC_SOP_EW06Appendix | Electionware Vol. VI: Appendices, Firmware Version 4.7 | 1.0 |
| EVS5240_DOC_SOP_Express Vote_HW2'1 | ExpressVote Operator's Guide, Hardware Version 2.1, Firmware Version 2.4 | 1.1 |
| System Maintenance Manuals | | |
| EVS5240_DOC_SMM_AMVAT | AutoMARK Maintenance Manual, Firmware Version 1.8 | 1.0 |
| EVS5240_DOC_SMM_DS200 | DS200 Maintenance Manual, Firmware Version 2.12 | 1.0 |
| EVS5240_DOC_SMM_DS450 | DS450 Maintenance Manual, Firmware Version 3.0 | 1.0 |
| EVS5240_DOC_SMM_DS850 | DS850 Maintenance Manual, Firmware Version 2.10 | 1.0 |

Table 3-1. EVS 5.2.4.0 TDP Documents (continued)

| Document ID | Description | Document Revision |
|---|--|--------------------------|
| EV5240_DOC_SMM_ExpressVote_HW1'0 | ExpressVote Maintenance Manual, Firmware Version 1.4 | 1.0 |
| EV5240_DOC_SMM_ExpressVote_HW2'1 | ExpressVote Maintenance Manual, Firmware Version 2.4, Hardware Version 2.1 | 1.0 |
| <i>Personnel Deployment and Training</i> | | |
| ESSSYS_T_D_0900_TRAININGPROGRAM | Personnel Deployment and Training Program | 1.1 |
| <i>Configuration Management Plan</i> | | |
| SSSYS_CM_P_1000_CMProgram | Configuration Management Program | 2.1 |
| EV5240_DOC_P_1000_TDPPROGRAM | Technical Documentation Program | 1.0 |
| <i>QA Program</i> | | |
| EV5240_M_P_1100_MNFQA PROGRAM | Manufacturing Quality Assurance Program | 1.0 |
| ESSSYS_QA_P_1100_SWQA PROGRAM | Software Quality Assurance Program | 1.2 |
| <i>System Change Notes</i> | | |
| EV5240_DOC_D_1200_ChangeNotes | ES&S Voting System 5.2.4.0 System Change Notes | 1.0 |
| <i>Attachments</i> | | |
| BPG_1'0_SOP | Ballot Production Guide for EVS | 2.9 |

3.1.1 Hardware Testing

For ExpressVote HW 2.1 hardware version 2.1.0.0, previous certification testing performed as part of the EVS 5.4.0.0 test campaign was used. For ExpressVote HW 2.1 hardware version 2.1.2.0, testing performed as part of the EVS 5.4.1.0 test campaign was used. *Note: Hardware testing on the ExpressVote 2.1.2.0 was performed as part of the EVS 5.4.1.0 test campaign, which is pending approval; however, testing was performed pursuant to the EVS 5.2.4.0 EAC Testing and Certification Test Campaign.*

The ExpressVote HW 2.1 was subjected to the hardware tests 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
- Acoustic

Pro V&V utilized third party testing during the performance of hardware testing. All hardware testing was performed at the NTS Longmont facility located in Longmont, Colorado. All testing was witnessed on-site by Pro V&V personnel, with the exception of Temperature Power Variation in which Pro V&V qualified staff executed all testing at the NTS Longmont facility.

Summary Findings

Electrical Testing was performed on the components listed above. The procedures and results for this testing are included in NTS Test Report No: TR-PR075829, presented in Attachment A, Part 1, and NTS Test Report No. ETR-PR075829, presented in Attachment A, Part 2. The test results from this testing are summarized below:

Table 3-2. Electrical Hardware Test Results

| Standard/Method | Description | Criteria | Class/Level | Result |
|--|--------------------------------------|----------|-------------|-----------|
| FCC 15.107 ICES-003 VVSG Vol. 1 4.1.2.9 | Power Line Conducted Emissions | N/A | Class B | Compliant |
| FCC 15.109 ICES-003 VVSG Vol. 1 4.1.2.9 | Radiated Emissions | N/A | Class B | Compliant |

Table 3-2. Electrical Hardware Test Results (continued)

| Standard/Method | Description | Criteria | Class/Level | Result |
|--|--------------------------------|---------------------------------|--|----------------|
| EN61000-4-11 VVSG Vol. 1 4.1.2.5 | Electrical Power Disturbance | Normal Operation & No Data Loss | Various | Compliant |
| EN61000-4-4 VVSG Vol. 1 4.1.2.6 | Electrical Fast Transient | Normal Operation & No Data Loss | ±2kV - Mains | Compliant |
| EN61000-4-5 VVSG Vol. 1 4.1.2.7 | Lightning Surge | Normal Operation & No Data Loss | ±2kV Line - Line ±2kV Line - Ground | Compliant |
| EN61000-4-2 VVSG Vol. 1 4.1.2.8 | Electrostatic Disruption | Normal Operation & No Data Loss | ±8kV Contact ±15kV Air | Compliant |
| EN61000-4-3 VVSG Vol. 1 4.1.2.10 | Electromagnetic Susceptibility | Normal Operation & No Data Loss | 10 V/m, 80 MHz – 1 GHz | Compliant |
| EN61000-4-6 VVSG Vol. 1 4.1.2.11 | Conducted RF Immunity | Normal Operation & No Data Loss | 10 Vrms, 150 kHz – 80 MHz | Compliant |
| EN61000-4-8 VVSG Vol. 1 4.1.2.12 | Magnetic Immunity | Normal Operation & No Data Loss | 30 A/m | Compliant |
| Overall Result | | | | Pass/Compliant |

The Electrical Supply portion of the Electrical Testing was performed at Pro V&V’s test facility. The ExpressVote completed the test requirements successfully with no deficiencies noted. Test Result – PASS

Environmental Testing was performed on the components listed above. The procedures and results for this testing, with the exception of the Acoustic Test, are included in NTS Test Report No: TR-PR075783, presented in Attachment A, Part 3. The test results from this testing are summarized below:

Acoustic (2005 VVSG Volume 1 Section 3.2.2.2.c.v and EAC RFI 2013-02)

The ExpressVote HW 2.1 was subjected to Acoustic Testing in accordance with Section 3.2.2.2 of the VVSG. Testing was performed at Pro V&V’s test facility. During test performance, the initial, high and peak decibel outputs were measured. All measurements were found to be within the allowable limits. Additionally, the output increments were verified to be within 10 decibels each. Test Result – PASS

Shock - Bench Handling (MIL-STD-810D, 516.3, I-3.8)

The ExpressVote HW 2.1 was subjected to Shock – Bench Handling Testing. Using one edge as a pivot, the opposite edge of the chassis of each unit was lifted until the face reached 45° with horizontal bench top, or 4 inches above bench top (whichever occurred first). This was repeated with each practical edge, of the same horizontal face. At the conclusion of testing, the

components were subjected to a visual inspection and an operational status check was performed.
 Test Result – PASS

Vibration – Basic Transportation (MIL-STD-810D, 514.3, I-3.2.1)

The ExpressVote HW 2.1 was subjected to Vibration – Basic Transportation Testing. Testing was performed at ambient/room temperature (20°C +/-3 °C) in the X, Y and Z axis at the levels identified in Figure 3-1. At the conclusion of testing, a visual inspection and an operational status check was performed. Test Result - PASS

| Axis | Profile |
|------------|-------------------------------|
| X | BREAKPOINTS FREQ PSD VALU |
| | 10 .00013 |
| | 20 .00065 |
| | 30 .00065 |
| | 78 .00002 |
| | 79 .00019 |
| | 120 .00019 |
| 500 .00001 | |
| Y | BREAKPOINTS FREQ PSD VALUE |
| | 10 .00650 |
| | 20 .00650 |
| | 120 .00020 |
| | 121 .00300 |
| | 200 .00300 |
| | 240 .00150 |
| | 340 .00003 |
| | 500 .00015 |
| Z | BREAKPOINTS FREQ PSD VALUE |
| | 10 .01500 |
| | 40 .01500 |
| | 500 .00015 |

Figure 3-1. Vibration Test Profiles

Low Temperature - Storage (MIL-STD-810D, 502.2, II-3)

The ExpressVote HW 2.1 was subjected to Low Temperature – Storage Testing. Samples were subjected to a temperature of -4°F (-20°C +/-3 °C) for a duration of 4 hours, after which operation was confirmed by Pro V&V. Samples were not powered, and were left in their packaging for the duration of the test. They were removed from the boxes for operational verification after the test. At the conclusion of testing, a visual inspection and an operational status check was performed.
 Test Result – PASS

High Temperature - Storage (MIL-STD-810D, 501.2, I-3.2)

The ExpressVote HW 2.1 was subjected to High Temperature – Storage Testing. Samples were subjected to a temperature of 140°F (60°C +/-3 °C) for a duration of 4 hours, after which operation was confirmed by Pro V&V. Samples were not powered, and were left in their packaging for the duration of the test. They were removed from the boxes for operational

verification after the test. At the conclusion of testing, a visual inspection and an operational status check was performed. Test Result – PASS

Humidity – Hot/Humid (MIL-STD-810D, 507.2, I-3.2)

The ExpressVote HW 2.1 was subjected to Humidity – Hot/Humid Testing. Samples were subjected as per Table 507.2-I, Hot-Humid (Cycle 1), for a duration of 240 hours (10 days), after which operation was confirmed by Pro V&V. Samples were not powered/operational, and were left in their packaging for the duration of the test, and were removed from the boxes for operational verification. At the conclusion of testing, a visual inspection and an operational status check was performed. Test Result – PASS

Temp-Power Variation Testing (MIL-STD-810D, 501.2/502.2)

The ExpressVote HW 2.1 was subjected to Temperature/Power Variation Testing. The ExpressVote components were powered and being operated by Pro V&V for the duration of the environmental profile, to confirm operation.

Test Result – PASS

| |
|---|
| 1- Ramp to 10°C |
| 2- Hold 10°C for 12 hours |
| 3- Ramp to 35°C over 1 hour |
| 4- Hold 35°C for 12 hours |
| 5- Ramp to 10°C over 1 hour |
| 6- Repeat until 85 hours cycling at profile is achieved |
| 7- Ramp to 35°C over 1 hour |
| 8- Hold 35°C for 12 hours |
| 9- Ramp to 23°C over 1 hour |
| 10- Hold for duration of test |

Figure 3-2. Temperature/Power Variation Profile

3.1.2 Source Code Review

Pro V&V reviewed 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 verified 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.

A combination of Automated Source Code Review and Manual Source Code Review methods were used to review the changes in the source code from the previously certified EVS 5.2.3.0 voting system. In addition, 10% of the source code comments were manually reviewed.

Summary Findings

- Automated Source Code Review: The Automated Source Code Review was performed during the EVS 5.2.4.0 Compliance and Trusted Builds. No source code issues were found during the Automated Source Code review.
- Manual Source Code Review: The Manual Source Code review was performed on 10% of the comments for compliance to VVSG Volume Section 5.2.7. No source code issues were found during the Manual Source Code review.
- Compliance Build: The compliance build was performed following the compliance review. Once the compliance review was performed and the source was deemed stable enough to proceed with testing, the source code and all additional packages were compiled into a Compliance Build.
- Trusted Build: The trusted build consisted of inspecting customer submitted source code, COTS, and third party software products and combining them to create the executable code. This inspection followed the documented process from the “United States Election Assistance Commission Voting System Test Laboratory Program Manual” Section 5.5 – 5.7. Performance of the trusted build includes the build documentation review. The Trusted Build was performed following the completion of the Functional Configuration Audit.

3.1.3 Physical Configuration Audit (PCA)

The Physical Configuration Audit (PCA) compares the voting system components submitted for qualification to the manufacturer’s technical documentation, and included 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 reviewed drawings, specifications, technical data, and test data associated with system hardware to establish a system hardware baseline associated with the 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

Summary Findings

During execution of the test procedure, the components of the EVS 5.2.4.0 system were documented by component name, model, serial number, major component, and any other relevant information needed to identify the component. For COTS equipment, every effort was made to verify that the COTS equipment had not been modified for use. Additionally, each technical document submitted in the TDP was recorded by document name, description, document number, revision number, and date of release. At the conclusion of the test campaign, test personnel verified that any changes made to the software, hardware, or documentation during the test process were fully and properly documented.

3.1.4 System Level Testing

System Level Testing included the Limited Functional Configuration Audit (FCA), the Accuracy Test, and the System Integration Tests. The Accuracy Test and the System Integration tests were performed as part of the regression test requirements for this campaign. System Level Testing also included a limited Accessibility/Usability Review on the Quad Express Cart, ExpressVote Single Table, ExpressVote Double Table, MXB ExpressVote Voting Booth, and AutoMark Table. System Level testing was implemented to evaluate the complete system. This testing included all proprietary components and COTS components (software, hardware, and peripherals). For software system tests, the tests were designed according to the stated design objective without consideration of its functional specification.

The system level hardware and software test cases were prepared independently to assess the response of the hardware and software to a range of conditions.

The FCA for this test campaign included an assessment of the submitted modifications and included inputs of both normal and abnormal data during test performance. This evaluation utilized baseline test cases as well as specifically designed test cases and included predefined election definitions for the input data. The System Integration Tests were performed to verify the EVS 5.2.4.0 functioned as a complete system.

Additionally, the system was configured exactly as it would for normal field use per the procedures detailed in the EVS 5.2.4.0 technical documentation. This included connecting all supporting equipment and peripherals including ballot boxes, voting booths (regular and accessible), and any physical security equipment such as locks and ties.

3.1.4.1 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 were conducted to ensure all applicable EAC VVSG 1.0 requirements were met.

Summary Findings

All functional tests were successfully executed.

3.1.4.2 Accuracy

The Accuracy Test ensured that each component of the voting system could 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 were used to test components of the voting system:

The accuracy requirements for the ExpressVote HW 1.0, DS200, DS450, DS850, and AutoMark were met as part of the previous EVS 5.2.3.0 test campaign. Only the ExpressVote HW 2.1 (hardware versions 2.1.0.0 and 2.1.2.0) were subjected to the Accuracy Test as part of this test campaign. Testing of the ExpressVote HW 2.1 was accomplished by the execution of the standard accuracy test utilizing manually voted activation cards, QR barcode pre-marked vote selections, and pre-marked vote summary cards of each card length supported.

Summary Findings

The ExpressVote HW 2.1 units successfully passed the Accuracy Test without issue. A total of 1,600,000 voting positions were scanned into the ExpressVote HW 2.1 with all actual results obtained during test execution matching the expected results.

3.1.4.3 System Integration

System Integration is a system level test that evaluates the integrated operation of both hardware and software. System Integration tests the compatibility of the voting system software components, or subsystems, with one another and with other components of the voting system environment. This functional test evaluates the integration of the voting system software with the remainder of the system.

Summary Findings

During test performance, the system was configured as it would be for normal field use. This involved 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 properly configured and tested the system by following the procedures detailed in the EVS 5.2.4.0 technical documentation.

A General Election and a Primary Election were successfully exercised on the voting system, as described below:

General election with the following breakdown:

- General Election GEN-03: A basic election held in two precincts. This election contains eight contests and compiled into two ballot styles. Four of the contests are in both ballot styles. The other four contests are split between the two precincts. This election is designed to functionally test the handling of multiple ballot styles, support for at least three languages including a character-based language, support for common voting variations, and audio support for at least three languages and an ADA binary input device.

Primary election with the following breakdown:

- Primary Election PRIM-03: A basic election held in two precincts. This election contains ten contests and is compiled into two ballot styles. Two of the contests are in both ballot styles. The other eight contests are split between the two parties' ballots. This Primary Election is designed to functionally test the handling of multiple ballot styles, support for at least three languages including a character-based language, support for common voting variations, and audio support for at least three languages and an ADA binary input device.

The EVS 5.2.4.0 system successfully passed the System Integration Test. During execution of the test procedure, it was verified that the EVS 5.2.4.0 system successfully completed the system level integration tests with all actual results obtained during test execution matching the expected results.

3.1.4.4 Usability and Accessibility Testing

A Limited Accessibility and Usability Review was performed on the Quad Express Cart, ExpressVote Single Table, ExpressVote Double Table, MXB ExpressVote Voting Booth, and AutoMark Table. During test performance, the voting system was configured as per the ES&S TDP. Primarily, the testing focused on the usability requirements for privacy detailed in Section 3.1.7 and the accessibility requirements for mobility detailed in Section 3.2.4.

Summary Findings

The EVS 5.2.4.0 successfully met the requirements of the limited Usability and Accessibility evaluation. During the evaluation, it was verified that the voting station prevented others from observing the contents of a voter's ballot when the voting station was deployed according to the ES&S TDP. Additionally, it was verified that the voting process was accessible to voters who use mobility aids, including wheelchairs.

3.2 Anomalies and Resolutions

When a result is encountered during test performance that deviates from what is standard or expected, a root cause analysis is performed. Pro V&V considers it an anomaly if no root cause can be determined. In instances in which a root cause is established, the results are then considered deficiencies. No anomalies occurred during the testing of the EVS 5.2.4.0.

3.3 Deficiencies and Resolutions

Any violation of the specified requirement or a result is encountered during test performance that deviates from what is standard or expected in which a root cause is established is considered to be

a deficiency. Upon occurrence, deficiencies are logged throughout the test campaign for disposition and resolution. No deficiencies were encountered during testing of the EVS 5.2.4.0.

4.0 RECOMMENDATION FOR CERTIFICATION

The EVS 5.2.4.0, as presented for testing, successfully met the requirements set forth for voting systems in the U.S. Election Assistance Commission (EAC) 2005 Voluntary Voting System Guidelines (VVSG), Version 1.0. Additionally, Pro V&V, Inc. has determined that the EVS 5.2.4.0 functioned as a complete system during System Integration Testing. Based on the test findings, Pro V&V recommends the EAC grant the EVS 5.2.4.0 identified in Table 4-1 certification to the EAC VVSG 1.0.

Table 4-1. EVS 5.2.4.0 System Components

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|------------------------------|-------------------------------------|----------------------------|--------------------------------------|
| ExpressVote HW 1.0 | 1.4.1.7 | 1.0 | Universal Voting System |
| ExpressVote HW 2.1 | 2.4.2.0 | 2.1.0.0 2.1.2.0 | Universal Voting System |
| ExpressVote Rolling Kiosk | --- | 98-00049 | Kiosk for use with ExpressVote |
| ExpressVote Voting Booth | --- | 87001 | Stationary Voting Booth |
| Quad Express Cart | --- | 41404 | Portable Voting Booth |
| MXB ExpressVote Voting Booth | --- | 95000 | Stationary Voting Booth |
| ExpressVote Single Table | --- | 87033 | Voting Table For One Unit |
| ExpressVote Double Table | --- | 87032 | Voting Table For Two Units |
| ADA Table | --- | 87031 | Voting Table For One Unit |
| DS200 | 2.12.2.0 | 1.2.1, 1.2.3, 1.3 | Precinct Count Tabulator |
| DS200 Plastic Ballot Box | --- | 1.2, 1.3, 1.4, 1.5 | Cast Ballot Container |
| DS200 Metal Ballot Box | --- | 1.0, 1.1, 1.2 | Cast Ballot Container |
| DS200 Collapsible Ballot Box | --- | 98-00009 | Cast Ballot Container |
| DS200 Tote Bin | --- | 00074 | Cast Ballot Container |
| AutoMARK A100 | 1.8.6.1 | 1.0 | ADA Ballot Marking Device |
| AutoMARK A200 | 1.8.6.1 | 1.1, 1.3 | ADA Ballot Marking Device |
| AutoMARK A300 | 1.8.6.1 | 1.3 | ADA Ballot Marking Device |
| AutoMARK Table | --- | 87033 | Voting Table |
| DS850 | 2.10.2.0 | 1.0 | Central Count Tabulator |
| DS850 Cart | ---- | 6823 | Cart For DS850 and Ancillary Devices |
| DS450 | 3.0.0.0 | 1.0 | Central Count Tabulator |

Table 4-1. EVS 5.2.4.0 System Components (continued)

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|----------------------------|-------------------------------------|---|--|
| DS450 Cart | ---- | 3002 | Cart For DS450 and Ancillary Devices |
| EMS Client Workstation | --- | Dell OptiPlex 980 or 5040 | Workstation for EMS Reporting |
| EMS Server | --- | Dell PowerEdge T710 | Server for EMS |
| EMS Client Workstation | --- | Dell Latitude E6410 | Laptop for EMS Reporting |
| EMS Standalone Workstation | --- | Dell Latitude E6410 | Laptop for EMS Reporting |
| DS850 Report Printer | --- | Oki B431dn, Oki B431d | Laser Report Printer |
| DS850 Audit Printer | --- | Oki Microline 420 | Dot Matrix Audit Printer |
| DS450 Report Printer | --- | Dell S2810dn | Laser Report Printer |
| DS450 Audit Printer | --- | Oki Microline 420 | Dot Matrix Audit Printer |
| DS450 UPS | --- | APC Back-UPS, Pro 1500 | UPS for DS450 |
| DS850 UPS | --- | APC Back-UPS RS 1500, APC Back-UPS Pro 1500 | UPS for DS850 |
| DS450 Surge Protector | --- | Tripp Lite Spike Cube | Surge Protector |
| DS850 Surge Protector | --- | Tripp Lite Spike Cube | Surge Protector for DS850 |
| USB Flash Drive | --- | Delkin 512MB, 1GB, 2GB, 4GB, 8GB | Storage for election and ballot definition |
| USB Flash Drive | --- | Delkin 16 GB | Validation purposes only |
| Flash Memory Card | --- | Delkin Devices 1.0 GB capacity | Storage for election and ballot definition |
| CF Card Reader/Writer | --- | 6381 | Delkin compact flash reader/writer |
| CF Card Reader/Writer | --- | 018-6305 | SanDisk compact flash reader/writer |
| Compact Flash Memory Card | --- | SanDisk 512MB, 1GB, 2GB | Storage for election and ballot definition |
| Paper roll (NCR/Nashua) | --- | N/A | Paper roll for report printer |

Table 4-1. EVS 5.2.4.0 System Components (continued)

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|---|-------------------------------------|----------------------------|---|
| Ink Cartridge (DS200) | --- | 2278 | Ink cartridge for ballot stamping |
| Ink Cartridge (DS850) | --- | 87002 | Ink cartridge for ballot number imprinting |
| Ink Cartridge (DS450) | --- | 87002 | Ink cartridge for ballot number imprinting |
| Print Cartridge (AutoMARK) | --- | 87002 | Ink cartridge for ballot marking |
| QR Scanner | --- | DS457-SR20009 | Barcode scanner manufactured by Zebra integrated with rolling kiosk |
| QR / Barcode Scanner | --- | DS9208 | Barcode scanner manufactured by Symbol |
| Headphones | --- | 86002 | COTS headphones manufactured by Avid |
| Electionware | 4.7.1.1 | --- | Election management software that provides end-to-end election management activities |
| Election Reporting Manager (ERM) | 8.12.1.1 | --- | Election results reporting program |
| Event Log Service (ELS) | 1.5.5.0 | --- | Logs users' interactions with EMS. |
| Removable Media Service (RMS) | 1.4.5.0 | --- | Utility that runs in the background of the Windows operating system |
| ExpressVote HW 1.0 Previewer | 1.4.1.7 | --- | Application within the EMS program that allows the user to preview audio text and screen layout prior to burning Election Day media for the ExpressVote |
| ExpressVote HW 2.1 Previewer | 2.4.2.0 | --- | Application within the EMS program that allows the user to preview audio text and screen layout prior to burning Election Day media for the ExpressVote |
| AutoMARK VAT Preview | 1.8.6.1 | --- | Application within the EMS program |
| Adobe Acrobat Standard | 11 | --- | Desktop publishing software |
| Cerberus FTP Server - Enterprise | 9.0.3.1 (x64) | --- | File transfer server for or precinct results network. |
| Microsoft Server 2008 | R2 w/SP1 | --- | Operating System for EMS and results servers |
| Microsoft Windows 7 | 64-bit/SP1 | --- | Operating System for standalone and client workstations. |
| WSUS Microsoft Windows Offline Update Utility | 11.1.1 | --- | Software updates(Update utility) |

Table 4-1. EVS 5.2.4.0 System Components (continued)

| System Component | Software or Firmware Version | Hardware Version(s) | Description |
|--|-------------------------------------|----------------------------|--------------------|
| Micro Focus RM/COBOL Runtime | 12.06 | --- | COBOL runtime |
| Symantec Endpoint Protection | 14.0.1_MP1 | --- | Anti-Virus |
| Symantec Endpoint Protection Intelligent Updater (File-Based Protection) | 20180227-001-core3sds5i64.exe | --- | Anti-Virus |
| Symantec Endpoint Protection Intelligent Updater (Network-Based Protection) | 20180226-040-IPS_IU_SEP_14RU1.exe | --- | Anti-Virus |
| Symantec Endpoint Protection Intelligent Updater (Behavior-Based Protection) | 20180225-001-SONAR_IU_SEP.exe | --- | Anti-Virus |
| Scanner (Zebra) | DS457-SR20009 | --- | QR Code Scanner |

APPENDIX A

HARDWARE TEST REPORTS

Part 1: NTS Longmont, Colorado: Immunity Test Report – TR-PR075829

Part 2: NTS Longmont, Colorado: Emissions Test Report – ETR-PR075829

Part 3: NTS Longmont, Colorado: Environmental Test Report – TR-PR075783

APPENDIX B

AS-RUN TEST PLAN

Pro V&V Document No. TP-01-01-ESS-2018-02.01 As-Run, "Test Plan for EAC VVSG 1.0 Certification Testing Election Systems and Software (ES&S) Voting System (EVS) 5.2.4.0"