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Test Report for State of Colorado Certification Testing
Clear Ballot Group ClearVote 2.1.5 Voting System

Version: 03

Date: 08/06/2021

SIGNATURES

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Michael Walker, VSTL Project Manager Date

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REVISIONS

Revision	Description	Date
00	Initial Release	06/30/2021
01	Formatting and Content Changes	07/23/2021
02	Additional Formatting. Added Section 3.2.3.4	07/28/2021
03	Updated Documentation Versions	08/06/2021

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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 state certification testing of the Clear Ballot Group ClearVote 2.1.5 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, and the voting systems requirements set forth by the State of Colorado. *Note: Colorado requires testing to the 2002 Voting Systems Standard (VSS) by statute; however, testing to the VVSG requirements is deemed sufficient since the requirements in the VSS and VVSG are almost identical.*

1.1 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"
- Colorado Secretary of State Election Rules [8 CCR 1505-1] Rule 21
- Clear Ballot ClearVote 2.1.5 Colorado Requirements Matrix
- Federal Election Commission (FEC) 2002 Voting Systems Standards (VSS)
- 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, 2020 Edition, "NVLAP Procedures and General Requirements (NIST Handbook 150)", dated July 2020
- 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 7.0
- EAC Requests for Interpretation (RFI) (listed on www.eac.gov)
- EAC Notices of Clarification (NOC) (listed on www.eac.gov)
- Clear Ballot Group's Technical Data Package *(A listing of the ClearVote 2.1.5 documents submitted for this test campaign is listed in Section 3.3 of this Test Report)*

1.2 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

"CM" – Configuration Management

"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

"ISO" – International Organization for Standardization

"NOC" – Notice of Clarification

"PCA" – Physical Configuration Audit

"QA" – Quality Assurance

"RFI" – Request for Interpretation

"TDP" – Technical Data Package

"UPS" – Uninterruptible Power Supply

"VSTL" – Voting System Test Laboratory

"VVSG" – Voluntary Voting System Guidelines

1.3 Background

Clear Ballot Group ("CBG") initiated the certification of the ClearVote 2.1.5 Voting System by submitting state requirements checklists and corresponding documentation and information. This submission was deemed complete and in abundant detail to warrant state certification testing. Pro V&V was then contracted to perform the required testing.

Prior to test initiation, the Colorado Requirements Matrix was reviewed to determine the scope of testing. To evaluate the test requirements, each section of the EAC 2005 VVSG was analyzed,

along with the Colorado Requirements Matrix, to determine the applicable tests. The EAC 2005 VVSG Volume I Sections, along with the strategy of evaluation, are described following paragraphs. Brief descriptions of all listed test cases are provided in Table A-1 located in Appendix A.

1.4 Description and Overview of System Being Modified

The ClearVote 2.1 Voting System used as the baseline for the submitted modification is a paper-based optical scan voting system consisting of the following major components: ClearDesign (ballot design and EMS), ClearCount (central count, tabulation, and reporting), and ClearAccess (accessible voting and ballot-marking device).

ClearDesign

ClearDesign is an Election Management System consisting of an interactive set of applications which are responsible for all pre-voting activities necessary for defining and managing elections. This includes ballot design, ballot proofing, ballot layout, and ballot production. The ClearDesign system consists of the physical components listed below. All of the components are unmodified COTS that are connected via a wired, closed, and isolated network not connected to any other systems or the internet.

- DesignServer: A laptop or desktop computer running the ClearDesign software and hosting its election database and the web server that serves its election reports.

- DesignStation(s): One or more laptop or desktop computers used to connect to the DesignServer. A browser is used to perform the necessary tasks. A user with administration privileges will be able to define users and manage the elections.

- Network Switch: Used to connect the DesignStations to the DesignServer using a wired, closed Ethernet.

ClearCount

ClearCount is a central, high-speed, optical scan ballot tabulator coupled with ballot processing applications. The ClearCount software runs on unmodified COTS laptop or desktop computers running the Windows operating system and supports specific models of scanners. The ClearCount central-count system consists of the physical components listed below. All of the components are unmodified COTS that are connected via a wired, closed, and isolated network not connected to any other systems or the internet.

- ScanServer: A laptop or desktop computer running the ClearCount software and hosting its election database and the web server that serves its election reports.

- ScanStation(s): One or more laptop or desktop/scanner pairs used to scan and tabulate ballots.

- Network Switch: Used to connect the ScanStations to the ScanServer using a wired, closed Ethernet.

- Election Administration Station and/or Adjudication Station: One or more Windows laptop or desktop computers installed with browser software, linked by a wired Ethernet connection to the ScanServer using the network switch. This station can serve multiple uses: user administration, election administration, adjudication, and reporting.

All files that make up the ClearCount software reside on a single ScanServer that is shared by all client ScanStations. The Tabulator software is executed by the ScanStations at run-time from files that reside on the ScanServer. The only software programs that have to be installed on ScanStations, apart from the Windows operating system, are the software and drivers required by the scanner hardware.

The ClearCount software consists of the following components:

- Tabulator: The Tabulator application handles ballot tabulation. The Tabulator software is stored on the ScanServer and an instance of Tabulator runs on each ScanStation. The Tabulator program analyzes the incoming images and transfers them to the local output folder named CBGBallotImages. The ScanServer retrieves the images from the folder and uploads them into the Election database.

- Election Database: A centralized election database that resides on the ScanServer and collects the output of each Tabulator.

- Election Reports: A browser-based suite of reports that provides election results and analysis and allows election officials to review individual ballot images. A web server on the ScanServer serves the reports.

- Card Resolutions tool: A web application that allows election officials to review and appropriately resolve unreadable voted ballots.

- User and Election Database Management through browser-based applications: On the User Administration dashboard, the administrator can add, rename, or delete users, assign permissions, and change user passwords. On the Election Administration dashboard, the administrator can create or delete an election, set an election as active, and backup or restore an election.

ClearAccess

ClearAccess is an accessible touchscreen ballot marking device (BMD) used for the creation of paper ballots that can be scanned and tabulated by ClearCount. The ClearAccess software runs on unmodified COTS laptop computers / tablets running a Windows operating system and supports specific models of accessible input devices.

1.5 Description of Modification

Clear Ballot Group has identified the following modifications from the baseline system:

ClearVote

- SW-10101: The Windows ED 20-02 security patch is included in installation directions.

ClearDesign

- SW-9447: This release adds the Election Ballot Code. This code allows a unique election identifier to be printed in the identification marks (code channel) on the bottom back of the ballot.
- SW-9949: This release adds the new ElectionBallotCode to the metadata.csv file of the BDF file.
- SW-9950: This release adds the new electionBallotCode field to the ADF file.
- SW-9948: If the election ballot code is defined in the election (that is, its value is not empty), the code channel printed on the back of the ballot now contains that value encoded in binary form as the right most 21 bits of the ID marks.

ClearAccess

- SW-9953: The ADF schema has been updated to include the electionBallotCode field.

ClearCount

- SW-7456: ClearCount now supports the export file format for Colorado. ClearCount adds the file extension co.csv to the zip file for the Cast Vote Record.
- SW-9473: This release fixes a potential deadlock error. Previously, this deadlock error could occur when running a delete box at the same time as saving a manually adjudicated ballot. This situation could result in "box already copied" errors when rescanning the deleted box. This situation no longer occurs.
- SW-9951: This release adds the ElectionBallotCode to the election database.
- SW-9952: ClearCount now uses the ElectionBallotCode or the ElectionDate to confirm that a ballot being scanned belongs to the current active election.

1.6 Scope of Testing

The scope of this testing event will incorporate a sufficient spectrum of physical and functional tests to verify that certain ClearVote 2.1.5 features and applications, which have been modified

from the previously certified ClearVote 2.1 baseline system, conform to the applicable EAC 2005 VVSG 1.0 and State of Colorado requirements.

Specifically, the testing event had the following goals:

- Verify that the ClearVote 2.1.5 System meets the applicable Colorado-specific requirements for voting systems.
- Evaluate the ClearVote 2.1.5 System to the applicable requirements of the FEC 2002 VSS *(Note: Testing was performed per the EAC 2005 VVSG, which encompasses the requirements for the evaluation of voting systems set forth in the FEC 2002 VSS; therefore, systems tested to the EAC 2005 VVSG will satisfy the requirements of the FEC 2002 VSS).*
- Ensure the ClearVote 2.1.5 System provides support for all Colorado election management requirements (i.e., ballot design, results reporting, recounts, etc.).
- Simulate pre-election, Election Day, absentee, recounts, and postelection activities on the ClearVote 2.1.5 System and corresponding components of the EMS.
- Source Code Review, Compliance Builds, and Build Documentation Review
- Physical Configuration Audit (PCA), including System Loads and Hardening
- Functional Configuration Audit (FCA)
- System Integration Testing, including Accuracy Testing and Regression Testing

1.7 Testing Overview

The evaluation of the ClearVote 2.1.5 Voting System incorporated a sufficient spectrum of physical and functional tests to verify that the modified system conformed to the applicable EAC 2005 VVSG 1.0 and State of Colorado requirements. The evaluation successfully addressed each of the following test goals in the manner described in the table below:

Table 1-0: Testing Overview

Test Goal	Testing Response
Verify that the ClearVote 2.1.5 System meets the applicable state-specific requirements for voting systems	This was tested by evaluating the ClearVote 2.1.5 System to identified state-specific requirements for voting systems.

Table 1-0: Testing Overview *(continued)*

Test Goal	Testing Response
Evaluate the ClearVote 2.1.5 System to the applicable requirements of the EAC 2005 VVSG	All modifications were evaluated to the applicable requirements of the EAC 2005 VVSG.
Ensure the ClearVote 2.1.5 System provides support for all identified state-specific election management requirements (i.e., ballot design, results reporting, recounts, etc.)	This was tested by evaluating the ClearVote 2.1.5 System to specific election scenarios using a combination of different ballot programming approaches, ballot designs, ballot sizes, languages, and tabulators.
Simulate pre-election, Election Day, absentee, recounts, and postelection activities on the ClearVote 2.1.5 System and corresponding components of the EMS	The components of the ClearVote 2.1.5 System were tested in pre-election, Election Day, postelection and recount situations and evaluated against documented behavior and expected results for all scenarios.
Source Code Review, Compliance Builds, and Build Documentation Review	Trusted Builds were generated during the test campaign. The source code submitted by CBG was reviewed and successfully built using the submitted COTS and third-party software products. Additionally, build documentation was reviewed.
Physical Configuration Audit (PCA), including System Loads and Hardening	A PCA was performed to compare the voting system components and materials submitted for testing against the manufacturer's technical documentation to ensure everything was in agreement and correct.
Functional Configuration Audit (FCA)	FCA regression testing was performed on all submitted modifications to the baselined system.
System Integration Testing, including Accuracy Testing and Regression Testing	The components of the ClearVote 2.1.5 System were tested to address the integration of hardware and software. This testing focused on the compatibility of the voting system software components and subsystems with one another and with other voting system components. Accuracy testing was performed that included over 1,549,703 ballot positions on the system.

2.0 TEST CANDIDATE

The ClearVote 2.1.5 Voting System is a paper-based optical scan voting system consisting of the following major components: ClearDesign (ballot design and EMS), ClearCount (central count, tabulation, and reporting), and ClearAccess (accessible voting and ballot-marking device).

The following paragraphs provide information for the ClearVote 2.1.5 Voting System evaluated during this test campaign.

Table 2-0. ClearVote 2.1.5 Voting System Software

Firmware/Software	Version
ClearDesign Components, Version 2.1.1	
Windows	10 Pro 1607
Google Chrome	79.0.3945.79
Ubuntu	18.04.1 LTS
MySQL	5.7.34
Apache	2.4.18
libapache2-mod-fcgid	2.3.9
PhantomJS	1.9.8
Unzip	6.0.21
Samba	4.7.6
Python PIP	9.0.1
Zip	3.0.11
Pyinstaller	3.2.1
Python JSMIN	2.2.1
Python	2.7.17
Python webpy	0.38
Python MySQL DB	1.3.10
SQLAlchemy	1.3.3
Python Pillow	5.1.0
Python Flup	1.0.2
Python DBUtils	1.3
Python XLRD	1.2.0
Python FontTools library	3.41.0
Python RTF	0.2.1
OpenSSL (FIPS)	2.0.10
OpenSSL	1.0.2g
DataTable	1.10.16
DataTable-Buttons	1.4.2
DataTable-Buttons-JSZip	2.5.0
DataTable-Buttons-Pdfmake	0.1.32
DataTablePlugins	1.10.16

Table 2-0. ClearVote 2.1.5 Voting System Software *(continued)*

Firmware/Software	Version
bootstrap	3.0.0
jquery	2.2.4
jquery-impromptu	6.2.3
jquery-qrcode	1.0
jquery-splitter	0.27.1
jquery-ui	1.12.1
jscolor	1.4.2
tinymce	4.1.9
libmp3lame	0.5.0
jszip	3.2.0
papaparse	4.6.0
jsmin	12/4/2003
ClearAccess Components, Version 2.1.1	
Windows	10 Pro 1607
Google Chrome	91.0.4472.114
nsis	3.01
PyInstaller	3.2
Python	2.7.10
webpy	0.38
Python-future	0.15.2
pefile	2018.8.8
pywin	223
jquery	1.10.2
DataTables	1.10.16
Zebra scanner driver	3.07.0004
ClearCount Components, Version 2.1.5	
Ubuntu	18.04.1 LTS
Apache	2.4.29
Google Chrome	79.0.3945.79
Python(part of Ubuntu)	2.7.15
MySQLdb (part of Ubuntu)	5.7.26
PyInstaller	3.2.1
PollyReports	1.7.6
python-lxml	4.2.1-1ubuntu0.1
DataTable-Buttons	1.5.6
DataTable-Buttons-JSZip	2.5.0
DataTable-Buttons-Pdfmake	0.1.36

Table 2-0. ClearVote 2.1.5 Voting System Software *(continued)*

Firmware/Software	Version
OpenSSL	1.1.0g
OpenSSL FIPS Object Module	2.0.10
JavaScript Bootstrap library	2.3.2
JavaScript Chosen library	1.8.7
JavaScript jQuery library	1.10.2
J JavaScript jQuery-migrate library	1.2.1
JavaScript DataTables library	1.10.18
JavaScript FixedHeader library	3.1.4
JavaScript hotkeys library	0.8
JavaScript tooltip library	1.3
JavaScript pep library	1.0
JavaScript LESS library	1.3.3
Fujitsu fi-6400/fi-7800	PaperStream 1.30.0
Fujitsu fi-6800/fi-7900	PaperStream 10.10.710
Fujitsu fi-7180	PaperStream 1.4.0
Aptitude	0.8.10-6ubuntu1
auditd	2.8.2
debconf	1.5.66
pmount	0.9.23
Samba	4.7.6
udisks	2.7.6

For COTS equipment, every effort was made to verify that the COTS equipment has not been modified for use. This was accomplished by performing research using the COTS equipment manufacturers' websites based on the serial numbers and service tag numbers for each piece of equipment. Assigned test personnel evaluated 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 was compared to the system information found on each machine. Physical external and internal examinations were also performed when the equipment was easily accessible without the possibility of damage. Hard drives, RAM memory, and other components were examined to verify that the components matched the information found on the COTS equipment manufacturers' websites.

Table 2-1. ClearVote 2.1.5 Voting System Equipment

Component	Model	Serial Number
ClearDesign Components		
Dell Latitude Laptop (client)	5580, 5590, 5500	CF3L3G2, B5TD1N2, 3C3M9Y2
Dell OptiPlex (client)	7440, XE3 SFF	JXDFHH2
Dell Precision Tower (client)	T3620	GSKRMV2
Dell PowerEdge Server (server)	T130, T140, T440, R440, T630	5G0YLN2, 8BFH3W2, H6JZLN2, GCHLHL2
Dell 27-inch Monitor	P2717H and P2719H	CWKZRS2 3MK2RS2
Dell 22-inch Monitor	P2217H and P2219H	FV8C8W2 DLV88W2
Cisco 8-Port Switch	SG250-08-K9-NA	PSZ21451MLJ
LG DVD Burner	GP65NB60	LG-DVD-001
Anker 10 port USB 3.0 Hub	AK-68ANHUB-B10A	22XGHFWC, 22XGHGKX
SySTOR Multiple USB Duplicator	SYS-USBD-11	ES-27095
Corsair Flash Padlock 3 32 GB	CMFPLA3B-32GB	N/A
SanDisk Extreme Go 64 GB USB	SDCZ800-064G-G46	N/A
SanDisk Ultra Flair 32 GB USB	SDCZ73-032G-A46, SDCZ73-032G-G46	N/A
ClearAccess Components		
ELO 15 inch AIO	E-Series (ESY15E2)	L17C014810 & A18C004080
Dell OptiPlex AIO	5250	HCGMGK2
Oki Data Laser Printer	B432dn	AK5B007647A0 & AK91021454C0
ELO 20 inch AIO	X-Series (ESY20X2)	D18Q000334, D18Q000335, B18Q001601, B18Q001599 & B18Q000597
Oki Data Laser Printer	B432dn-B	AK8C017022C0
Dell Inspiron 15”	7573	80S1YD2
Clear Ballot Transport Case	CV-1022-2.0	Case-001
Clear Ballot UPS Transport Case	CV-1157-2.0	UPS-Case-001
Micrologic Tray Kit	B432TrayKit	CBG-MTK-001
Zebra Technologies Bar Code Scanner and cable	DS457-SR, CBL-58926-05	18059000501984, 18059000501981, 18095000500487, 18095000500491
Storm EZ Access Keypad	EZ-08-22201, EZ-08-22200	15000005, 20010073

Table 2-1. ClearVote 2.1.5 Voting System Equipment *(continued)*

Component	Model	Serial Number
Origin Instruments Sip/Puff Breeze with Headset	AC-0300-MU	CBG-SP-001, 002, 003
Samson Over-Ear Stereo Headphones	SASR350	SR350J8G390 & SR350J8G396
Clear Ballot Privacy Screen	CB-1097-1.5	CBG-PVS-001
Ergotron Neo-Flex	33-329-085	N/A
Corsair Flash Padlock 3 32 GB	CMFPLA3B-32GB	N/A
SanDisk Extreme Go 64 GB USB	SDCZ800-064G-G46	N/A
SanDisk Ultra Flair 32 GB USB	SDCZ73-032G-A46, SDCZ73-032G-G46	N/A
Wurth Elektronic Ferrite	742-711-32, 742-712-22, 742-717-22, 742-416-33S, 742-416-22S, 742-716-22S	FRT021 through FRT025
Polyamide Film Tape 1" 2 mil	CV-1210-2.0	N/A
Polyamide Film Tape 2" 2 mil	CV-1211-2.0	N/A
Polyamide Film Tape 4" 2 mil	CV-1212-2.0	N/A
APC Smart-UPS	SMT2200C	AS1809160852
Lifetime 4-Foot Folding Table	4428	FT-001
LG DVD Burner	GP65NB60	LG-DVD-002
CyberPower Smart App UPS	PR1500RT2U	PY3HZ2002933, PY3HZ2003000
ClearCount Components		
Dell Latitude Laptops (ScanStation)	5580, 5590, 5500	2F3L3G2, 9W5D1N2, JV3WXY2
Dell Precision Tower (Election Administration)	T3620	GSKQMN2
Dell Latitude Laptops (Election Administration)	5580, 5590, 5500	C9S22G2, 5M5D1N2
Dell PowerEdge Server (ScanServer)	T130, T140, T330, T440, R440	5G0ZLN2, 8BFJ3W2, FHV9RD2, H6J5MN2, 55FDB03
Dell OptiPlex (Election Administration)	7440, XE3 SFF	JXDFHH2, 93XDB03
Fujitsu Scanner	fi-7180	A20DC10302 & A20D000798
Fujitsu Scanner	fi-6800	A9HCA00737 & A9HCC00543
Fujitsu Scanner	fi-6400	AKHCC00362 & AKHCC00609
Fujitsu Scanner	fi-7800	C39C000034

Table 2-1. ClearVote 2.1.5 Voting System Equipment *(continued)*

Component	Model	Serial Number
Fujitsu Scanner	Fi-7900	C30C000270
LG DVD Burner	GP65NB60	LG-DVD-003
Western Digital 4 TB External HD	WDBFJK0040HBK-NESN, WDBBGB0040HBK-NESN	WCC7K7YF11ZD
Western Digital 8 TB External HD	WDBFJK0080HBK-NESN, WDBBGB0080HBK-NESN	75H4PXJD
Netac Keypad Encryption Portable Hard Disk	K390 (86024554)	R4JT22619T
Dell 27 inch Monitor	P2717H and P2719H	CWKZRS2 3MK2RS2
Dell 22 inch Monitor	P2217H and P2219H	7818672, FV8C8W2 DLV88W2
Cisco 8-Port Switch	SG250-08-K9-NA	PSZ21451MYX
Cisco 26-Port Switch	SG250-26-K9-NA	DNI203400A6 & DNI203400AW
Corsair Flash Padlock 3 32 GB	Secure USB 3.0 Flash Drive	CMFPLA3B-32GB
SanDisk Extreme Go 64 GB USB	3.1 USB Drive	SDCZ800-064G-G46
SanDisk Ultra Flair 32 GB USB	3.0 Drive	SDCZ73-032G-A46, SDCZ73-032G-G46
Anker USB Hub	AK-68ANHUB-B10A	22XGHFWC, 22XGHGKX
APC Smart-UPS	SMT-1500C	3S1831X12280
WorkEZ Executive Scanning Shelf	WEEs (661799222990), WEEb (661799222983)	CBG-EZ-001, 002,003, & 004
StarTech 4-Port VGA KVM Switch w/Hub	SV431USB	G73011TG80247
Brother Laser Printer	HL-L2340DW, HL-L2350DW	U63879M4N62861, U64964A8N263531

2.1 System Limits

Table 2-2. System Limits

Characteristic	Tested Limit
Election Parameters	
Precincts per election	3200
Splits per election	3200

Table 2-2. System Limits *(continued)*

Characteristic	Tested Limit
District categories per election	100
Districts per single category	3200
Districts per election	3200
Contests per election	3200
Choices per election	3200
Choices per contest	300
Vote positions per side	420
Card styles per election	3200
Contests per ballot style	60
Card styles per precinct	50
Parties per election	50
Counter groups per election	7
"Vote for" per contest	50
Languages per election	15
Cards per ballot (per language)	5
Write-ins per contest	50
Reporting Name Parameters (Reports Only)	
Election name (characters)	60
Jurisdiction name (characters)	60
Precinct name (characters)	60
Vote center name (characters)	60
Contest name (characters)	60
Candidate name (characters)	60
Party name (characters)	60
Write-in length (characters)	60
System Parameters	
Central-count scanners per network	10
Cards per precinct-voting device	10,000
Cards per central-count device	4,000,000

2.2 Supported Languages

The submitted voting system supports:

- English
- Spanish
- Chinese
- Korean
- Vietnamese
- Danish
- Dutch

- Flemish
- French
- German
- Italian
- Japanese
- Norwegian
- Portuguese
- Swedish

Due to the limited scope of testing, only 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.

2.3 Supported Functionality

The ClearVote 2.1.5 is designed to support the following voting variations:

- General Election
- Primary Election (Open and Closed)
- Early Voting
- Partisan/Non-Partisan Offices
- Write-In Voting
- Primary Presidential Delegation Nominations
- Straight Party Voting
- Split Precincts
- Vote for N of M
- Ballot Rotation
- Provisional or Challenged Ballots

2.4 System Overview

The system overview of the submitted voting system is depicted in Figures 1-1 and 1-2.

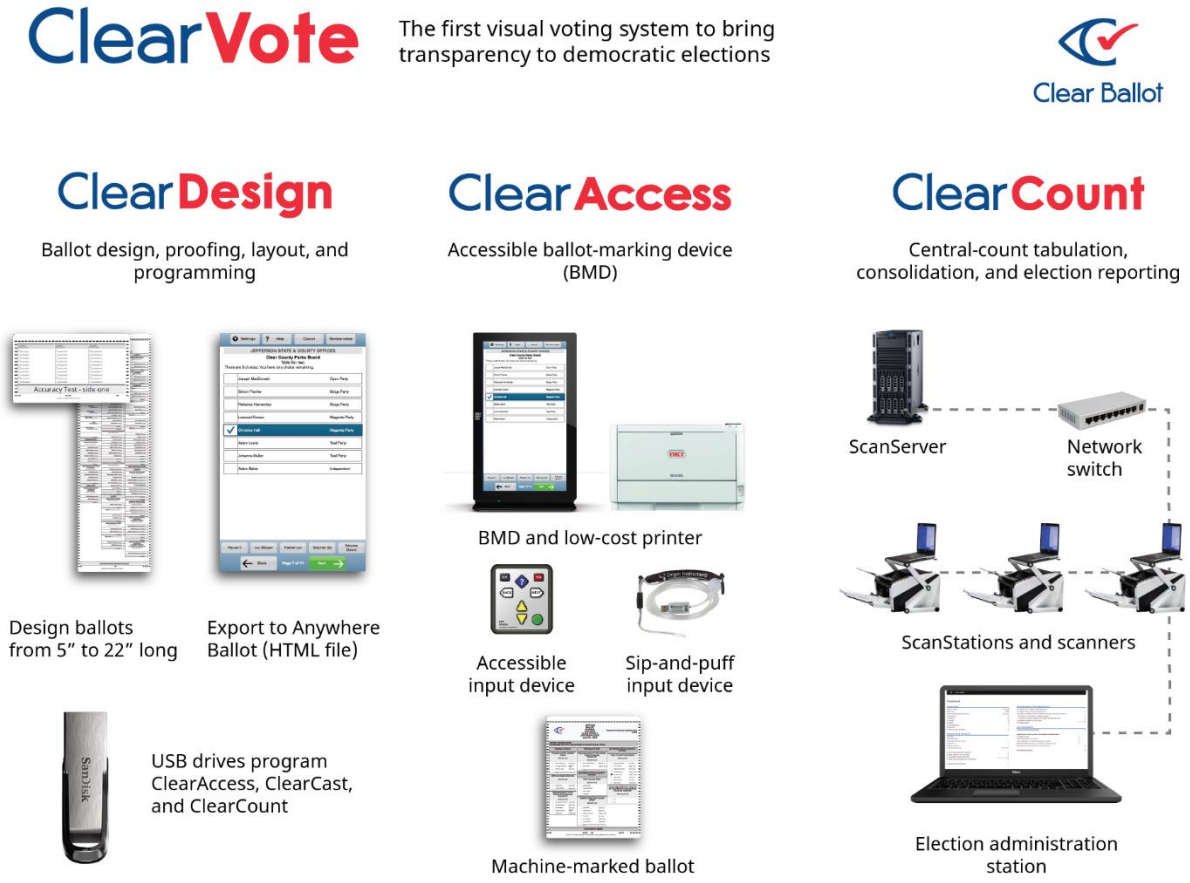

Figure 1-1. ClearVote 2.1.5 product family

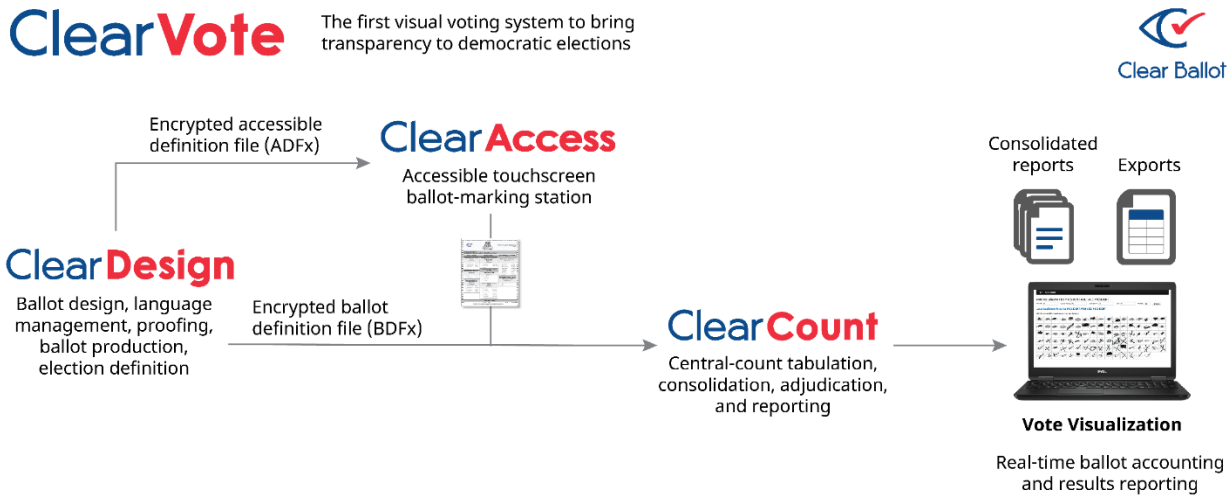

Figure 1-2. ClearVote 2.1.5 component relationship

2.5 Technical Data Package

A listing of all documents contained in the ClearVote 2.1.5 TDP is provided in Table 2-3.

Table 2-3. TDP Documents

Document Number	Description	Version
ClearVote Documents		
100101-10017	ClearVote 2.1 Approved Parts List	1.2.4
100067-10017	ClearVote 2.1 Ballot Stock and Printing Specification	1.0.13
100057-10017	ClearVote 2.1 Configuration Management Plan	1.0.18
100069-10017	ClearVote 2.1 Glossary	1.0.12
100058-10017	ClearVote 2.1 Personnel Deployment and Training Plan	1.0.13
100059-10017	ClearVote 2.1 Quality Assurance Program	1.0.14
100086-10017	ClearVote 2.1 Security Policy	1.0.15
100071-10017	ClearVote 2.1 System Overview	1.1.2
100073-10017	ClearVote 2.1 Test and Verification Specification	1.0.14
100128-10020	ClearVote 2.1.5 Change Notes	1.0.2
100154-10020	ClearVote 2.1.5 Documentation Set	---
100143-10021	Windows 10 ED-20-02 Security Patch	---
ClearDesign Documents		
100082-10017	ClearDesign 2.1 Maintenance Guide	1.0.12
100045-10017	ClearDesign 2.1 Security Specification	1.0.14
100072-10017	ClearDesign 2.1 Software and Design Specification	1.0.20
100074-10020	ClearDesign 2.1.5 System Identification Guide	2.0.3
100043-10017	ClearDesign 2.1 System Overview	1.0.16
100041-10020	ClearDesign 2.1.5 User Guide	2.0.16
100011-10017	ClearDesign 2.1 Acceptance Test Checklist	1.0.8
100062-10020	ClearDesign 2.1.5 Administration Guide	1.0.14
100133-10020	ClearDesign 2.1.5 Accessible Definition File Guide	1.0.4
100131-10020	ClearDesign 2.1.5 Ballot Definition File Guide	1.0.4
100083-10017	ClearDesign 2.1 Build Procedures	1.0.9
100103-10020	ClearDesign 2.1.5 Database Specification	1.0.9
100046-10017	ClearDesign 2.1 Functionality Description	1.0.14
100098-10017	ClearDesign 2.1 Hardware Specification	1.0.12

Table 2-3. TDP Documents *(continued)*

Document Number	Description	Version
100063-10017	ClearDesign 2.1 Installation Guide	1.0.25
ClearCount Documents		
100102-10017	ClearCount 2.1 Acceptance Test Checklist	1.0.12
100005-10020	ClearCount 2.1.5 Database Specification	1.1.5
100004-10020	ClearCount 2.1.5 Election Administration Guide	1.0.21
100006-10017	ClearCount 2.1 Election Preparation and Installation Guide	1.2.12
100021-10017	ClearCount 2.1 Functionality Description	1.0.14
100022-10017	ClearCount 2.1 Hardware Specification	1.0.14
100023-10017	ClearCount 2.1 Maintenance Guide	1.0.15
100070-10020	ClearCount 2.1.5 Reporting Guide	1.1.4
100013-10017	ClearCount 2.1 Scanner Operator Guide	1.1.8
100026-10017	ClearCount 2.1 Security Specification	1.0.14
100019-10017	ClearCount 2.1 Software Design and Specification	1.0.16
100047-10020	ClearCount 2.1.5 System Identification Guide	2.0.3
100024-10017	ClearCount 2.1 System Operations Procedures	1.0.13
100025-10017	ClearCount 2.1 System Overview	1.0.14
100009-10017	ClearCount 2.1 Build Procedures	1.6.4
100130-10017	ClearCount 2.1 Quick Guide XML Report Conversion Tool	---
ClearAccess Documents		
100109-10017	ClearAccess 2.1 Acceptance Test Checklist	1.1.3
100051-10017	ClearAccess 2.1 Build Procedures	1.1.3
100049-10017	ClearAccess 2.1 Functionality Description	1.5.5
100126-10017	ClearAccess 2.1 Hardware Compliance Addendum	---
100085-10017	ClearAccess 2.1 Hardware Specification	1.5.3
100053-10017	ClearAccess 2.1 Installation Guide	1.7.8
100052-10017	ClearAccess 2.1 Maintenance Guide	1.8.3
100054-10017	ClearAccess 2.1 Poll Worker Guide	1.8.4
100050-10017	ClearAccess 2.1 Security Specification	1.4.9
100099-10017	ClearAccess 2.1 Software Design and Specification	1.5.3
100055-10017	ClearAccess 2.1 Supervisor Guide	1.8.4

Table 2-3. TDP Documents *(continued)*

Document Number	Description	Version
100038-10020	ClearAccess 2.1.5 System Identification Guide	2.0.3
100044-10017	ClearAccess 2.1 System Overview	1.6.6
100056-10017	ClearAccess 2.1 Voter Guide	1.1.6

2.6 Test Support Materials

The following materials were supplied by Clear Ballot to facilitate testing:

- USB Flash Drives, 32 and 64 GB capacity
- Test Decks
- Power Cords
- Ballot Paper, 60-pound cover or 90-pound index or similar paper for results reports
- Labels
- Other materials and equipment as required

3.0 TEST PROCESS AND RESULTS

Certification testing of the Clear Ballot Group ClearVote 2.1.5 Voting System submitted for evaluation was performed to verify that the ClearVote 2.1.5 System conforms to the State of Colorado Requirements. The State of Colorado requirement matrix was used as a guide to determine the specific tests to be performed.

All testing was conducted under the guidance of Pro V&V by personnel verified by Pro V&V to be qualified to perform the testing. The examination was performed at the Pro V&V, Inc. test facility located in Huntsville, AL.

Section 2: Functional Requirements

The requirements in this section were tested during the FCA, Accuracy, and System Integration Test. This evaluation utilized baseline test cases as well as specifically designed test cases and included predefined election definitions for the input data. The test cases specifically designed to evaluate the modifications are listed in Table A-1 located in Appendix A of this document.

Section 3: Usability and Accessibility Requirements

The requirements in this section were not tested during this state certification effort as results were re-used from previous test campaigns.

Section 4: Hardware Requirements

The requirements in this section were not tested during this state certification effort as results were re-used from previous test campaigns.

Section 5: Software Requirements

The requirements in this section were tested utilizing a combination of review and functional testing during the Source Code Review, TDP Review, and FCA.

Section 6: Telecommunications Requirements

The requirements in this section were not tested due to Colorado Rule 20.6.1 (f) prohibiting the use of modems.

Section 7: Security Requirements

The requirements in this section were not tested during this state certification effort as results were re-used from previous test campaigns.

Section 8: Quality Assurance Requirements

The requirements in this section were not tested during this state certification effort as results were re-used from previous test campaigns.

Section 9: Configuration Management Requirements

The requirements in this section were not tested during this state certification effort as results were re-used from previous test campaigns.

3.1 Test Configuration

The testing event utilized one setup of the ClearVote 2.1.5 System and its components. The following is a breakdown of the ClearVote 2.1.5 System components and configurations for the test setup:

Standard Testing Platform:

The standard testing platform consisted of one ClearVote 2.1.5 System in a standalone configuration. In the pre-election phase of testing, ballots were created utilizing ClearDesign, the EMS component of the ClearVote 2.1.5 System. Ballot styles were then imported into ClearAccess for ballot marking. Once ballots were marked and the polls were closed, ballot reconciliation procedures were performed and the ballots were tabulated by ClearCount, the central count tabulation and reporting component of the ClearVote 2.1.5 System.

3.2 Summary Findings and Recommendation

Summary findings for the System Level Testing (System Integration Testing, Accuracy, and FCA), PCA, and Source Code Review are detailed in the relevant sections of this report.

3.2.1 Source Code Review/Compliance Build

A source code review was performed in order to review the submitted source code to the specific requirements. Both manual and automated review techniques were used per EAC approved procedures. The automated source code review tools utilized were JSHint and PyLint. The Source Code Review included a Compliance Build of the submitted source code. To perform the Compliance Build, CBG-submitted source code, COTS, and third-party software products were inspected and combined to create the executable code. Additionally, during the performance of the Compliance Build, the build documentation was reviewed.

Summary Findings:

At the conclusion of the Source Code Review, compliant source code was available for performance of the Trusted Build process. During execution of the Trusted Build, the source code submitted by Clear Ballot Group and reviewed by PRO V&V was successfully built using the submitted COTS and third-party software products, and the reviewed build documentation.

3.2.2 Physical Configuration Audit (PCA)

The PCA compares the voting system components submitted for testing to the manufacturer's technical documentation. The PCA includes 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 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

- Review the 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 ClearVote 2.1.5 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.

3.2.3 System Level Testing

System Level Testing included the 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 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 modification 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 ClearVote 2.1.5 Voting System functioned as a complete system.

During System Level Testing, the system was configured exactly as it would for normal field use per the procedures detailed in the ClearVote 2.1.5 technical documentation. This included connecting all supporting equipment and peripherals as well as any physical security equipment such as locks and ties

3.2.3.1 Functional Configuration Audit (FCA)

The FCA verifies the system meets the applicable state-specific requirements for voting systems as well as the applicable requirements of the EAC 2005 VVSG. During this area of testing, the specific functionality of the modified system under evaluation that is claimed by the manufacturer in their supplied change notes and scope was targeted to ensure the product functions as documented. This testing used both positive and negative test data to test the robustness of the system.

Regression testing was performed on all system components to verify that all functional and/or firmware modifications made during the test campaign did not adversely affect the system and its operation.

Summary Findings:

To perform the FCA, the modifications were evaluated against baseline test cases supplemented with specifically designed test cases. The FCA testing included verification of the submitted modifications detailed in the change notes.

During execution of the test procedure, it was verified that the ClearVote 2.1.5 System successfully completed the functional tests with all actual results obtained during test execution matching the expected results.

3.2.3.2 Accuracy

The accuracy test ensured that each component of the system could process at least 1,549,703 consecutive ballot positions correctly within the allowable target error rate (the maximum acceptable error rate in the test process is one in 500,000 ballot positions). The Accuracy test was 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 was defined as an error rate. This rate is the maximum number of errors allowed while processing a specified volume of data. For paper-based Systems, such as the ClearVote 2.1 System, 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 System:

The accuracy requirements for the ClearCount system were met by the execution of the standard accuracy test utilizing ClearAccess produced ballots. For the accuracy test, voting sessions were started using manual session activation.

The ClearCount system was tested by utilizing premarked ballots to achieve accuracy rate greater than 1,549,703 correct ballot positions.

Summary Findings

The ClearVote 2.1.5 System under test successfully passed the accuracy test. A total of 2,000 ballots were scanned on each component resulting in 1,560,000 voting positions being voted on each component. No functional issues were noted during the execution of this test and all results were imported, tabulated, and validated via the ClearCount reporting function. All actual results obtained during test execution matched the expected results, resulting in an achieved tabulation error rate of 0% and an accuracy of 100%. The total number of voting positions voted exceeded the minimum required for test performance.

3.2.3.3 System Integration

System level certification tests were performed to address the integration of the hardware and software. This testing focused 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 was configured as would be for normal field use.

Successful completion of system integration testing ensures the system provides support for all identified state-specific election management requirements (i.e., ballot design, results reporting, recounts, etc.). This is accomplished by simulating pre-election, Election Day, absentee, recounts, and postelection activities on the voting system and corresponding components of the EMS.

Summary Findings:

Two General Elections and One Primary Election were successfully exercised on the System, as described below:

Two general elections with the following breakdowns:

- General Election GEN-01: A basic election held in four precincts, one of which is a split precinct. This election contains 19 contests compiled into four ballot styles. Five of the contests are in all four ballot styles. The other 15 contests are split between at least two of the precincts with a maximum of four different contests spread across the four precincts.

- General Election GEN-03: A basic election held in 2 precincts. This election contains 8 contests and compiled into 2 ballot styles. 4 of the contests are in both ballot styles. The other 4 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.

One primary election with the following breakdowns:

- Primary Election PRIM-02: Open Primary Election held in two precincts. This election contained thirteen contests compiled into three ballot styles. One contest is in all three ballot styles; all other contests are independent.

The ClearVote 2.1.5 System successfully passed the System Integration Test. During execution of the test procedure, it was verified that the ClearVote 2.1.5 System successfully completed the system level integration tests with all actual results obtained during test execution matching the expected results.

3.2.3.4 Regression Testing

Regression testing was conducted on the ClearVote 2.1.5 system to establish assurance that the modifications had no adverse impact on the compliance, integrity, or performance of the system. No new faults or issues were found during regression testing.

4.0 TEST FINDINGS

Based on the results obtained during the test campaign, Pro V&V determines that the ClearVote 2.1.5 System, as presented for evaluation, meets the requirements set forth for voting systems in the Colorado Requirements Matrix, which incorporates the 2002 VSS requirements and the Colorado-specific requirements in the Colorado Secretary of State Election Rules [8 CCR 1505-1] Rule 21. Throughout the test campaign, as tests were executed, resultant data was inspected and technical documentation reviews were performed to ensure that each applicable requirement was met; therefore, fulfilling the test goals.

Note: The completed Colorado Requirements Matrix for this test campaign will be provided as a separate document.

APPENDIX A

TEST CASE DESCRIPTIONS

Table A-1. Test Case Descriptions

Test Case	Description	Result (Pass/Fail)
Functional Requirements		
ClearDesign SW-9947 - This release adds the Election Ballot Code. This code allows a unique election identifier to be printed in the identification marks (code channel) on the bottom back of the ballot. TC-CV2105-001 Election Ballot Code Added to Election	Testing to verify that an Election Ballot Code can be defined for an election and its associated ballots. To test this an Election Ballot Code will be set for an election and ballots will be generated. These ballots will then be cast on ClearCount to ensure that the ballots are counted properly.	PASS
ClearDesign SW-9949 – This release adds the new ElectionBallotCode to the metadata.csv file of the BDF file. TC-CV2105-002 ElectionBallotCode Field Added to metadata.csv in BDF File	Testing that the ElectionBallotCode field is present within the metadata.csv file contained within the BDF file. To test this the metadata.csv file contained within the BDF file will be opened and viewed. The data within the ElectionBallotCode will then be compared to the Election Ballot Code input in ClearDesign to ensure they are identical.	PASS
ClearDesign SW-9950 – This release adds the new ElectionBallotCode field to the ADF file. TC-CV2105-003 ElectionBallotCode Field Added to ADF File	Testing that an Election Ballot Code can be defined for an election and is included within the ADF file. To test this an election with a defined Election Ballot Code will have its ADF file exported. The ADF file will be loaded on a ClearAccess unit and a ballot will be printed. The printed ballot will then be cast on ClearCount to ensure that the printed ballot is valid for the election.	PASS
ClearDesign SW-9948 – If the election ballot code is defined in the election (that is, its value is not empty), the code channel printed on the back of the ballot now contains that value encoded in binary form as the right most 21 bits of the ID marks. TC-CV2105-004 Election Ballot Code Encoded in Code Channel on Back of Ballot	Testing that a specified Election Ballot Code is encoded in the Code Channel printed on the back of ballots. To test this, ballots from an election with a defined Election Ballot Code will be inspected to verify that the Election Ballot Code is encoded in the code channel on the back of the ballots, in binary form.	PASS

Table A-1. Test Case Descriptions *(continued)*

Test Case	Description	Result (Pass/Fail)
ClearCount SW-7456 – Added a file ending in extension .co.csv that implements the Colorado export file format to the Cast Vote Record zip file package. TC-CV2105-005 Colorado Export File	Testing that the Colorado Export File Format is added to the Cast Vote Record Zip file package and cast vote records export in the expected format and with the expected values. To test this cast vote records will be exported from an election with election results and Cast Vote Records will be inspected to verify that they export in the Colorado format and exported values match expected values.	PASS
ClearCount SW-9473 - Fixed potential 'deadlock' error that could happen if a deletebox was run at the same time as a manually adjudicated ballot was being saved. TC-CV2105-006 Potential Deadlock Error	Testing to verify that running the deletebox command on ClearCount at the same time that a manually adjudicated ballot is being saved does not result in a deadlock error. To test this the deletebox command is executed at the same time as a manually adjudicated ballot is being saved and the system is observed to ensure that a deadlock does not occur as a result.	PASS
ClearCount SW-9951 – This release adds the ElectionBallotCode to the election database. TC-CV2105-007 Election Ballot Code Added to Election Database in ClearCount	Testing that an election with a defined Election Ballot Code, only accepts ballots with the Election Ballot Code encoded in their code channel. To test this, ballots with the Election Ballot Code will be cast in the election on ClearCount to ensure that they are accepted and counted. Additionally, ballots from a different election but with the same Election Date will be cast to ensure that they are not accepted in the election.	PASS
ClearCount SW-9952 – ClearCount now uses the ElectionBallotCode or the ElectionDate to confirm that a ballot being scanned belongs to the current active election. TC-CV2105-008 ClearCount Uses Election Ballot Code or Election Date to Determine if Ballot is Valid Ballot for an Election	Testing that elections use the Election Ballot Code or the Election Date to ascertain whether or not a ballot is a valid ballot in an election. To test this, ballots from an election with a defined Election Ballot Code will be cast in the election on ClearCount to ensure they are accepted and counted. Ballots from an election with a different Election Ballot Code will be cast on ClearCount to ensure that they are rejected by the election and not counted. Additionally, ballots without Election Ballot Codes defined will be cast in an election on Clear Count to ensure that the Election Date is used to differentiate whether or not the ballots are valid for an election. Ballots with a different election date will then be cast on ClearCount to ensure that they are not accepted and counted by the election.	PASS

Table A-1. Test Case Descriptions *(continued)*

Test Case	Description	Result (Pass/Fail)
ClearAccess SW-9953 – The ADF schema has been updated to include the electionBallotCode field. TC-CV2105-009 ADF Schema Updated to Include Election Ballot Code Field	Testing that the ElectionBallotCode field has been added to the ADF schema. To test this, ballots will be printed from the ClearAccess units, and will be cast in ClearCount to verify that the ballots cast successfully.	PASS
Accuracy Testing		
TC-ACC-001 Accuracy	Testing the integrated operation of the final iteration of the voting system under test as a whole (hardware, software, documentation, telecommunications, etc.), to validate that the voting system functions correctly when all elements are used together. VSTL Test Procedure VSTL-TP-1230-1.0	PASS
System Integration		
TC-SI-001 System Integration	Testing the ability of the voting system to capture, record, store, consolidate, and report the specific selections, and absence of selections, made by the voter for each ballot position without error. VSTL Test Procedure VSTL-TP-1220-1.0	PASS