pennsylvania
DEPARTMENT OF STATE

Report Concerning the Examination Results of Clear Ballot ClearVote 2.5 with ClearCast and ClearCast Go Precinct Scanners, ClearAccess and ClearMark Ballot Marking Devices, ClearCount Central Count Tabulator, and ClearDesign EMS

Issued By:

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March 23, 2026

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I. Introduction

Article XI-A of the Pennsylvania Election Code, 25 P.S. §§ 3031.1 et seq., authorizes the use of electronic voting systems. Section 1105-A of the Pennsylvania Election Code, 25 P.S. § 3031.5, requires that the Secretary of the Commonwealth (Secretary) examine all electronic voting systems used in any election in Pennsylvania and that the Secretary make and file a report stating whether, in his opinion, the electronic voting system can be safely used by voters and meets all applicable requirements of the Election Code.

Upon the request of Clear Ballot Group (CBG), the Department of State's Bureau of Elections (Department) scheduled an examination for December 15, 2025, of the ClearVote 2.5 voting system. The voting system presented for certification in Pennsylvania included the ClearDesign election management software used in conjunction with the following components:

1) ClearCast precinct scanner;
2) ClearCast Go precinct scanner;
3) ClearAccess ballot marking device;
4) ClearMark ballot marking device; and
5) ClearCount central scanner.

The 2.5 release of ClearVote includes the addition of the ClearMark ballot marking device, a new collapsible ballot storage box, bugfixes, and multiple enhancements to security and quality of life features.

The Secretary appointed Pro V&V, Inc. as professional consultants to conduct the examination of ClearVote 2.5. The examination process included a public demonstration, functional examination, and security testing. Department staff also consulted with Whitney Quesenbery from the Center for Civic Design as the accessibility examiner to discuss pertinent changes from previously certified releases and examine the new ClearMark ballot marking device.

The functional examination was performed in Room 114/OA Training Room of the Keystone Building at 400 North Street, Harrisburg PA 17120, adjacent to the Capitol Complex. Ryan Wilson of Pro V&V's Voting Systems Test Laboratory (Functional Examiner) conducted the functional examination of ClearVote 2.5 pursuant to Section 1105-A(a) of the Election Code, 25 P.S. § 303l.5(a). The examination commenced on December 15, 2025, and lasted approximately two days. In attendance during the examination were the following additional persons:

- Sindhu Ramachandran, Chief of the Division of Election Security and Technology, representing the Secretary of the Commonwealth;
- Casey Brady, Voting Systems Analyst, representing the Secretary of the Commonwealth;
- Brandon McCulloch, Elections Analyst, representing the Secretary of the Commonwealth; and
- Russ Dawson, Certification Program Manager, representing Clear Ballot Group; and

- Brett Turner, Senior Customer Relations Manager, representing Clear Ballot Group.

Additional staff members from the Department also attended portions of the examination. The functional examination was open to the public and the public demonstration portion of the examination was recorded by Commonwealth Media Services staff and placed on the Department's website (https://www.pa.gov/agencies/dos/resources/voting-and-elections-resources/voting-systems). Security testing of the ClearVote 2.5 system was performed at Pro V&V's facilities located at 6705 Odyssey Drive Suite C, Huntsville, Alabama separate from the functional examination. The accessibility testing of the ClearVote 2.5 system was performed remotely after the completion of the in-person examination.

II. The ClearVote 2.5 Voting System

ClearVote 2.5 components considered for use in Pennsylvania provide a paper-based optical scan voting system that provides end-to-end election support; from defining an election to generating final reports. The system is comprised of both precinct and central count tabulators and ballot marking device components to satisfy Americans with Disabilities Act (ADA) requirements. The following is a description of ClearVote 2.5 components summarized from the System Overview section of the Functional Examiner's Test Report TR-01-03-PA-001-CBG2.5-01 and the ClearVote 2.5 System Overview document submitted by Clear Ballot as part of the Technical Data Package (TDP).

A. 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, including ballot design, ballot proofing, ballot layout, and ballot production. ClearDesign is composed of the following hardware components:

- DesignServer: A laptop or desktop computer running Ubuntu with the ClearDesign software and hosting the election database.
- DesignStation(s): One or more laptops or desktops running Windows used to connect to the DesignServer. A browser is used to perform the necessary tasks. A user with administrative rights can define users and manage the elections.
- Network Switch: Used to connect DesignStations to the DesignServer using a wired, closed Ethernet-based network.

B. ClearCast

The ClearCast tabulator is a precinct count ballot scanning solution suitable for early and election day in person voting, including processing ballots printed by the ClearAccess and ClearMark accessible ballot marking devices. The ClearCast application runs on the precinct tabulator, and is used to scan, count and tally marked ballots. Its functionality is divided into three essential modes, Election Mode, which is used to process voter cast ballots during the election, Pre-Election Mode, which is used to test all system functionality and logic prior to the election, and Post-Election Mode, which is used to perform administrative functions following the close of the election.

C. ClearCast Go

The ClearCast Go tabulator is a precinct count ballot scanning solution suitable for early and election day in person voting, including processing ballots printed by the ClearAccess and ClearMark accessible ballot marking devices. The ClearCast application runs on the precinct tabulator, and is used to scan, count and tally marked ballots. Its functionality is divided into three essential modes, Election Mode, which is used to process voter cast ballots during the election, Pre-Election Mode, which is used to test all system functionality and logic prior to the

election, and Post-Election Mode, which is used to perform administrative functions following the close of the election.

D. ClearAccess

ClearAccess is an accessible paper-based ballot marking device that provides touch screen vote or assistive device navigation and capture that incorporates the printing of the voter's selections on an independent voter-verifiable paper ballot using a thermal or laser printer to be scanned for tabulation in any one of the Clear Ballot polling place or central tabulators.

E. ClearMark

ClearMark is an accessible paper-based ballot marking device that provides touch screen vote or assistive device navigation and capture that incorporates the printing of the voter's selections on an independent voter-verifiable paper ballot using a thermal or laser printer to be scanned for tabulation in any one of the Clear Ballot polling place or central tabulators.

F. ClearCount

ClearCount is a high-speed central scanner and tabulator system that simultaneously scan the front and back of hand-marked paper ballots and/or machine-marked paper ballots from the ClearAccess and ClearMark ballot marking devices. The ClearCount software runs on unmodified COTS laptop or desktop computers running the Windows operating system and supports specific models of scanners. Coupled ballot processing applications capture a digital image of each ballot and convert voter selection marks to electronic Cast Vote Records.

ClearCount handles central count tabulation, consolidation of imported results from precinct voting locations, results reporting, and activity logging. ClearCount consists of the following physical subcomponents:

- CountServer - A computer running the ClearCount software and hosting its election database and the web server that serves its election reports. The ScanServer uses a Linux operating system (a configured version of which is installed with the ClearCount software).
- ScanStations - One or more computer - COTS scanner pairs used to scan and tabulate ballots. The ScanStation computers use the Microsoft Windows operating system.
- Network Switch - Connects the ScanStations and the election administration stations to the CountServer via a closed, wired Ethernet connection.
- CountStation: One or more Windows laptop or desktop computers installed with browser software, linked by a wired Ethernet connection to the CountServer using the network switch. This station can serve multiple uses: user administration, election administration, adjudication, and reporting. This station is also used to consolidate the vote totals and ballot images from the ClearCast precinct tabulator. The vote totals and ballot images are consolidated by the ClearCount Software via the ClearCast USB drive.

G. Manufacturer Software and Firmware

The ClearVote 2.5 Voting System consists of the following software and firmware components:

Application	Software or Firmware Version
ClearAccess	2.5.6
ClearMark	2.5.6
ClearCast	2.5.3
ClearCast Go	2.5.3
ClearCount	2.5.8
ClearDesign	2.5.9

H. Manufacturer Hardware

Below is a high-level listing of the proprietary hardware components that comprise the entire ClearVote 2.5 system categorized by system functionality:

Hardware	Hardware Version
Clear Ballot Group Collapsible Ballot Bag	CV-1032-1.5, CV-1032-2.0
Clear Ballot Group Collapsible Ballot Box	CV-1033-1.5 CV-1033-2.0
ClearCast Go Transport Ballot Box	61211-1-3
ClearCast Soft Collapsible Ballot Box	Standard (14620) Long (14616)
ClearCast Soft Insert Collapsible Ballot Receptacle	Standard (14452) Long (14460)
ClearCast Go Soft Collapsible Ballot Box	Standard (14148) Long (14156)
ClearCast Go Soft Insert Collapsible Ballot Receptacle	Standard (14452) Long (14460)
ClearMark AIO Touchscreen	46100-1-1
ClearMark Thermal Printer	46200-1-1
ClearMark Thermal Printer Transportation and Setup Case	62321-1-2
ClearMark Lexmark Printer Transportation and Setup Case	62322-1-2

I. COTS Software and Firmware

Additional COTS software and firmware included in the system have been defined as part of the EAC system certification scope appended to this report as Attachment A.

III. Examination Approach

To ascertain whether ClearVote 2.5 can be securely used by voters at elections in the Commonwealth and whether it meets all the requirements put forth in the Election Code, the Examiners developed test protocols for the examination. The Examination was broadly divided into three categories; a Functional Examination, Security Testing, and an Accessibility Examination.

A. Functional Examination Approach

The test protocols separated the requirements of Article XI-A of the Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 - 3031.22, into three main areas of test execution:

1) Physical Configuration Audit

The Physical Configuration Audit for this campaign was performed to establish a configuration baseline of software and hardware to be tested and confirm whether manufacturer's documentation is sufficient for the user to install, validate, operate, and maintain the voting system. The Functional Examiner validated compliance of the system to the following sections of the Election Code during this documentation review:

- Section 1105-A(a), 25 P.S. § 3031.5(a), requiring that an electronic voting system has been examined and approved by a federally recognized Independent Testing Authority (ITA);
- Section 1107-A(11), 25 P.S. § 3031.7(11), requiring an electronic voting system to be suitably designed in terms of usability and durability, and capable of absolute accuracy;
- Section 1107-A(13), 25 P.S. § 3031.7(13), requiring an electronic voting system to correctly tabulate every vote;
- Section 1107-A(14), 25 P.S. § 3031.7(14), requiring an electronic voting system to be safely transportable;
- Section 1107-A(15), 25 P.S. § 3031.7(15), requiring an electronic voting system to be designed so voters may readily understand how it is operated;

2) Functional Configuration Audit

The Functional Configuration Audit (FCA) encompassed an examination to verify that the system hardware and software perform all the functions necessary to meet the defined requirements as set forth in the Pennsylvania Election Code. 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 and validate compliance to the following sections of the Pennsylvania Election Code:

- Section 1101-A, 25 P.S. § 3031.1, requiring an electronic voting system to provide for a permanent physical record of all votes cast;

- 25 P.S. § 3031.7(1), provides for voting in absolute secrecy and prevents any person from seeing or knowing for whom any voter, except one who has received or is receiving assistance as prescribed by law, has voted, or is voting.
- 25 P.S. § 3031.7(2) - Provides facilities for voting for such candidates as may be nominated and upon such questions as may be submitted.
- 25 P.S. § 3031.7(5) - Permits each voter to vote for any person and any office for whom and for which he is lawfully entitled to vote, whether or not the name of such person appears upon the ballot as a candidate for nomination or election.
- 25 P.S. § 3031.7(7) - If it is of a type that registers the vote electronically, the voting system shall preclude each voter from voting for more people for any office than he is entitled to vote for or upon any question more than once.
- 25 P.S. § 3031.7(10) - If it is of a type that registers the vote electronically, the voting system shall permit each voter to change his vote for any candidate or upon any question appearing on the official ballot up to the time that he takes the final step to register his vote and to have his vote computed. If it is of a type that uses paper ballots or ballot cards to register the vote and automatic tabulating equipment to compute such votes, the system shall provide that a voter who spoils his ballot may obtain another ballot; any ballot thus returned shall be immediately cancelled and at the close of the polls shall be enclosed in an envelope marked "Spoiled" which shall be sealed and returned to the county board.
- Section 1107-A(12), 25 P.S. § 3031.7(12), requiring an electronic voting system to provide acceptable ballot security procedures and impoundment of ballots to prevent tampering with or substitution of any ballots or ballot cards; and
- 25 P.S. § 3031.7(16), requiring an electronic voting system which provides for precinct level tabulation to: (i) display a public counter of ballots entered for tabulation, visible from outside of the automatic tabulating equipment during operation, (ii) require a lock, or locks, by the use of which all operation of the tabulation element of the automatic tabulating equipment is absolutely prevented immediately after the polls are closed (iii) preclude every person from seeing or knowing the number of votes theretofore registered for any candidate or question and preclude every person from tampering with the tabulating element, (iv) preclude tabulation of an over-vote, and (v) print a record at the beginning of its operation that verifies that counters are set to zero before processing ballots, and print at the finish of its operation of the total number of voters whose ballots have been tabulated, the total number of votes cast for each candidate whose name appears on the ballot, and the total number of votes cast for, or against, any question appearing on the ballot.
- 25 P.S. § 3031.7(17), requiring an electronic voting system which provides for central count tabulation to (i) preclude tampering with the tabulating element during the course of operation, (ii) preclude tabulation of an over-vote; and (iii) indicate that counters are set to zero before processing ballots, either by district or with the capability to generate cumulative report;

3) System Integration Testing

System Integration Testing is a system level test for the integrated operation of both hardware and software. The System Integration Test evaluates the compatibility of the voting system software components or subsystems with one another, and with other components of the voting system environment. This compatibility was determined through functional tests integrating the voting system software with the remainder of the system. During test performance, the system was configured exactly as it would be for normal field use in an election environment. 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. System Integration evaluated the following sections of the election code for compliance:

- Section 1107-A(4), 25 P.S. § 3031.7(4), requiring an electronic voting system to permit a voter to vote for candidates of all different parties, and write-in candidates;
- Section 1107-A(6), 25 P.S. § 3031.7(6), requiring an electronic voting system to permit a voter to cast votes for candidates and ballot questions he or she is entitled to vote for, and prevents a voter from casting votes the voter is not entitled to vote on;
- Section 1107-A(8), 25 P.S. § 3031.7(8), requiring an electronic voting system to prevent a person from casting more than one vote for a candidate or question, except where this type of cumulative voting is permitted by law; and
- Section 1107-A(9), 25 P.S. § 3031.7(9), requiring an electronic voting system to permit voters to vote in their own parties' primaries, and prevents them from voting in other parties' primaries, while also permitting voters to vote for any nonpartisan nomination or ballot question they are qualified to vote on.

B. Security Testing Approach

Security Testing provided a means to assess the required security properties of the voting system under examination and ascertain compliance with PA Election Code requirements, including 25 P.S. §§ 3031.7(11), (12), (16) and (17). A complete security evaluation was performed on the system. The security tests were based on the PA Election Code and PA Voting System Security Standard, published as Attachment E to the Directive for Electronic Voting Systems. The Security Examiner (Pro V&V Labs) conducted the penetration evaluation in two phases: Testing Assessment and Penetration Testing.

1) Testing Assessment

The primary goal of the Testing Assessment was to prioritize threats and maximize effectiveness of testing efforts throughout the penetration testing process. This phase was referred to as the planning and discovery phase. During this time, the Examiner assessed potential ways to subvert the voting system's security. The Security Examiner also conducted a vulnerability assessment and penetration testing against systems that were configured and secured in the same manner that would be when used in a live election.

2) Penetration Testing

The focus of Penetration Testing was to seek out and exploit vulnerabilities in the voting system identified during Testing Assessment that might be used to change the outcome of an election, to interfere with voters' ability to cast ballots or have their votes counted accurately during an election, or to compromise the secrecy of vote. The test evaluated whether the voting system under examination possesses the security properties to be successfully used in Pennsylvania.

C. Accessibility Examination Approach

The Department of State, in consult with the Whitney Quesenbery of the Center for Civic Design, found that the conclusions taken from the ClearVote 1.4.5/1.5, 2.0, and 2.3 releases' Accessibility Examinations can also be extended to ClearVote 2.5, since there were only minor hardware or software changes to any accessibility features. The only new equipment not included in any Accessibility Examination prior is the ClearMark ballot marking device. The Accessibility Examiner reviewed the changes and new equipment for ClearVote 2.5 and issued observations that will be included with reports from the previous releases' accessibility examinations.

The accessibility examination was designed to provide insights about each voting system component's usability and accessibility especially for voters with disabilities, as well as how effectively the system could be deployed by poll workers and voters. The Accessibility Examination included a team of three examiners with accessibility, usability and election process experience collectively referred as Accessibility Examiner. The examination process was divided into three parts:

1) Expert Review by Accessibility Examiner

Expert review of the system was performed by the Accessibility Examiner, using scenarios based on personas of people with disabilities from National Institute of Standards and Technology (NIST) and their professional experience.

2) Usability Review with Voters with Disabilities

Voters with disabilities used the system voting a reasonable length PA ballot and completed a questionnaire about their experience. The Accessibility Examiner observed and made notes.

3) Election Process Experience with Poll Workers

Election officials and poll workers tested the accessibility features to evaluate how they would be activated during an election during a review of the system guided by the Accessibility Examiner. They commented on the system based on their experience.

IV. Examination Processes and Procedures

The procedures and processes used during the examination of ClearVote 2.5 are listed in the sections below. The final recommendations contained later in this report are based on combined analyses of the results and conclusions from all examinations.

A. Functional Examination Processes and Procedures

Clear Ballot supplied all required equipment, including any software or firmware to be tested during the examination. All software and firmware required to perform the examination was already on hand since Pro V&V was the Voting System Test Laboratory (VSTL) that tested the voting system during certification through the Election Assistance Commission. All trusted builds of the software and firmware of each device were installed using the appropriate media and methodologies for installation.

The hash codes for all components of the system were captured by the Functional Examiner with assistance from a Clear Ballot representative by using the process listed in the manufacturer's Technical Data Package (TDP). The Functional Examiner further compared all the captured hash codes to ensure they matched the hash codes for the EAC certified system executables before executing the test cases or continuing with the examination. During the hash validation process, it was discovered that the drivers for the Lexmark MS521nd COTS printer were not included in trusted build hashes for the Elo-X and Elo-E configurations of the ClearAccess ballot marking devices and were not able to be tested as part of this examination. As such, the Lexmark MS521nd is not certified for use with the Elo-E and Elo-X configurations of the ClearAccess BMDs. The drivers for the OKI-B432 COTS printer were included in the trusted build, and using the OKI-B432 instead of the Lexmark MS521nd allowed all drivers to match the trusted build hashes for the examination. The Elo-POS configuration of the ClearAccess ballot marking device included drivers for the Lexmark MS521nd and is certified for use with that COTS printer.

The public demonstration and functional examination portions of the testing commenced on December 15, 2025, in Room 114/OA Training Room of the Keystone Building at 400 North Street, Harrisburg PA 17120, adjacent to the Capitol Complex. Members of the public were allowed and encouraged as observers for the duration of the examination, and public notice of the date and time of the examination and the public demonstration was provided in advance on the Department of State website. The execution of all testing tasks took approximately two days. The functional examiner performed the hash validation component of the Physical Configuration Audit, all components of the Functional Configuration Audit and System Integration testing onsite during the public examination. The documentation review portion of the Physical Configuration Audit was completed prior to the public examination at Pro V&V test lab facilities in Huntsville, AL.

1) Physical Configuration Audit

The Functional Examiner reviewed submitted components and compared the voting system components submitted for evaluation to the manufacturer's technical documentation and

the defined configuration for use in testing. During execution of the PCA, the components of the ClearVote 2.5 system were documented by component name, model, serial number, major component, and any other relevant information needed to identify the component. The Functional Examiner also performed a verification of the Trusted Builds of the software installed on each system component to ensure the certified versions of the software were installed correctly. If any of the software was unable to be verified, the Trusted Build of the software was installed on the component. The ClearAccess Elo-E and Elo-X units brought for evaluation were only tested with the OKI B432 printers due to the drivers for the Lexmark MS521nd being missing from the trusted build hashes for both present touchscreen configurations.

The following was the configuration used for testing, as documented during the PCA by the Functional Examiner:

Election Management System (ClearDesign)

- Design Server – Dell T150 Server – S/N: 54GDL84
  - Dell Monitor E2725H – S/N: DJN3Z34
- Design Station – Thinkpad E14 Gen5 – S/N: PF-5BMRGZ

Central Scanner and Tabulator (ClearCount):

- Count Server – Dell T150 – S/N: 64GDL84
  - Dell E2723H Monitor – S/N: G4FXMY3
- Count Station – Thinkpad E14 Gen5 Laptop – S/N: PF-58NC62
  - Western Digital MyBook – S/N: WCC7KYF11ZD
- Scan Station – Thinkpad E14 Gen5 – S/N: PF58T2Q1
- Network Switch – Cisco Catalyst 1300 – S/N: PVM29111DJ2
- Scanner – Ricoh fi-8950 – S/N: CLAC000020
- Reports Printer – Brother HLL2460DW – S/N: U67398C5M431911

Poll Place Scanner and Tabulator (ClearCast)

- ClearCast Model D – S/N: CCD041903768
  - ClearCast Collapsible Ballot Box

Poll Place Scanner and Tabulator (ClearCast Go)

- ClearCast Model D – S/N: 4410002012
  - ClearCast Go Setup Case/Ballot Box

Ballot Marking Device (ClearAccess)

- ClearAccess Unit # 1 – S/N: 120C001311
  - Elo E – S/N: 120C001311
  - Oki B432 – S/N: AK9C008809C0
  - Storm Interface EZ Access Keypad – S/N: 15020480
- ClearAccess Unit # 2 – S/N: 120C001311
  - Elo X – S/N: E18Q000078
  - Oki B432 – S/N: AK9C008809C0

- Storm Interface EZ Access Keypad – S/N: 15020480

Ballot Marking Device (ClearMark)

- ClearMark Unit #1 – S/N: 00001488
  - ClearMark Setup Case
  - Thermal Printer
- ClearMark Unit #2 – S/N: 00002056
  - ClearMark Setup Case
  - Lexmark MS521 Printer

2) Functional Configuration Audit

This testing included all proprietary components and COTS components (software, hardware, and peripherals) in a configuration consistent with the system's intended use. The tests were designed to assess the system's ability to meet the requirements of the election code and each applicable software and hardware component of the system was included in the tests. For software system tests, the tests were designed according to the stated design objective without consideration of its functional specification. Specifically, the Functional Configuration Audit for the ClearVote 2.5 campaign consisted of executing the following test cases for each listed component:

Election Management System (ClearDesign)

- Evaluation of Election Management System (EMS)

Poll Place Scanner and Tabulator (ClearCast)

- 01 – 25 P.S. § 3031.7(1) Voter Secrecy
- 02 – 25 P.S. § 3031.7(2) Selection of Candidates and Questions by Voter
- 05 – 25 P.S. § 3031.7(5) Selection of Candidate and Write-in
- 07– 25 P.S. § 3031.7(7) Attempt to Over Vote Contests and Questions
- 10 – 25 P.S. § 3031.7(10) Ballot Review and Change
- 16 – 25 P.S. § 3031.7(16) Public Counter, No Reopening of Polls, Media Security with Tamper Proof Locks and Zero Proof and Tally Reports

Poll Place Scanner and Tabulator (ClearCast Go)

- 01 – 25 P.S. § 3031.7(1) Voter Secrecy
- 02 – 25 P.S. § 3031.7(2) Selection of Candidates and Questions by Voter
- 05 – 25 P.S. § 3031.7(5) Selection of Candidate and Write-in
- 07– 25 P.S. § 3031.7(7) Attempt to Over Vote Contests and Questions
- 10 – 25 P.S. § 3031.7(10) Ballot Review and Change
- 16 – 25 P.S. § 3031.7(16) Public Counter, No Reopening of Polls, Media Security with Tamper Proof Locks and Zero Proof and Tally Reports

Central Scanner and Tabulator (ClearCount):

- 02 – 25 P.S. § 3031.7(2) Selection of Candidates and Questions by Voter
- 05 – 25 P.S. § 3031.7(5) Selection of Candidate and Write-in
- 07– 25 P.S. § 3031.7(7) Attempt to Over Vote Contests and Questions
- 17 – 25 P.S. § 3031.7(17) Public Counter, No Reopening of Polls, Media Security with Tamper Proof Locks and Zero Proof and Tally Reports

Ballot Marking Device (ClearAccess)

- 01 – 25 P.S. § 3031.7(1) Voter Secrecy (ADA Voter)
- 02 – 25 P.S. § 3031.7(2) Selection of Candidates and Questions by Voter (Regular/ADA)
- 05 – 25 P.S. § 3031.7(5) Selection of Candidate and Write-in
- 07– 25 P.S. § 3031.7(7) Attempt to Over Vote Contests and Questions (Regular/ADA
- 10 – 25 P.S. § 3031.7(10) Ballot Review and Change (Regular/ADA)

Ballot Marking Device (ClearMark)

- 01 – 25 P.S. § 3031.7(1) Voter Secrecy (ADA Voter)
- 02 – 25 P.S. § 3031.7(2) Selection of Candidates and Questions by Voter (Regular/ADA)
- 05 – 25 P.S. § 3031.7(5) Selection of Candidate and Write-in
- 07– 25 P.S. § 3031.7(7) Attempt to Over Vote Contests and Questions (Regular/ADA
- 10 – 25 P.S. § 3031.7(10) Ballot Review and Change (Regular/ADA)

3) System Integration Test

During the System Integration testing, one General Election and one Primary Election were exercised on the voting system. The Functional Examiner created the election definition using ClearDesign, and Clear Ballot transport media was used to transfer those elections to ClearCast, ClearCast Go, ClearCount, ClearAccess, and ClearMark units. The polls were opened, and zero reports were printed and verified where applicable. Hand-marked paper ballots and ballots marked electronically via the ClearAccess and ClearMark ballot marking devices were cast and tabulated through the ClearCount central tabulation equipment and ClearCast and Go precinct count optical scan tabulators.

Polls were closed, and results reports were generated with results for the election. The result reports were confirmed to match the expected results of the voted ballots. Adjudication and write-in management were then performed in ClearCount on both General and Primary elections to demonstrate the adjudication capabilities of the ClearVote 2.5 voting system.

General Election System Integration Testing

For the General Election testing, the testing team determined the test ballot parameters and constructed a typical PA ballot combining presidential year contests, non-presidential year contests, and municipal contests into a single election held in three precincts, one of which is a split precinct on the "Representative in the General Assembly" contests. The individual contests

consisted of a mix of contest types and variation in the number of candidates to be voted for each contest. Fifteen of the contests are in all ballot styles. The other six are split between at least two of the precincts with a maximum of twenty different contests spread across the three precincts. All voting variations supported by the Commonwealth of Pennsylvania are defined in this election. The voting variations included the following:

- Partisan contest
- Non-Partisan contest
- N of M contest
- Referendum contest
- Retention Contest
- Write-In voting
- Split Precinct
- Cross-Party Nominated

This general election was designed to functionally test the handling of multiple ballot styles across geographical subdivisions, support for English and Spanish languages, support for all Pennsylvania voting variations, and audio support for English and Spanish.

Primary Election System Integration Testing

For the Primary Election testing, the testing team determined the test ballot parameters and constructed a typical PA ballot for a closed primary for two parties in three precincts. This election contains thirty-five contests compiled into six ballot styles. Each ballot style contains fifteen contests. The voting variations included in the testing are as follows:

- Partisan contest
- Non-Partisan contest
- Primary Presidential Delegation Nominations
- Write-In voting
- N of M contest
- Cross-Party Filed Candidates

This closed primary election was designed to functionally test the handling of multiple ballot styles across geographical subdivisions, support for English, Spanish, and Chinese languages, and support for common primary specific voting variations.

B. Security Testing Processes and Procedures

The Security Testing was done at Pro V&V lab facilities in Huntsville, Alabama. The Security Examiner received the hardware devices from Clear Ballot and already had the software and firmware since Pro V&V served as the Examiner for EAC certification. The Examiner installed the Trusted Build prior to the examination using the appropriate media for installation. The Security Testing is comprised of a series of test suites which are utilized for verifying that a voting system will correspond to applicable security requirements within the Pennsylvania Election Code and PA Security Standards, requiring testing of the following security categories:

1) Documentation Review;

2) Design;

3) Software Security – Software;

4) Access Control;

5) Encryption, Network, Audit Logging;

6) Physical Security and;

7) Penetration Testing.

The requirements associated to each area of testing were applied to the ClearVote 2.5 system in the following manner. The Security Examiner conducted penetration testing as an attempt to bypass or break the security of the system or device under examination. Penetration testing was conducted without the confines of a pre-determined test suite and relied on the experience and expertise of Pro V&V's knowledge of the system, the component devices and associated vulnerabilities, and the ability to exploit those vulnerabilities.

Testing for this campaign was divided into two distinct but united efforts: Testing Assessment and Penetration Testing which were completed after the Security Examiner documented each component name, model, serial number, major component, and any other relevant information needed to identify the component via a Physical Configuration Audit.

1) Testing Assessment

The objective of the Testing Assessment phase of Security testing was to evaluate the effectiveness of the voting system in detecting, preventing, recording, reporting, and recovering from security threats. To assess system integrity, Pro V&V developed specifically designed test cases in an attempt to defeat the access controls and security measures documented in the system TDP using the following methodology:

1) Planning and Preparation
    a. Identify Rules and Assumptions for the attack
    b. Set Test Goals
2) Asset Identification: Identifies the components in need of protection
3) Threat Identification: Identifies who or what constitutes a threat, as well as from where and why.
4) Risk Assessment
    a. Describe Vulnerabilities: Identifies the weaknesses and assets that are exposed.
    b. Determine Likelihood: Quantifies the chance that a threat will successfully exploit a potential vulnerability.
    c. Determine Impact: Quantifies the maximum effect a threat has after exploiting a potential vulnerability.
    d. Determine Risk: Calculates a relative score based on likelihood and impact for each potential vulnerability.

5) Discovery Testing
    a. Information Gathering and Scanning
    b. Perform Preliminary Assessment
    c. Vulnerability Analysis
6) Develop Plan of Action for Penetration Testing attack

2) Penetration Testing

Once the Testing Assessment phase of Security Testing was completed, the results were used to conduct Penetration Testing. Test scenarios were selected and prioritized based on threat / vulnerability pairs derived from conducting the risk assessment of the system. The risk assessment was conducted to gather sufficient analysis to support the selection and prioritization of threat vulnerability pairs used in penetration testing. The risk assessment was used to produce ClearVote 2.5 product component-based (L1) matrices showing malicious opportunity hot spots. A matrix was created for each L1 component, with each matrix representing a qualitative measure of vulnerability exploit opportunity in the systems. These hot spots were used to research and identify potential technical vulnerabilities to be targeted during Penetration Testing.

Penetration Testing was conducted under the guidelines of the Commonwealth of Pennsylvania Security Testing Standard. The scope of Penetration Testing included, but was not limited to, the following: voting system security, voting system physical security while voting devices are in storage, being configured, being transported, and voting system use procedures in back-office and in-precinct environments.

C. Accessibility Examination Processes and Procedures

Whitney Quesenbery of the Center for Civic Design, serving as the Accessibility Examiner, reviewed the changes between the previously certified versions and ClearVote 2.5. Department staff also facilitated discussion and a demonstration of the new ClearMark ballot marking device via teleconference with the Accessibility Examiner and Clear Ballot; Accessibility Examiner provided her insights in an Accessibility Report which will be included in the Examination Results portion of this certification report. A summary of test details is provided below.

The accessibility examination portion for ClearVote 1.4.5/1.5 commenced on October 29, 2018, at Room G24A/B of the Commonwealth Capitol Complex - Finance Building, 613 North Street, Harrisburg, PA 17120. The examination lasted approximately three days followed by a debrief meeting on October 31,2018 with DOS and the Center for Civic Design to discuss initial findings. The Accessibility Examiner did a retest of the sip-and-puff device on February 5, 2019 because the initial examination did not provide enough evidence that the device works accurately. The examination included expert review by the Accessibility Examiner, five sessions with nine total poll workers broken out into groups, and sessions with 7 voters with disabilities using different accessible devices for voting.

1) Expert Review by Accessibility Examiner

The Accessibility Examiner conducted a review of the voting system under examination prior to sessions with voters and poll workers. The Accessibility Examination team included both accessibility and usability expertise to ensure background and knowledge of the issues for accessible voting. The Accessibility Examiner had experience working with people with a wide variety of disabilities and their impact on daily life, knowledge of the range and use of assistive technologies that voters with disabilities might rely on for access, experience conducting usability evaluations with voters and strong knowledge of best practices and design principles for digital technology and voting systems. The expert review gave the examiners a chance to make sure they understood how the system and accessibility features work and to note anything they wanted to watch for during other testing.

2) Usability Review with Voters with Disabilities

During the ClearVote 1.4.5/1.5 accessibility examination, the Accessibility Examiner used the same ballot and instructions to be used for voter review, for their expert review, so they would be familiar with the interaction voters would experience.

Sessions with Voters

The following voter population with ages was represented in the test sessions:

- 2 voters blind from birth;
- 1 voter with late onset blindness;
- 2 voters with low vision;
- 1 voter with low vision and dexterity limitations; and
- 1 voter with mobility limitations.

The voters' age ranged from 35 through 70 years old, and were from Allegheny, Cumberland, Dauphin, and Philadelphia counties.

Each voter session took about an hour. They included:

1. An opening interview about their previous voting experience and the types of assistive technologies they use in daily life and in voting.
2. A very basic orientation to the system with opportunities for voters to ask questions about any assistive technologies available.
3. Set-up of the machine using the provided assistive access features based on the needs of the individual voter. Where a blind voter would typically use the provided or personal headset to listen to the audio instructions, the tests used an external speaker so that the testers could inquire about the voters understanding of the instructions.
4. Voting a ballot, following voting instructions given verbally by the facilitator, where necessary, and by reading them. Voters were encouraged to give feedback about their experiences, both positive and negative, as they went through the ballot. The

Accessibility Examiner and the voters discussed any feedback and questions that occurred during the voting sessions and re-evaluated any findings as necessary. \

5. A closing interview including a questionnaire about their voting experience and reactions to the system.

3) Election Process Experience with Poll Workers

During the ClearVote 1.4.5/1.5 accessibility examination, the Accessibility Examiner used the same ballot and instructions to be used for poll worker review, for their expert review, so they would be familiar with the interaction voters would experience.

Sessions with Poll Worker Groups

Poll workers were invited to come in teams, in five separate sessions of differing team sizes. The teams included a total of 10 individuals. These poll workers:

- were from Dauphin, Lancaster, and Perry counties;
- had between five and twenty-six years of experience;
- were familiar with the now-decertified systems: Danaher ELECTronic 1242, the ES&S iVotronic, and Hart InterCivic ESlate systems;
- included one Election Commissioner;
- included one Judge of Elections; and
- had mostly limited experience serving voters with disabilities.

Each poll worker session took approximately one hour depending on the group size. Each session included:

1) A brief orientation to the voting systems and the accessibility features, similar to a poll worker training.
2) An opportunity for the poll workers to review vendor-provided instructions before trying the system. They marked ballots and experimented with the accessibility features.
3) An opportunity for the poll workers to interact with role-played voters in two to six different access-needs scenarios, depending on the size of the group and available time. Each scenario involved an examiner roll-playing as a voter with an unspecified disability. In some scenarios, the voter didn't immediately identify their disability. Since this was not intended to test the poll-worker's ability to determine appropriate accommodations, each simulated voter provided information about the accommodations they needed, in general language. This sometimes required the poll worker to ask the voter what additional assistance she or he might need. Then the poll worker activated the necessary accessibility features for the voter. Poll worker groups did not participate in scenarios for voters with physical dexterity disabilities because the only device for these voters, the sip-and-puff was not working properly, so this left only the audio and tactile keypad for demonstrations.

The Accessibility Examiner took notes about aspects of the system that worked well and problems they encountered during all three phases of the examination. The issues were then categorized as follows based on their impact on a voter's ability to vote independently and privately:

- Positives – things that voters mentioned as meeting or exceeding their expectations;
- Annoyances – things voters mentioned as problems, but which did not significantly slow their progress in marking their ballot;
- Problem solving – instances where voters hesitated and had to figure out how to complete an action or task, but were able to do so on their own, by exploring the system or relying on past experience with technology;
- Needs assistance - problems that could only be solved with help, such as instructions or assistance from a poll worker; and
- Show stoppers - problems that could prevent successful independent and private voting, even with good knowledge about how to use the system and accessibility features.

The Accessibility Examiner then compiled the findings including categorizations from the examination into a report submitted to the Secretary.

V. Examination Results

The Examiner's Test Report for Functional Testing for ClearVote 2.5 (TR-01-03-PA-001-CBG2.5-01) included details of the test cases, execution, and successful completion. The Examiner's Security Testing and Evaluation Report for ClearVote 2.5 (TR-01-03-PA-CBG2.5-02) included details of the penetration testing planning, methodology, and execution results. The Accessibility Examiner's Accessibility Report for ClearVote 2.5 included observations and recommendations for ways the system could be configured to improve accessibility.

The following Sections contain a summary of all results of the examination as explained in fuller detail in the respective Examiners' Reports.

A. Functional Examination Results

The Functional Examiner's report indicated that the system successfully completed tests executed to ascertain compliance with requirements of the Code. The Examiner report for ClearVote 2.5 included details of the test execution and indicated successful completion and identified pertinent observations. The following section is a summary of the results of the examination as set forth in fuller detail in the Examiner's Report.

1) Physical Configuration Audit

Functional Examiner concluded that the following election code requirements were met by ClearVote 2.5 voting system and were addressed as part of the PCA and documentation review:

- 1105-A(a), 25 P.S. § 3031.5(a);
- 1107-A(11), 25 P.S. § 3031.7(11);
- 1107-A(13), 25 P.S. § 3031.7(13);
- 1107-A(14), 25 P.S. § 3031.7(14); and
- 25 P.S. § 3031.7(15).

2) Functional Configuration Audit

The test cases for ClearDesign, ClearCast, ClearCast Go, ClearCount, ClearMark, and ClearAccess units were all performed successfully, and results were verified. The Functional Examiner also noted that the paper ballots will allow statistical recounts as required by Sections 1117-A, 25 P.S. § 3031.17. Test cases utilized during the performance of the Functional Configuration Audit are included below:

Statutory Requirement and Test Case Explanation	**Device Tested**
25 P.S. § 3031.7(1) - Provides for voting in absolute secrecy and prevents any person from seeing or knowing for whom any voter, except one who has received or is receiving assistance as prescribed by law, has voted, or is voting.	ClearCast ClearCast Go ClearMark ClearAccess

Functional Examiner validated that the voter's selections cannot be observed after a ballot has been cast with ClearCast or ClearCast Go. Functional Examiner validated that the observer was not able to determine the voter's selection on ClearAccess or ClearMark ballot marking devices from any observation position where the straight center measurement is 12 feet, and the side distance observation points are approximately 17 feet. Functional Examiner also reviewed federal test cases and test results to confirm this requirement.	
25 P.S. § 3031.7(2) - Provides facilities for voting for such candidates as may be nominated and upon such questions as may be submitted. Functional Examiner tested selection of partisan candidates in multiple contests for vote for one, "N of M" contest, and ballot questions on ClearMark and ClearAccess ballot marking devices. Functional Examiner also validated that all the votes were counted appropriately on ClearCount, ClearCast, and ClearCast Go.	ClearCount ClearCast ClearCast Go ClearMark ClearAccess
25 P.S. § 3031.7(5) - Permits each voter to vote for any person and any office for whom and for which he is lawfully entitled to vote, whether or not the name of such person appears upon the ballot as a candidate for nomination or election. Functional Examiner tested and confirmed that the system allows voting for any candidate on the ballot and allowed the voter to cast a write-in vote. System Integration Testing was used to further confirm that the candidates were presented with the correct contests that they were eligible to vote.	ClearCount ClearCast ClearCast Go ClearMark ClearAccess
25 P.S. § 3031.7(7) - If it is of a type that registers the vote electronically, the voting system shall preclude each voter from voting for more people for any office than he is entitled to vote for or upon any question more than once. Functional Examiner tested to confirm that ClearAccess and ClearMark ballot marking devices prevented overvotes, ClearCast and ClearCast Go precinct tabulators warned voters for overvotes if configured, and ClearCount central count tabulators did not count any votes for a contest that was overvoted.	ClearCount ClearCast ClearCast Go ClearMark Clear Access
25 P.S. § 3031.7(10) - If it is of a type that registers the vote electronically, the voting system shall permit each voter to	ClearCast ClearCast Go

change his vote for any candidate or upon any question appearing on the official ballot up to the time that he takes the final step to register his vote and to have his vote computed. If it is of a type that uses paper ballots or ballot cards to register the vote and automatic tabulating equipment to compute such votes, the system shall provide that a voter who spoils his ballot may obtain another ballot; any ballot thus returned shall be immediately cancelled and at the close of the polls shall be enclosed in an envelope marked "Spoiled" which shall be sealed and returned to the county board. Functional Examiner tested to confirm that ClearMark and ClearAccess ballot marking devices allowed the voter to make changes until a ballot is printed. ClearCast and ClearCast Go tabulation devices allowed for the voter to scan the new ballot received after they spoiled the original ballot.	ClearMark ClearAccess
25 P.S. § 3031.7(16) - If the voting system is of a type which provides for the computation and tabulation of votes at the district level, the district component of the automatic tabulating equipment shall include the following mechanisms or capabilities: (i) A public counter, the register of which is visible from the outside of the automatic tabulating equipment component into which the ballots are entered, which shall show during any period of operation the total number of ballots entered for computation and tabulation. (ii) A lock, or locks, by the use of which all operation of the tabulation element of the automatic tabulating equipment is absolutely prevented immediately after the polls are closed or where the tabulation of votes is completed. (iii) It shall be so constructed and controlled that, during the progress of voting, it shall preclude every person from seeing or knowing the number of votes theretofore registered for any candidate or question; and it shall preclude every person from tampering with the tabulating element. (iv) If the number of choices recorded for any office or on any question exceeds the number for which the voter is entitled to vote, it shall reject all choices recorded on the ballot for that office or question, provided, that if used during the period of voting it may also have the capacity to indicate to a voter that he has improperly voted for more candidates for any office than he is entitled to vote for, and in such case it shall have the capacity to permit the voter to mark a new ballot or to forego his opportunity to make such correction.	ClearCast ClearCast Go

(v) It shall be equipped with an element which generates a printed record at the beginning of its operation which verifies that the tabulating elements for each candidate position and each question and the public counter are all set to zero and with an element which generates a printed record at the finish of its operation of the total number of voters whose ballots have been tabulated, the total number of votes cast for each candidate whose name appears on the ballot, and the total number of votes cast for, or against, any question appearing on the ballot. Functional Examiner validated that intended selection are recorded, stored, and reported as input by the voter. The voting device does not allow the reopening of the polls and is able to produce a "Zero Proof" and "Tally Report". The voting device has a visible public counter and the counter increments correctly.	
25 P.S. § 3031.7(17) - If the voting system is of a type which provides for the computation and tabulation of all votes at a central counting center or if it provides for the tabulation of district totals at such a central counting center, the central automatic tabulating equipment shall include the following mechanisms or capabilities: (i) It shall be constructed so that every person is precluded from tampering with the tabulating element during the course of its operation. (ii) If the number of choices for any office or on any question exceeds the number for which the voter is entitled to vote, it shall reject all choices recorded on the ballot for that office or question. (iii) It shall have a means by which to verify that the counters for each candidate position and for each question are all set to zero and shall be able to generate a printed record of each election district showing the total number of voters whose ballots have been tabulated, the total number of votes cast for each candidate whose name appears on the ballot, and the total number of votes cast for, or against, any question appearing on the ballot. It may also be capable of generating cumulative election reports. Functional Examiner validated that intended selection are recorded, stored, and reported as input by the voter. The voting device does not allow the reopening of the polls and is able to produce a "Zero Proof" and "Tally Report". The voting device has a visible public counter and the counter increments correctly.	ClearCount

Functional Examiner concluded that the following additional election code requirements were met by ClearVote 2.5 voting system and were addressed as part of the FCA:

- 1101-A, 25 P.S. § 3031.1; and
- 1107-A(12), 25 P.S. § 3031.7(12);

The Functional Examiner identified that the following requirements within Article XI-A of the Pennsylvania Election Code, sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 – 3031.22. are not applicable to the current examination, as each deal with non-functional testing aspects of acquisition, use and maintenance aspects of a voting, that a jurisdiction would be tasked with following: 25 P.S. § 3031.2, 3031.3, 3031.4, 3031.6, 3031.8, 3031.9, 3031.10, 3031.11, 3031.12, 3031.13, 3031.14, 3031.15, 3031.16, 3031.18, 3031.19, 3031.20, 3031.21, and 3031.22.

3) System Integration Test

During execution of the test procedure, it was verified that the ClearVote 2.5 voting system successfully completed the system level integration tests with all actual results obtained during test execution matching the expected results.

Functional Examiner concluded that the ClearVote 2.5 system met election code requirements 1107-A(4), 25 P.S. § 3031.7(4) , 1107-A(6), 25 P.S. § 3031.7(6), 1107-A(8), 21 25 P.S. § 3031.7(8), and 1107-A(9), 25 P.S. § 3031.7(9) as demonstrated by test cases used during the Primary and General Elections.

Accuracy requirements of 1107-A(11), 25 P.S. § 3031.7(11), that were ascertained by reviewing EAC test reports during the physical configuration audit documentation review were further validated by the successful tabulation and validation of the primary and general elections run by the Functional Examiner.

System Integration testing verified that the system as an aggregate is capable of conducting a full election, from creation of the election definition to creation of media used to conduct in-person and central count polling activities, and accumulation and publishing of the election's final results.

B. Security Testing Results

The Examiner states in Section VII: Conclusion of their Security Testing and Evaluation report that "The ClearVote 2.5 system, as presented for testing, successfully met the requirements contained within *Attachment E* to the *Directive for Electronic Voting Systems - PA Voting System Security Standard*. Based on the test findings, Pro V&V recommends the ClearVote 2.5 system be considered safe and secure for use by voters at elections."

C. Accessibility Examination Results

The Accessibility Examiner compiled the findings including categorizations from the examination into a report submitted to the Secretary. This report, as well as the original report from the in-person ClearVote 1.4.5/1.5 Accessibility Examination and reports from ClearVote 2.0 and 2.3 Accessibility Examinations, is provided with this report as Attachment B.

VI. Observations

During the examination, and in the review of documentation, the Examiner and/or Department staff noted the following observations:

- ClearVote 2.5 does not support cumulative voting.
- Straight party voting is no longer a part of the electoral process in the Commonwealth of Pennsylvania, so any observations included pertaining to it are no longer relevant.
- The ADA compliant ballot marking devices, ClearAccess and ClearMark presented as part of the ClearVote 2.5 system, could be effectively used by all voters. This allows jurisdictions to expand the use of these devices for a larger universe of voters and not restrict their use to voters using assistive device.
- Observations/Findings identified during the Accessibility Examinations for previous certified versions of ClearVote are provided in Appendix B.
- If they are not new, the USB devices and other portable media used with the voting system components need to be reformatted before each election.
- Lexmark MS521nd cannot be used with Elo-X and Elo-E. The drivers for the Lexmark MS521nd were not included in trusted build hashes for the ClearAccess ballot marking devices Elo-X and Elo-E used for testing during this campaign. Please note that the Elo-POS configuration of ClearAccess remains certified and can be used with Lexmark MS521nd. Hash validation confirmed that the hashes for Lexmark MS521nd were included with the Elo-POS configuration of the ClearAccess ballot marking device.

The ClearAccess and ClearMark ballot marking devices can accommodate 11-12 voters using assistive devices per hour and 20-60 voters per hour when used as the primary voting system, depending on the size of the ballot. The ClearCast and ClearCast Go precinct tabulators can serve 45-60 voters per hour depending on the length of the ballot. ClearCast and ClearCast Go collapsible ballot boxes will hold approximately 1000 14-inch ballots. The hard ballot box with internal tote will hold up to 2500 ballots.

All testing of ClearVote 2.5 was performed using executables verified by hash validation to be from the EAC Trusted Build, in association with the appropriate hardware version as declared for ClearVote 2.5.

The Functional Examiner also noted that the paper ballots will allow recounts as required by Sections 1117-A, 25 P.S. § 3031.17.

After all testing activities, the examiners and Department concluded that ClearVote 2.5 demonstrates compliance with all applicable requirements as delineated in Article XI-A of the Pennsylvania Election Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 – 3031.22 .

VII. Conditions for Certification

Based on the results of the examination that occurred in December 2025, and the reported findings of the Examiners as set forth in their reports, the Secretary of the Commonwealth certifies ClearVote 2.5 for sale and use in Commonwealth elections subject to the following conditions:

A. Pennsylvania counties using ClearVote 2.5 must comply with the Directive Concerning the Use, Implementation and Operations of Electronic Voting Systems by the County Boards of Elections issued by the Secretary of the Commonwealth on September 22, 2025 (the "Use Directive"), any subsequent revisions of the Use Directive, and any other applicable directives currently in effect or issued in the future. Specifically, Pennsylvania counties must adhere to item four (4) of the Use Directive when setting up and positioning ClearAccess and ClearMark ballot marking devices in the polling place to assure compliance with the constitutional and statutory requirements that secrecy in voting be preserved (see Pa. Const Art. VII § 4; and Section 1107-A(l) of the Election Code, 25 P.S. § 3031.7(1)).

B. Reported field issues or anomalies that occur in Pennsylvania or elsewhere with any piece of equipment deployed in the Commonwealth of Pennsylvania must be relayed to the Department of State by each jurisdiction ClearVote 2.5 is used in as laid out in the Directive Regarding the Uniform Reporting of Voting System Malfunctions to the Department of State issued September 22, 2023.

C. No components of ClearVote 2.5 shall be connected to any modem or network interface, including the Internet, at any time. A standalone local area wired network configuration may be considered, in which all connected devices are certified voting system components. Transmission of unofficial results can be accomplished by writing results to media and moving the media to a different computer that may be connected to a network. Any wireless access points in the district components of ClearVote 2.5, including wireless LAN cards or network adapters, must be uninstalled or disabled prior to shipping to a County Board of Elections.

D. Because ClearVote 2.5 is a paper-based system, counties using ClearVote 2.5 must comply at a minimum with Section 1117-A of the Election Code, 25 P.S. § 3031.17, that requires a "statistical recount of a random sample of ballots after each election using manual, mechanical or electronic devices of a type different than those used for the specific election." This audit must be conducted exclusively via a manual count of the voter marked paper ballots. Counties must include in the sample ballots such samples as may be marked by ADA compliant components. Counties are advised to consult the Directive Concerning the Use, Implementation and Operation of Electronic Voting Systems by the County Boards of Elections issued by the Secretary of the Commonwealth on September 22, 2025, any subsequent revisions of that Directive, and any other directives that may apply to audits of electronic voting systems.

E. All jurisdictions implementing ClearVote 2.5 need to carry out a full Logic and Accuracy test on each device without fail and maintain evidence of Logic and

Accuracy (L&A) testing in accordance with the statutory requirements for pre-election and post-election testing. The Department does not recommend automated L&A testing and discourages the use of preprinted ballots provided by vendors. All components being used on election day, including any Electronic Poll Books being used, must be part of the L&A testing.

F. Jurisdictions implementing ClearVote 2.5 in Pennsylvania must use the ballot stock recommended by the vendor in the TDP and test the ballot marking devices with the same paper stock that will be used during election. All components must be tested during the L&A testing with the same ballot stock that will be used on Election Day. Clear Ballot must work with jurisdictions to ensure that the correct ballot stock is used, and the printer and scanner settings adhere to the identified values in TDP. Clear Ballot must work with the jurisdictions to add training sessions during implementation to ensure that the quality of ballots is maintained while handling, before, during and after elections.

G. Jurisdictions must work with Clear Ballot to ensure that the sip-and-puff devices are calibrated, and the devices work for completing a ballot marking session. Jurisdictions must use it during L&A testing to complete a ballot. Jurisdictions implementing the ClearVote 2.5 system must hold voter education sessions specifically addressed to voters using accessible devices, including sip-and-puff, and must clearly communicate the unavailability of the dual switches and allow enough sessions for the voters to get used to the sip-and-puff device for use on Election Day.

H. The USB port used for attaching the sip-and-puff device must be sealed with a tamper evident seal and must be opened for any session needed and then resealed after the session. Poll worker training must include details around how to manage the device securely during Election Day.

I. Jurisdictions implementing ClearVote 2.5 must implement the use of privacy sleeves to be used by voters carrying marked ballots between the ClearAccess and ClearMark ballot marking devices and ClearCast and ClearCast Go precinct scanners. Poll worker training must emphasize the need for helping voters without violating their privacy. This must include but not be limited to having standard instructions for poll workers to use to guide a voter in casting their own ballot, or narrating the poll worker's actions, so that the voter understands what the poll worker is doing.

J. The ClearAccess and ClearMark printers allow the ballot stock to be secured inside the printer tray if it is less than 22 inches long. If the ballots are longer than 22 inches, ample care must be taken to make sure that the voter education materials instruct voters on how to insert ballot stock into the printer. Poll worker training must include sessions on identifying issues surrounding the insertion of the ballot and getting the printouts, without violating the privacy of the voter.

K. Lexmark MS521dn printer is not certified for use with for Elo-E and Elo-X configurations of ClearAccess as noted in the Observation section of this document.

L. ClearVote 2.5 is a paper-based system, and hence, implementation of the system for precinct or central count scanning is scalable. Jurisdictions must calculate the

number of voting booths and the number of ballots necessary to accommodate the number of registered voters in a precinct to avoid long lines. Jurisdictions must include the ClearAccess or ClearMark as an ADA compliant device in configuring a precinct polling place. Jurisdictions must also take into consideration scanning speed and ballot box and transport media capacities of polling place components when deciding on the number of voting booths. For ClearCast and ClearCast Go, ballot box capacity, jurisdictions can refer to the operator's guide from Clear Ballot.

M. All jurisdictions implementing ClearVote 2.5 must implement administrative safeguards and proper chain of custody, and document the same, to facilitate the safety and security of electronic systems pursuant to the Guidance on Electronic Voting System Preparation and Security, October 2020, and any subsequent revisions or directives.

N. Jurisdictions implementing ClearVote 2.5 with the Central Count Tabulator as the primary system, where votes are counted only at the central counting location using central scanners, must comply with Section 301(a) of Help America Vote Act of 2002. The mandate requires counties using central count paper-based systems to develop voting system specific voter education programs that inform voters of the effect of over voting and instruct voters on how to correct a ballot before it is cast, including instructions on obtaining a replacement ballot. Additionally, the mandate requires that the central count voting system must be designed to preserve voter confidentiality.

O. All jurisdictions implementing ClearVote 2.5 must ensure that no default passwords are used on any devices and that all passwords are complex and secured. Counties must implement an audit process to review and ensure that no default passwords are used upon equipment install/reinstall and routinely change passwords (at least once prior to preparing for each primary and election) to avoid the possibility of any password compromise. The passwords and permissions management must at a minimum comply with the password requirements outlined in NIST 800-63. This publication can be accessed at https://pages.nist.gov/800-63-3/.

P. Jurisdictions implementing ClearVote 2.5 must ensure strict adherence to strong physical and administrative controls with respect to servers. It is imperative that root passwords (OS and database) are protected and only given to those in roles with a need to know. Jurisdictions must ensure proper operating system account creation based on roles and limit it to the minimum required access required to perform the assigned responsibility.

Q. Jurisdictions implementing Clear Vote 2.5 must ensure implementation of a predetermined backup and recovery strategy for DesignServer data assets.

R. Jurisdictions must protect installations of the Clear Design and Clear Count on portable devices and must protect the laptops to prevent lost or stolen devices.

S. All jurisdictions implementing ClearVote 2.5 must configure the polling place components of the voting system to notify voters when they attempt to cast overvotes. This is to ensure that the system implementation adheres to the requirement of notifying the voter of overvotes as mandated by 25 P.S. § 3031.7(16).

T. All jurisdictions implementing ClearVote 2.5 must work with Clear Ballot to ensure that only the certified system configuration is installed both on first purchase, as well as any time a system component is replaced or upgraded. Jurisdictions must as part of their user acceptance test verify the implementation to ensure that the components, software, and firmware belong to the certified system. Jurisdictions must also perform a trusted build validation as part of the election preparation activities and post-election canvass activities utilizing the vendor supplied methods of validation and verification of voting system integrity. Any time the system is installed after the first purchase or an upgrade is completed, the vendor and the county must complete the implementation attestation and must make a copy available to the Secretary on request. A sample format that can be used for the attestation is included as Attachment C to this document.

U. Clear Ballot must work with the jurisdictions implementing ClearVote 2.5 to ensure that the system has been hardened for a secure implementation. Jurisdictions must implement processes to ensure that all components of the voting system have been hardened per the instructions in the TDP.

V. Jurisdictions can make use of the ClearCount adjudication functionality to adjudicate write-ins and evaluate questionable ballots, contests, or selections to determine voter intent. Any decisions made during the adjudication process must be agreed upon by a team of at least two reviewers authorized by the election official following Election Code requirements. The election official must, when necessary, consult the paper ballot to assist with determinations made during adjudication. In the event of a recount, the voter verifiable paper ballots must be used for the count.

W. Jurisdictions implementing ClearVote 2.5 must work with Clear Ballot to ensure that the implemented configuration is capable of operating for a period of at least two hours on backup power as required by the VVSG. If the system components don't include internal battery packs for reliable power, the Uninterruptible Power Supply (UPS) specified in the EAC certified configuration must be purchased and used at the polling places.

X. Jurisdictions using the services of Clear Ballot or a third-party vendor for election preparation activities must work with Clear Ballot or the vendor to ensure that systems used for ballot definition activities are considered part of the voting system, and they must use certified voting system components. The systems used for ballot definition must be configured securely following conditions outlined in this report and following any applicable Directives and Guidance issued by the Secretary. Any data transfer between the vendor and county must be done using encrypted physical media or a secure file transfer process. The file transfer and download must be tracked and audited to make sure that data has not been accessed by unauthorized personnel.

Y. BMD Condition - Jurisdictions implementing ClearAccess and ClearMark ballot marking devices must ensure that the configuration allows voters to review their vote selections on the screen and on the marked paper ballot before it is cast.

Z. Clear Ballot must ensure that any implementations in Pennsylvania counties must appropriately indicate that the ClearAccess and ClearMark ballot marking devices are printing the ballot and the final messaging on the ballot marking device must instruct the voter on how to complete the voting process. Any references to "casting the ballot" must not be present. The changes must be done during implementation by Clear Ballot support personnel and verified by county election officials.

AA. Jurisdictions must have appropriate instructions on the ClearAccess and ClearMark ballot marking devices to ensure that the voter reviews the entire ballot before printing the ballot.

BB. Jurisdictions must work with Clear Ballot to ensure that the entire audio ballot including audio rates and volumes on the audio ballot are tested before deploying to polling places. Jurisdictions must also ensure that poll worker training includes potential situations and questions from voters using the audio ballot.

CC. Jurisdictions must work with Clear Ballot during the ballot definition to ensure that voters using assistive devices have clear instructions for the write-in process. The onscreen instructions must be adjusted to have the audio ballot explain the process. The audio instructions must include instructions on how to navigate and find the write-in keyboard.

DD. Jurisdictions must work with Clear Ballot to thoroughly test and review audio ballot instructions to ensure that the voters using an audio ballot can cast the ballot without requesting assistance. Jurisdictions must consider the following while reviewing the ballot:

i. The audio ballot must fully inform the voter what has happened and is occurring, and how to select/deselect their choices;

ii. The feedback messages must explain to voters what is happening, including the number and names of candidates being deselected;

iii. The audio ballot must provide feedback on the reason for the changes in any selections; and

iv. The audio ballot instructions regarding messages on the system must communicate the specific information for the task or screen displayed before the general, repeated instructions.

EE. Jurisdictions implementing ClearVote 2.5 must include poll worker training as part of the implementation plan. The training must include hands-on practice for poll workers. Poll workers must be provided with instructions on how to offer support to help voters get started with (or re-familiarize themselves with) the key layout of the devices and functions as necessary. Follow-on training for replacement poll workers, and refresher training must also be considered. Specific consideration must be given to voters using assistive devices and also poll worker education to assist voters with disabilities. Refer to Attachment B, listing detailed recommendations for deployment noted by the Accessibility Examiner.

FF. Jurisdictions implementing ClearVote 2.5 must include voter training as part of the implementation plan. The training must include hands-on practice for voters. As part of voter education and outreach efforts, specific consideration must be given to

voters using assistive devices. These voters must be provided with the opportunity to use the system tactile keypad in advance of election day so that the voters will know how to use the system effectively.

GG. Jurisdictions must implement ClearAccess and ClearMark ballot marking devices in such a way to ensure that only one contest is displayed per screen.

HH. Jurisdictions implementing ClearVote 2.5 must consider the following during voting booth set up for serving voters requiring assistive devices:

i. A table or stand for voters using the tactile keypad who do not use wheelchairs with trays that can hold the keypad to relieve fatigue and make it easier to use with both hands.

ii. Voters with disabilities may have assistive technology or personal notes that they need to be placed within reach. They may also need room to place the printed ballot on a flat surface to use personal technology such as magnifiers or text readers to verify it.

iii. For the BMD and configured as a marker where the voter has to complete the voting process by scanning the ballot on a precinct scanner, the path to the scanner should be as easy as possible, ideally a straight line with no obstructions. The path should include ample room to turn and maneuver a wheelchair if the machine is positioned with the screen facing the wall. The ADA standards suggest a minimum of 60 x 60 inches for this. Refer to Appendix B, listing detailed recommendations for deployment noted by the Accessibility Examiner.

II. The electronic voting system must be physically secured and protected while in transit, storage, and while in use at their respective locations. Unmonitored physical access to devices can lead to compromise, tampering, and/or planned attacks. Pennsylvania counties using ClearVote 2.5 must comply with the Directive Concerning Access to Electronic Voting Systems, including but not limited to the Imaging of Software and Memory Files, Access to Related Internal Components, and the Consequences to County Boards of Allowing Such Access issued by the Secretary of the Commonwealth on July 8, 2021, any subsequent revisions of the Directive, and any other applicable directives currently in effect or issued in the future.

JJ. Jurisdictions must implement processes and procedures involving management, monitoring and verification of seals, locks/keys, and other access methods, before, during and after the election.

KK. Jurisdictions must seal any unused ports on the voting system components using tamper evident seals even if the port is inside a locked compartment. Jurisdictions must work with Clear Ballot and use physical port blocking plugs to close unused ports whenever possible before placing the tamper evident seal. The Department also recommends using port blocking plugs for exposed ports for components of the voting system housed in county office which can be removed by authorized personnel when the port is needed.

LL. Jurisdictions must implement processes to gather and safekeep system logs for each component of the voting system after each election. Consistent auditing of

system logs and reports is vital to maintain system transparency and to ensure that any compromise or malfunction is observed, reported and resolved in a timely manner.

MM. Jurisdictions implementing ClearVote 2.5 must ensure that the USB devices and any other removable media used for election activities are maintained with strict chains of custody. There must be a process to manage the removable media inventory to avoid misplaced and lost media. The devices must be reformatted before use in each election. Appropriate steps must be taken to ensure that the format is a full reformat of the USB devices. Jurisdictions implementing ClearVote 2.5 must implement policy and procedures to ensure the use of ONLY approved, designated, and clearly marked USB's for use in any component of the system. The system is heavily dependent on USB for intra-component transfer of data assets.

NN. Jurisdictions implementing ClearVote 2.5 must work with Clear Ballot to ensure that appropriate levels of training for election officials are planned and undertaken on implementation. Counties must ensure that training adheres to the "Minimum Training Requirements" specified in Attachment D of this document.

OO. Clear Ballot must submit the following system education materials to the Department of State and must consent to the publication and use of the video on any websites hosted by any Pennsylvania counties and the Pennsylvania Secretary of the Commonwealth, or any publicly available social media platform. The videos must be closed captioned for the hearing impaired.

i. A video (in an electronic format) for voters that demonstrates how to cast a vote and ballot using the Voting System.

ii. A video (in an electronic format) for precinct election officials that demonstrates how to setup, operate, and shutdown the Voting System components on an Election Day. The video must demonstrate how to set up and operate the voting system accessible devices for use by voters.

iii. A "quick reference guide" for precinct election officials to consult on Election Day. The guide must be specific to the purchasing county's setup and use of the Voting System, including accessible options.

iv. A "quick reference guide" with images that demonstrates to voters how to cast a vote. This must be provided in additional languages for any jurisdictions required to meet language thresholds requirements of the Voting Rights Act.

PP. Clear Ballot must adhere to the following reporting requirements and submit the following to the Secretary:

i. Equipment Reporting. Reported field issues or anomalies that occur in Pennsylvania or elsewhere with any piece of equipment deployed in the Commonwealth of Pennsylvania within 3 days of the occurrence;

ii. Advisory Notices. System advisory notices issued for any piece of equipment deployed in the Commonwealth of Pennsylvania regardless of whether the incident behind the notice occurred in Pennsylvania or elsewhere;

iii. Ownership, Financing, Employees, Hosting Location. Any changes to information on the Supplier's employees and affiliates, locations, company size and ability to provide technical support simultaneously to several counties in the Commonwealth of Pennsylvania and other jurisdictions that use its Voting System. Additionally, Clear Ballot must provide information on foreign ownership/financing, data hosting, and production for any equipment or ancillary products, including any potential conflict of interest that may have developed for employees and affiliates;

iv. Security Measures and any updated security testing or risk/vulnerability assessments conducted by the Supplier or a third-party.

QQ. Clear Ballot must adhere to the "Source Code and Escrow Items Obligations" specified in Attachment F of this document.

RR. Clear Ballot must work with jurisdictions to ensure that the system is configured to comply with all applicable requirements of the Pennsylvania Election Code delineated in Section Article XI-A of the Pennsylvania Election Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 – 3031.22.

SS. Jurisdictions implementing ClearVote 2.5 and Clear Ballot must work together to implement the system under this certification and must comply with the conditions found in this report, and any directives issued by the Secretary of the Commonwealth regarding the use of this System, in accordance with Section 1105-A(a)-(b) of the Election Code, 25 P.S. § 303l.5(a)-(b). Clear Ballot must ensure that future releases of the voting system with enhanced security and accessibility features are presented for approval to the Secretary.

TT. Clear Ballot must work with counties and the Department of State to ensure that the system can integrate with Pennsylvania Department of State's Election Night Reporting (ENR) system.

UU. Pursuant to the Directive on Electronic Voting Systems issued by the Secretary of the Commonwealth on August 8, 2006, the Directive Concerning the Use, Implementation and Operation of Electronic Voting Systems by the County Boards of Elections issued on June 9, 2011, and Section 1105-A(d) of the Pennsylvania Election Code, 25 P.S. § 3031.5(d), this certification and approval is valid only for ClearVote 2.5. If the vendor or a County Board of Elections makes any changes to the ClearVote 2.5 Voting System after the date of its examination, it must immediately notify both the Pennsylvania Department of State and the relevant federal testing authority or laboratory, or their successors. Failure to do so may result in the decertification of the ClearVote 2.5 Voting System in the Commonwealth of Pennsylvania.

VV. Clear Ballot must work with counties and Department of State to ensure that the counties are trained on generating the reports from ClearCount required for results certification audits.

WW. Jurisdictions implementing ClearVote 2.5 must ensure that personnel responsible for secure operations of the system components need to be familiar with the entire technical data package. Security topics are found in different sections of the TDP.

XX. ClearBallot must ensure that the COTS printers used for ClearAccess and ClearMark must be configured to ensure that the printer settings cannot be changed by the voter at the polling place. The configuration must ensure that the printer settings can only be modified by authorized personnel.

The Secretary's certification for ClearVote 2.5 is predicated on the EAC final certification decision dated 11/19/2025. The final EAC certification report is appended to this certification report as Attachment A.

VIII. Recommendations

A. All jurisdictions implementing ClearVote 2.5 should take appropriate steps to ensure that voter education is part of the implementation plan.
B. All jurisdictions implementing ClearVote 2.5 should ensure that precinct election officials and poll workers receive appropriate training and are comfortable using the system.
C. All jurisdictions considering purchasing the ClearVote 2.5 voting system should review the System Limitations as mentioned in the EAC certification scope added as Attachment A to this report.
D. The Secretary recommends that Clear Ballot and counties work with the Department on any changes to their voting equipment including, but not limited to, purchase and upgrades.
E. The Secretary recommends in-house ballot definition activities at county location whenever possible. If an external vendor location is used the county should implement checks and balances to ensure that election data including ballot definition files and audit logs stored on devices outside of the county is protected from unauthorized access.
F. The Secretary recommends configuring the election with only one contest being displayed on each screen presented to the voter on the ClearAccess and ClearMark ballot marking devices. This is to ensure that all screens presented to the voter are similar and voters don't need to adapt to situations where there may be multiple contests displayed on a screen.

IX. Conclusion

As a result of the examination, and after consultation with the Department's staff and the Examiners, the Secretary of the Commonwealth concludes that ClearVote 2.5 can be safely used by voters at elections as provided in the Pennsylvania Election Code and meets all of the requirements set forth in the Code, provided the voting system is implemented with the conditions listed in Section IV of this report. Accordingly, the Secretary certifies ClearVote 2.5 for use in this Commonwealth.

X. Attachment A – EAC Certification Scope

ClearVote 2.5
Certificate and Scope

United States Election Assistance Commission

Certificate of Conformance

Clear Ballot ClearVote 2.5

VVSG 2005 VER. I

EAC CERTIFIED

The voting system identified on this certificate has been evaluated at an accredited voting system testing laboratory for conformance to the *Voluntary Voting System Guidelines Version 1.0 (VVSG 1.0)* . Components evaluated for this certification are detailed in the attached Scope of Certification document. This certificate applies only to the specific version and release of the product in its evaluated configuration. The evaluation has been verified by the EAC in accordance with the provisions of the EAC *Voting System Testing and Certification Program Manual* and the conclusions of the testing laboratory in the test report are consistent with the evidence adduced. This certificate is not an endorsement of the product by any agency of the U.S. Government and no warranty of the product is either expressed or implied.

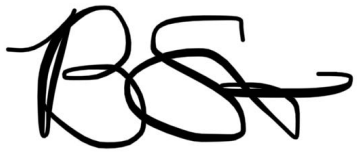
Product Name: ClearVote

Model or Version: 2.5

Name of VSTL: Pro V&V

EAC Certification Number: CBG-CV-25

Date Issued: 11/19/25



Brianna Schletz, Executive Director

Scope of Certification Attached

Scope of Certification

Manufacturer: *Clear Ballot Group*
System Name: *ClearVote 2.5*
Certificate: *CBG-CV-25*
Laboratory: *Pro V&V*
Standard: *VVSG 1.0*
Date: *November 19, 2025*

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Introduction

This document describes the scope of the validation and certification of Clear Ballot Group's ClearVote 2.5. Any use, configuration changes, revision changes, additions or subtractions from the described system are not included in this evaluation.

Significance of EAC Certification

An EAC certification is an official recognition that a voting system (in a specific configuration or configurations) has been tested to and has met an identified set of Federal voting system standards. An EAC certification is not:

- An endorsement of a Manufacturer, voting system, or any of the system's components.
- A Federal warranty of the voting system or any of its components.
- A determination that a voting system, when fielded, will be operated in a manner that meets all HAVA requirements.
- A substitute for State or local certification and testing.
- A determination that the system is ready for use in an election.
- A determination that any component of a certified system is certified for use outside the certified configuration.

Representation of EAC Certification

Manufacturers may not represent or imply that a voting system is certified unless they have received a Certificate of Conformance for that system. Statements regarding EAC certification in brochures, on websites, on displays, and in advertising/sales literature must be made solely in reference to specific systems. Any action by a Manufacturer to suggest EAC endorsement of its product or organization is strictly prohibited and may result in a Manufacturer's suspension or other action pursuant to Federal civil and criminal law.

System Overview

This system is a modification of the Clear Ballot ClearVote 2.3 Voting System, previously certified by the EAC. The Clear Ballot ClearVote 2.5 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 election reporting), ClearCast (precinct count and tabulation), ClearAccess (accessible voting and ballot marking device), and ClearMark (accessible voting and ballot marking device).www.eac.gov

Components Included:

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 the components and generation of voting machine election definition file packages 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 Ubuntu with the ClearDesign software and hosting the election database.
- DesignStation(s): One or more laptops or desktops running Windows used to connect to the DesignServer. A browser is used to perform the necessary tasks. A user with administrative rights can define users and manage the elections.
- Network Switch: Used to connect DesignStations to the DesignServer using a wired, closed Ethernet-based network.

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 running on an Ubuntu Linux operating system, with Ethernet connections to workstations running the Windows operating system consists of the physical components listed below. All the components are unmodified COTS that are connected via a wired, closed, and isolated network not connected to any other systems or the Internet.

- CountServer: An Ubuntu Linux 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 Windows laptop or desktop/scanner pairs used to scan and tabulate ballots.
- Network Switch: Used to connect the ScanStations to the CountServer using a wired, closed Ethernet.
- CountStation(s): One or more Windows laptop or desktop computers installed with browser software, linked by a wired Ethernet connection to the CountServer using the network switch. This station can serve multiple uses: user administration, election administration, adjudication, and reporting.

This station is also used to consolidate vote totals and ballot images from the ClearCast precinct tabulator. Vote totals and ballot images are consolidated by the ClearCount Software via the ClearCast USB drive.

All files that make up the ClearCount software reside on a single CountServer that is shared by all client ScanStations. The Tabulator software is executed by the ScanStations at run-time from files that reside on the CountServer. The only software programs that must be installed on ScanStations, apart from the Windows operating system, are the Fujitsu PaperStream Capture 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 CountServer, and an instance of Tabulator runs on each ScanStation. The Tabulator counts the ballots and adjudicates the vote for the ballots scanned on that ScanStation. Upon completion of a batch of ballots, the Tabulator application sends its results and the associated card images to the central election database on the CountServer.
- Election Database: A centralized election database that resides on the CountServer and collects the output of each Tabulator.
- Election Reports: A suite of reports that provides election results and analysis and allows election officials to review individual ballot images.
- Card Resolutions tool: A web application that allows election officials to review and appropriately resolve unreadable voted ballots. It also allows manual adjudication of automatically adjudicated ballots where officials determine changes need to be made to reflect voter intent.
- User and Election Database Management through web 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, merge ClearCast election results, and backup or restore an election.

ClearCast and ClearCast Go

The ClearCast and ClearCast Go tabulators are precinct count ballot scanning solutions suitable for early and election day in-person voting, including processing ballots printed by the ClearAccess and ClearMark accessible ballot marking devices. The ClearCast application runs on the precinct count-based tabulator, and is used to scan, count and tally marked ballots. Its functionality is divided into three essential modes, Election Mode (Early Voting and/or Election Day), which is used to process voter cast ballots, Pre-Election Mode, this occurs prior to Election Mode,

and is used to test all system functionality prior to the start of the election, and Post-Election Mode, which is used to perform administrative functions following the close of the election.

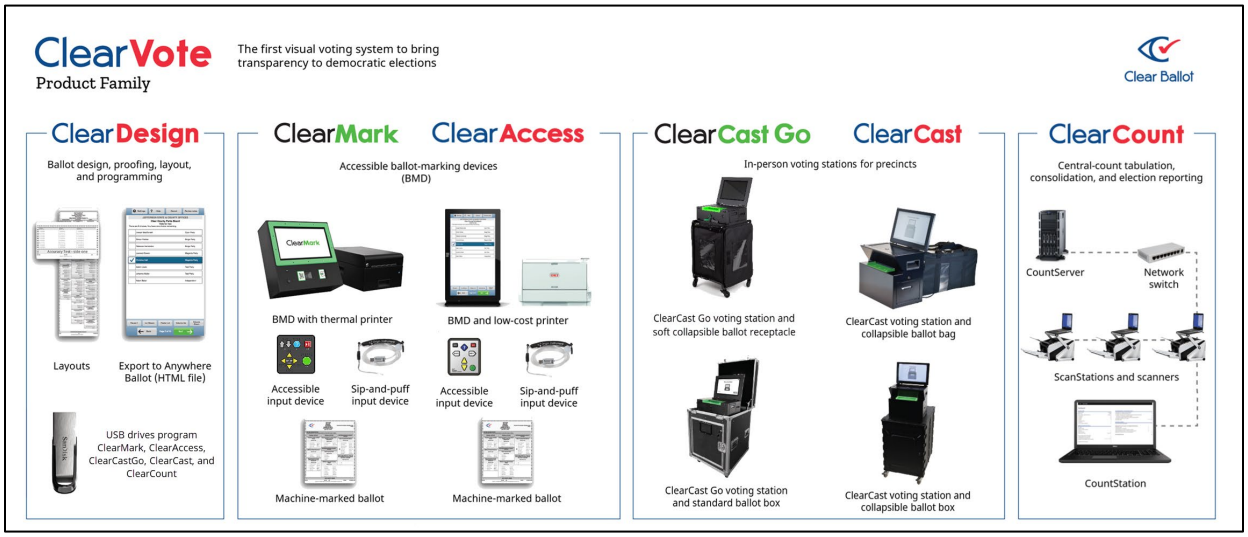
ClearAccess

ClearAccess is an accessible touchscreen ballot marking device (BMD) used for the creation of paper ballots that can be scanned and tabulated by ClearCast or ClearCount. The ClearAccess components of the ClearVote voting system consist of computers combined with personal assistive devices, printers, and uninterruptible power supplies to form a ballot marking device.

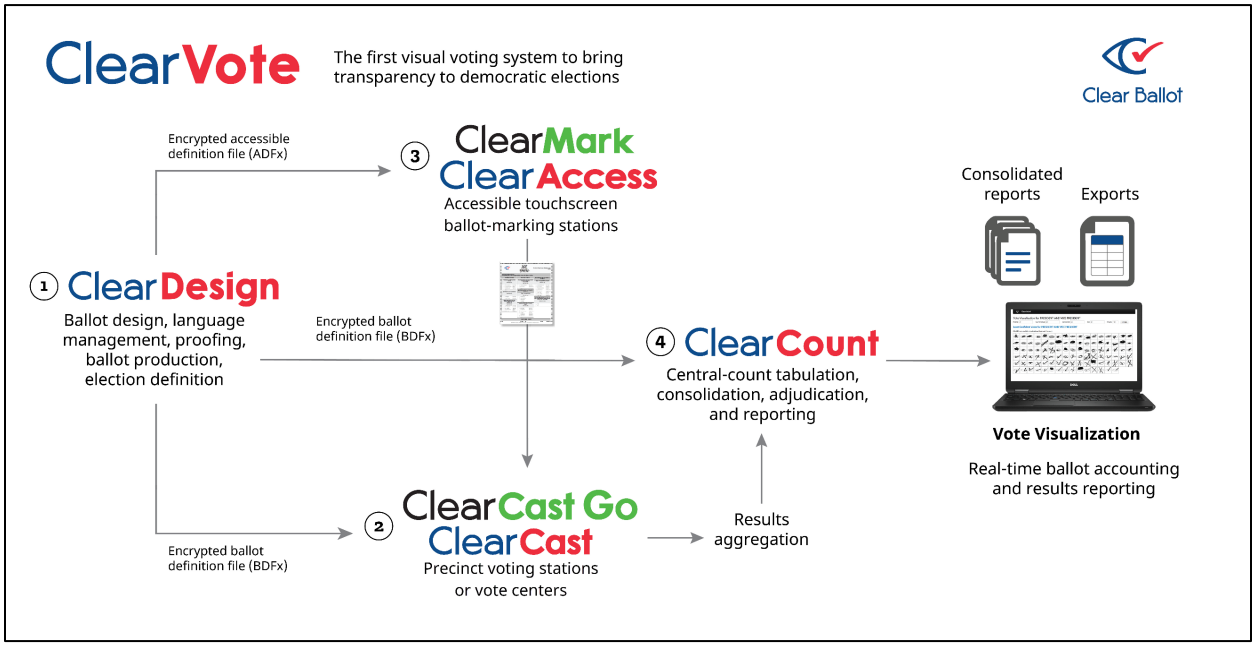
ClearMark

ClearMark is an accessible touchscreen ballot marking device (BMD) used for the creation of paper ballots that can be scanned and tabulated by ClearCast or ClearCount. The ClearMark components of the ClearVote voting system consist of computers combined with personal assistive devices, printers, and uninterruptible power supplies to form a ballot marking device.

System Diagrams



System Components



System Component Relationship

List of Modifications

The submitted modifications include the following changes from version 2.3 to 2.5.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-11928	Ballot Tabulator	Enables ClearCount to properly tabulate a card that only has contests on the back side.
SW-10691	ClearAccess, ClearCast	Minor version update to the libssl and openssl libraries
SW-10690	ClearAccess, ClearDesign	Updated the ADF to account for the new page number macros introduced in this release.
SW-11531	ClearCast	The ClearCast results reports now include a party breakdown rather than aggregating all the votes for a candidate into one number.
SW-11604	ClearCast	Updated OpenSSL1.0 version to 1.0.2n-1ubuntu5.8 and OpenSSL1.1 version to 1.1.1f-1ubuntu2.12 to address CVE-2022-0778.
SW-11655	ClearCast	Users can now log in with the poll worker password after the ClearCast unit is restarted. Previously, a user would have to log in with the election administrator password before the poll worker login was enabled.
SW-11694	ClearCast	ClearCast would occasionally fail to start the application in Chrome kiosk mode and instead show the Ubuntu login screen. The system now detects when this occurs and restarts the browser if the application does not start successfully.
SW-12422	ClearCast	Each ClearCast unit has a unique public/private key pair used for digitally signing ballot images and Cast Vote Records.
SW-12423	ClearCast	The public key fingerprint of the ClearCast unit is printed on all result reports and the Power On report.
SW-12425	ClearCast	The election_state.txt file now stores the public key value corresponding to each private key that is used to sign election data.
SW-12467	ClearCast	The voting_sigs.txt file now includes the digital signature of the archive.tar file.
SW-12648	ClearCast	"Active Directory" value added to the Election Management screen, and metadata inconsistency errors no longer halt normal operation.
SW-13207	ClearCast	ClearCast now attempts to detect a hard shutdown which may occur due to an application failure, holding down the power button, or power failure and logs a message in the system log to aid in troubleshooting.
SW-14397	ClearCast	Adds 'Protected Card Count' to the vote and administrative screens.
SW-8167	ClearCast	The ClearCast code has been updated to Python 3.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-9523	ClearCast	Changing the time zone setting in ClearCast now also updates the current time accordingly.
SW-9689	ClearCast	A ballot that belongs to a ballot set which is not associated with a specific vote center category in ClearDesign under the "paper scanner" settings will not be accepted by ClearCast when configured for those vote centers.
SW-12417	ClearCast, ClearCount	All Cast Vote Records produced by ClearCast are digitally signed with a private key.
SW-12418	ClearCast, ClearCount	All ballot images produced by ClearCast are digitally signed with a private key.
SW-11624	ClearCast, ClearDesign	If a voter votes for a cross-endorsed candidate more than once, they can be notified upon inserting their ballot into ClearCast that only the first instance will count, allowing a user to take their ballot back and adjust their vote if desired. ClearDesign has an option to configure whether to warn on double vote for the paper scanner and the ability to set the wording of the double vote warning.
SW-13208	ClearCast, ClearMark	The ClearCast Go operating system has been upgraded to Ubuntu 20.04.6.
SW-10118	ClearCount	Add support to export card images filtered by contests, precinct, counter groups, boxes, and voting conditions (overvoted, undervote, write-ins).
SW-10222	ClearCount	On the Election Administration page, the Redact Small Vote Subtotals column will no longer default to hidden.
SW-10224	ClearCount	Creating an election with no parser row in the metadata.csv no longer defaults to "Premier". Instead, an error is thrown stating the field is missing and required.
SW-10432	ClearCount	Improve the positioning of the green line used to show what contest is being adjudicated in the Resolver.
SW-10663	ClearCount	Added the Statement of Votes Cast with Parties to the reports menu.
SW-10733	ClearCount	Previously the 'whole' precinct record was record with the minimum BallotStyleID and now it is the precinct with BallotStyleID equal to 0.
SW-11261	ClearCount	Added "Precinct" Localization to BDFExport metadata. Allows Localization to be uploaded to ClearCount when creating an Election under Election Administration.
SW-11391	ClearCount	Add support for displaying ClearDesign landscape ballots in the proper orientation.
SW-11605	ClearCount	Updated OpenSSL1.0 version to 1.0.2n-1ubuntu5.8 and OpenSSL1.1 version to 1.1.1f-1ubuntu2.12 to address CVE-2022-0778.
SW-11640	ClearCount	Changed the ClearCount API to require authentication before uploading files (such as ballot images and tabulation results) to the server.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-11641	ClearCount	Removed dead code related to encrypted backups.
SW-11911	ClearCount	Enables ClearCount to properly tabulate a card that only has contests on the back side.
SW-11921	ClearCount	Previously, doing a "Safely merge updateable BDF content" operation would create an additional "Invalid" candidate name in the Write-in Assignments Tool for each contest that has write-in choices. There is now only one "Invalid" entry in the candidate names regardless of whether a safe merge has been performed.
SW-11925	ClearCount	Updated OpenSSL1.0 version to 1.0.2n-1ubuntu5.9 and OpenSSL1.1 version to 1.1.1f-1ubuntu2.13 to address https://ubuntu.com/security/notices/USN-5402-1.
SW-12213	ClearCount	Installer now prompts for and sets the grub username and password
SW-12244	ClearCount	Previously the OpenSSL command line utility was used to check the expiry date on the SSL certificate. Now the check is done using the OpenSSL shared library.
SW-12247	ClearCount	Previously, for performance reasons, the 'find' utility was used to find files, such as election backups, and ballot images. Now an equally efficient internal function has been created to 'find' the files.
SW-12253	ClearCount	Data exported into CSV format (for example, cast vote records) now has double quotes around all strings to guard against SQL injection.
SW-12290	ClearCount	Users logged into the Ubuntu operating system on the CountServer are logged out automatically after 5 minutes of inactivity.
SW-12303	ClearCount	Previous versions incorrectly created summary counts for ballots where the card style could be determined but not the precinct. This version only creates counters when both the card style and precinct id are valid.
SW-12466	ClearCount	Added functionality to detect whether system logging is running and to display an error message if it has been disabled.
SW-13211	ClearCount	The ClearCount operating system has been upgraded to Ubuntu 20.04.5.
SW-13520	ClearCount	Increase the maximum length of ballot supported for scanning from 28 to 30 inches
SW-7916	ClearCount	The SOVC by Choice report no longer includes withdrawn candidates.
SW-8070	ClearCount	The CountStation operating system has been upgraded to Windows 10 IoT Enterprise LTSC 2021.
SW-8071	ClearCount	The ScanStation operating system has been upgraded to Windows 10 IoT Enterprise LTSC 2021.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-8166	ClearCount	The ClearCount code has been updated to Python 3.
SW-9194	ClearCount	"Show Party Subtotals" option should only show for a closed primary/semi-closed. These are elections with more than one party associated with it.
SW-10336	ClearDesign	Fixed a bug preventing the accurate display of non-Latin characters on the digital ballot.
SW-10639	ClearDesign	Added "Precinct" Localization to BDFExport metadata. Allows Localization to be uploaded to ClearCount when creating an Election under Election Administration.
SW-10700	ClearDesign	This release implements the New York Grid Style Ballot layout.
SW-11184	ClearDesign	During a ClearAccess voting session, if a voter votes for a cross-endorsed candidate more than once, they will be notified that only the first instance will count. This warning is always enabled for ClearMark.
SW-11342	ClearDesign	Changed the behavior for the 'float' language option so that each language only uses the space required rather than each language being allocated the same width.
SW-11606	ClearDesign	Updated OpenSSL1.0 version to 1.0.2n-1ubuntu5.8 and OpenSSL1.1 version to 1.1.1f-1ubuntu2.12 to address CVE-2022-0778.
SW-11661	ClearDesign	Updated system configuration for the CIS SCAP Ubuntu 20.04 revision 1.1.0 profile.
SW-11816	ClearDesign	A unique smart card customer key is now generated when a customer is created in ClearDesign, or when a customer that did not previously have a smart card key is upgraded from a previous version.
SW-11817	ClearDesign	A unique smart card election key is now generated when an election is created in ClearDesign, or when an election that did not previously have a smart card key is upgraded from a previous version.
SW-11819	ClearDesign	The ADFx has been modified to contain the smart card customer and election keys.
SW-11820	ClearDesign	The smart card election key can be regenerated for the Accessible Marker device.
SW-11927	ClearDesign	Updated OpenSSL1.0 version to 1.0.2n-1ubuntu5.9 and OpenSSL1.1 version to 1.1.1f-1ubuntu2.13 to address https://ubuntu.com/security/notices/USN-5402-1
SW-12214	ClearDesign	The username and password for the grub boot loader are now set during the installation of the system, when the install-setup script is run.
SW-13204	ClearDesign	Fix issue with not displaying the party separator '.' between parties when multiple parties endorse a choice.
SW-13210	ClearDesign	The ClearDesign operating system has been upgraded to Ubuntu 20.04.5.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-13263	ClearDesign	Resolves an issue that could cause HTML ballots to not layout properly due to the VoterGroupID not being set properly.
SW-8069	ClearDesign	The DesignStation operating system has been upgraded to Windows 10 IoT Enterprise LTSC 2021.
SW-8168	ClearDesign	The ClearDesign code has been updated to Python 3.
SW-10177	ClearDesign, ClearMark	Fixes an issue that caused elements of the touchscreen to be accidentally double-clicked by voters.
SW-10460	ClearDesign, ClearMark	Support new key mappings specific to ClearMark keypad.
SW-10560	ClearDesign, ClearMark	Instructional text bugfix for sip-and-puff input device.
SW-11108	ClearDesign, ClearMark, ClearAccess	Fixed issue with not displaying contests if there were contests for only one partisan party and no nonpartisan contests on the ballot in an open primary election.
SW-10353	ClearMark	Sets the default screen orientation for ClearMark to portrait mode.
SW-10840	ClearMark	Added support for the Lexmark MS520 Series.
SW-11062	ClearMark	Added a "Save System Info" feature to ClearMark which enables export of system logs and other troubleshooting information.
SW-11133	ClearMark	Added feature for a voter to be able to initiate a voting session with a smart card.
SW-11134	ClearMark	Added feature for a poll worker to be able to activate a smart card for a voter to use in ClearMark.
SW-11135	ClearMark	Added feature for an administrator to initialize a blank smart card, enabling its use by that jurisdiction for session activation.
SW-11136	ClearMark	Simplified the payload for barcodes used to select a ballot style in ClearMark to make the resulting QR code easier to read.
SW-11487	ClearMark	Change version of ADF to support grid style ballots.
SW-11598	ClearMark	Updated OpenSSL1.0 version to 1.0.2n-1ubuntu5.8 and OpenSSL1.1 version to 1.1.1f-1ubuntu2.12 to address CVE-2022-0778.
SW-8164	ClearMark	The ClearMark code has been updated to Python 3.
SW-9892	ClearMark	The ClearAccess software was ported to run on Ubuntu for ClearMark.
SW-11930	ClearVote	Upgraded to use Windows Enterprise IoT 21H2 release.
SW-10275	ClearAccess	When the user opens an election, if there are more than 1000 logs in the system log, the system log will

Unique ID	Component	Description of Fix/Modification/Enhancement
		now be automatically rolled to a new log to prevent performance issues.
SW-14573	ClearAccess	Exported csv files now have double quotes around all strings.
SW-14711	ClearAccess	Allows for Windows IoT OS to run on all required versions of ClearAccess hardware.
SW-14825	ClearAccess	Updates hardening scripts to more thoroughly protect software and OS.
SW-14888	ClearAccess	Resolves an issue that caused a timeout when using the "Save System Info" feature as a maintenance user
SW-14993	ClearAccess	Provides more specificity of which ClearAccess build/version number is being used.
SW-14572	ClearAccess, ClearMark	Resolves an issue that caused an extra column in the CSV when exporting logs.
SW-14830	ClearAccess, ClearMark	Updates battery status indicators/messaging to remove confusion that could result from some hardware configurations.
SW-13575	ClearAccess, PrintNow	Updates the ClearAccess software to allow it to run on all needed hardware configurations and associated operating systems.
SW-11841	ClearCast	Resolves error that resulted from a System Admin attempting to validate an election.
SW-12469	ClearCast	Creates an interface for regenerating private keys when an election is not loaded in ClearCast.
SW-13388	ClearCast	Resolves an issue that could cause ClearCast to not properly delete an election
SW-13526	ClearCast	Resolves an issue that would let FolderScanner continue to scan ballots even after the USB stick is full.
SW-14639	ClearCast	ClearCast database upgraded to MySQL 8.
SW-14831	ClearCast	Updates older versions of ClearCast to be compatible with changes made to other ClearVote components.
SW-14929	ClearCast	This allows ClearCast to scan and tabulate a paper ballot with a RCV contest, provide warnings to the voter for the RCV contest, and store the tabulated ballot on a USB stick that will be loaded into ClearCount.
SW-14930	ClearCast	This allows an election worker to generate reports in ClearCast that include RCV contests as well as a RCV-specific contest report that shows rank data.
SW-15441	ClearCast	Adds a total count of duplicate/double votes to each rank in the RCV contest report on ClearCast.
SW-9597	ClearCast	Updates logging to record any time that a low battery warning is presented.
SW-14241	ClearCast, ClearCount, ClearDesign, ClearMark	ClearCount, ClearMark and ClearCast are now compatible with BDFs and ADFs that include RCV contest and ruleset data.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-14471	ClearCast, ClearCount, ClearMark	Updated ballot tabulation functionality in ClearCount, ClearCast, and ClearMark to be able to adjudicate ranked-choice contests.
SW-13877	ClearCast, ClearMark	Expands the ClearMark hardware offering to include a tabletop variation.
COTS-192	ClearCount	Ricoh fi-7600 scanner
DEV-648	ClearCount	Ricoh fi-8950 scanner
SW-10508	ClearCount	Database and threading updates to make ClearCount more performant, especially with many concurrent tasks and larger elections.
SW-10792	ClearCount	Reduces ClearCount security vulnerabilities regarding SQL injection.
SW-14459	ClearCount	Allows for RCV contests to be included in ClearCount web and PDF reports with a Rank filter to determine which ranks should be included on those reports.
SW-14470	ClearCount	This creates a function in ClearCount to export a zip with the RCV CVRs and their associated configuration files that are needed to tabulate the contest in RCTab.
SW-14549	ClearCount	Upgrades the ClearCount database to MySql 8 and InnoDB.
SW-14710	ClearCount	Resolves an issue that caused Ballot Tabulator to fail to start properly.
SW-14727	ClearCount	Provides more specificity of which ClearCount build/version number is being used.
SW-14743	ClearCount	This updates manual adjudication for RCV contests to work through the contest one rank at a time and seamlessly integrates it with adjudication of non-RCV contests.
SW-14744	ClearCount	This allows Oval Visualization in ClearCount to display ovals for RCV contests, applies a Rank filter to the page so that a user can choose to see ovals for only a given rank or ranks, and updates the oval hover to show the RCV contests appropriately.
SW-14758	ClearCount	Added a new report "Statement of Votes Cast by Rank' which is available in the report menu if the election contains RCV contests. This report displays the votes grouped by Contest and Rank.
SW-14806	ClearCount	Updates to ClearCount to ensure core functionality remains intact after the database upgrades.
SW-14817	ClearCount	Updates requirements in order to reach MySql database to prevent any unintentional access.
SW-14822	ClearCount	Updates user creation to validate user names in order to prevent errors with logging.
SW-14877	ClearCount	Updates the XML functionality to accommodate RCV contest data.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-14913	ClearCount	Provides more specificity of which ClearDesign build/version number is being used.
SW-15395	ClearCount	Resolves an issue that could cause XML exports to have inconsistent count of Ballots Cast when using multi-card ballots.
SW-15634	ClearCount	RCV contest exports are created more efficiently, so that files can be ready for download more quickly.
SW-16037	ClearCount	Resolves the issue in the previous ClearCount 2.5 version that did not correctly handle duplicate boxes.
SW-13545	ClearCount, ClearDesign	Previous versions of ClearDesign did not reserve space for the Judges Initial's box and so could end up with a box of zero height. The new release ensures the box is at least 2/3 of a timing mark high.
SW-13555	ClearDesign	Enhance the message displayed when ovals overlap front to back (coincide) to include the candidate and contest names cause the issue.
SW-13760	ClearDesign	Allows a user to save name and sort seq changes to an image without requiring a change of the image itself.
SW-14012	ClearDesign	SW-14012. Added support for ranked-choice voting tabulation rulesets and ranked-choice voting contest type.
SW-14062	ClearDesign	This allows ClearDesign to layout a paper ballot that includes a RCV contest, with consideration of the RCV contest's layout configurations, number of ranks/candidates and the other contests and content on the ballot.
SW-14063	ClearDesign	This updates the voter experience on the HTML ballot to allow for ranking and re-ranking of candidates in RCV contests on HTML ballots, provide appropriate on-screen and audio warnings for RCV contests, updates the Review page to show candidates ranked and allows for printing of a ballot with RCV contests.
SW-14253	ClearDesign	This allows for the creation and editing of a RCV ruleset with specific tabulation and layout rules. The ruleset can then be associated to a RCV contest, where some of the rules can be overwritten.
SW-14754	ClearDesign	This allows for the RCV Ruleset functionality to be disabled or enabled for a given user.
SW-14818	ClearDesign	Updates the BDF/ADF to allow for contests with no candidates, or with Label Only candidates, to be used throughout ClearVote.
SW-14864	ClearDesign	Updates the Text Editor translation tool to hide a Google Translator overlay which made it difficult to click the Save button.

Unique ID	Component	Description of Fix/Modification/Enhancement
SW-15242	ClearDesign	Updates the way that ballot PDFs are named by ClearDesign to they can be more easily identified and organized.
SW-15280	ClearDesign	Updates the BlankBallotFileName value in the BDF to match the updates made to ballot PDF naming in SW-15242.
SW-15583	ClearDesign	Previous versions did not include the audio that was recorded in ClearDesign in the file created using the Export Audio function. This version now includes them.
SW-15587	ClearDesign	Resolves an issue on very large elections/ballot sets that could cause Printing of ballots to result in an internal server error.
SW-15917	ClearDesign	Ensure functionality conforms with VVSG 1.0 Volume 1 Sec 3.1.6 d. ii. "No key or control on a voting machine shall have a repetitive effect as a result of being held in its active position."
COTS-195	ClearDesign, ClearCount	Brother HL-L2460DW printer.
HW-5555	ClearMark	Resolves an issue that resulted in errors when starting a voting session using the barcode scanner.
SW-14567	ClearMark	Resolves an issue when exporting logs that caused the CSV to have an extra column.
SW-14684	ClearMark	Resolves an issue that would show no information about an attached Smart Card Reader on the ClearMark Setup page.
SW-14992	ClearMark	Provides more specificity of which ClearMark build/version number is being used.
SW-15116	ClearMark	Resolves an issue that caused unnecessary and repetitive system logs during scanner calibration.
SW-15142	ClearMark	Resolves an issue that could sometimes cause paper jam error messages to not be displayed at the correct time.
COTS-11	ClearVote	Add Dell OptiPlex XE4 as an admin station for ClearDesign and ClearCount.
COTS-144	ClearVote	Add Dell Latitude 5540 as admin station for ClearDesign and ClearCount, and as a ClearCount ScanStation.
COTS-40	ClearVote	Add Dell PowerEdge T150 as a DesignServer and a CountServer.
COTS-41	ClearVote	Add Dell PowerEdge R450 as a DesignServer and a CountServer.
COTS-208	ClearVote	Add Dell Latitude 5550 as admin station for ClearDesign and ClearCount, and as a ClearCount ScanStation.
DEV-1139	ClearDesign	This resolves an issue that caused an error message when creating an election in ClearCount using a BDF that was originally generated from the 2.3 version of ClearDesign.

Unique ID	Component	Description of Fix/Modification/Enhancement
DEV-3519	ClearMark, ClearAccess	This resolves an issue that caused various buttons to be too small to meet VVSG 1 size/spacing requirements.
DEV-3723	ClearDesign, ClearMark, ClearAccess	Introduces a new default ABC onscreen keyboard for voters when adding write-in candidates with buttons that meet size requirements and moves the QWERTY keyboard to an optional alternate input method.
DEV-3252	Doc	Add Lexmark MS531 printer to APL for use with ClearAcccess EloPOS
DEV-4193	Doc	Add additional Sandisk USB stick option (64gb) to APL
DEV-3474	Doc	Remove Ballot Verification scanner from APL for use with ClearMark
DEV-1489	ClearCount	Adds the option in the Ballot Saving queue views to requeue any items that have not moved out of the queue.
DEV-3306	ClearCount	Resolves an issue where logs could sometimes contain incorrect information
DEV-3305	ClearCount	Resolves an issue where the flash message content could be unrelated to the action the user just took.
DEV-4521	ClearCount	Resolves an issue where the user isn't given an appropriate error message when they attempt to merge a ClearCast USB stick with an invalid HMAC or hash value.
DEV-4556	ClearDesign	Resolves an issue in the HTML ballot wherein ballots printed via ClearMark display write-in lines as misaligned with their corresponding ovals.
DEV-4909	ClearDesign	Updates the RCV Ruleset configuration dialog to remove the option for Bottoms Up Percentage Threshold as a RCV Type option.

Proprietary Software

System Component	Software or Firmware Version
ClearAccess	2.5.6
ClearCount	2.5.8
ClearDesign	2.5.9
ClearMark	2.5.6
ClearCast	2.5.3
ClearCast Go	2.5.3

Proprietary Hardware

Description	Version
Clear Ballot Group Collapsible Ballot Bag	CV-1032-1.5, CV-1032-2.0
Clear Ballot Group Collapsible Ballot Box	CV-1033-1.5, CV-1033-2.0
ClearCast Go Transport Ballot Box	61211-1-3

ClearCast Soft Collapsible Ballot Box	Standard (14620) Long (14616)
ClearCast Soft Insert Collapsible Ballot Receptacle	Standard (14452) Long (14460)
ClearCast Go Soft Collapsible Ballot Box	Standard (14148) Long (14156)
ClearCast Go Soft Insert Collapsible Ballot Receptacle	Standard (14452) Long (14460)
ClearMark AIO Touchscreen	46100-1-1
ClearMark Thermal Printer	46200-1-1
ClearMark Thermal Printer Transportation and Setup Case	62321-1-2
ClearMark Lexmark Printer Transportation and Setup Case	62322-1-2

COTS Software and Firmware

Description	Version
ClearDesign 2.5.9	
Google Chrome	87.0.4280.141
Ubuntu	20.04.5 LTS
MySQL	5.7.37
Apache	2.4.29
PhantomJS	1.9.8
Unzip	6.0
Samba	4.15.13
auditd	2.8.5
libpam-pwquality	1.4.2
apparmor-utils	2.13.3
libapache2-mod-apparmor	2.12
Python PIP	22.0.4
Zip	3.0.11
Pyinstaller	4.7
Python JSMIN	3.0.0
Python	3.8.10
Python altgraph	0.17
Python dev	3.8.10
Python wheel	0.37.0
Python setuptools	59.5.0
jaraco.functools	3.4.0

gcc	10.3.0
build-essential	12.8
m4	1.14.18
bc	1.07.1
Python Webpy	0.62
PyMySQL	1.0.2
SQLAlchemy	1.3.24
Python Pillow	8.3.2
Python DBUtils	1.3
Python XLRD	1.2.0
Python FontTools	3.41.0
Python RTF	0.2.1
Python Gunicorn	20.0.4
OpenSSL (FIPS)	2.0.16
OpenSSL	1.0.2n
LibSSL	1.0.2n
DataTable	1.10.16
DataTable-Buttons	1.4.2
DataTable-Buttons-Bootstrap	1.4.2
DataTable-Buttons-JSZip	2.5.0
DataTable-Buttons-Pdfmake	0.1.32
DataTable-Plugins	1.10.16
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
jslibmp3lame	0.5.0
jszip	3.2.0
jsmin	4.6
papaparse	4.6.0
jquery-throttle-debounce	1.1
ClearAccess 2.5.6	
nsis	3.06.1
PyInstaller	4.2
Windows	Windows 10 IoT Enterprise LTSC 2021
Google Chrome	87.0.4280.141
DataTables	1.10.16
EloPOS driver pack	12/5/2019

jquery	1.10.2
jsmin	10/30/2019
LGPO	3
pefile	2019.4.18
pyserial	3.5
Python	3.8.10
Python-future	0.18.2
pywin	302
Webpy	0.62
Zebra Corescanner Driver	3.07.0042
ClearCast 2.5.3	
Ubuntu	20.04.5
chromium-browser	112.0.5615.49
pyinstaller	3.2.1
openssl-fips	2.0.16
openssl	1.0.2n
libScanAPI.a	2.0.5.0
DataTables	1.10.22
JTSage DateBox	4.0.0
jQuery.NumPad	1.4
jQuery	3.5.1
jquery.ui	1.12.1
ClearCast Go 2.5.3	
Ubuntu	20.04.5
Linux kernel	5.4.52
U-boot	2020.1
rk3399_loader	1.25.126
rk3399_bl31	1.35
trust_merger	1.0 (2015-06-15)
boot_merger	1.31
rk3399_ddr-800MHz	1.25
rk3399_miniloader	1.26
rkdeveloptool	1.2
chromium-browser	112.0.5615.49
libssl	1.0.0_1.0.2n
openssl	1.0.0_1.0.2n
libscanAPI.a	1.0.7.0
DataTables	1.10.22
JTSage DateBox	4.0.0
jQuery.NumPad	1.4
jQuery	3.5.1
jquery.ui	1.12.1

ClearCount 2.5.8	
Windows	Windows 10 IoT Enterprise LTSC 2021
Google Chrome	87.0.4280.141
Ubuntu	20.04.5 LTS
Python(part of Ubuntu)	3.8.10
MySQLdb (part of Ubuntu)	8.0.37
OpenSSL	1.0.2n
OpenSSL FIPS Object Module	2.0.10
sqlalchemy	1.3.24
Six	1.14.0
Python-DateUtil	2.8.2
Apache	2.4.29
auditd	2.8.5
debconf	1.5.73
pmount	0.9.23
Samba	4.15.13
udisks2	2.8.4
python3-audit	2.8.5
python-debconf	1.5.73
libzbar0	0.23
libpam-pwquality	1.4.2
apparmor	2.13.3
apparmor-utils	2.13.3
ufw	0.36
xserver-xorg-core	1.20.13
xinit	1.4.1
lightdm	1.30.0
xfce4	4.14
menu	2.1.47
menu-xdg	0.6
xubuntu-default-settings	20.04.4
xfce4-whiskermenu-plugin	2.4.3
xfce4-terminal	0.8.9.1
xfce-power-manager	1.6.6
leafpad	0.8.18.1
exfat-fuse	1.3.0
exfat-utils	1.3.0
screen	4.8.0
zip	3.0
unzip	6.0
sudo	1.8.31
JavaScript Bootstrap library	2.3.2, & 4.3.1

JavaScript Chosen library	1.8.7
JavaScript jQuery splitter library	0.28.3
JavaScript jQuery library	1.10.2J
J JavaScript jQuery-migrate library	1.2.1
JavaScript jQuery hotkeys library	0.8
JavaScript jQuery tooltip library	1.3
JavaScript DataTables library	1.10.18
JavaScript DataTables Buttons	1.5.6
JavaScript DataTables Buttons ColVisLibrary	1.0.8
JavaScript DataTables Buttons html5 library	1.3.3
JavaScript DataTables FixedHeader library	3.1.4
JavaScript DataTables pdfmaker library	0.1.36
Javascript Vue	2.6.10
JavaScript bootstrap-vue library	2.0.2
ClearMark 2.5.6	
Ubuntu	20.04.6
chromium-browser	97.0.4692.99
DataTables	1.10.16
jquery	1.10.2
jsmin	09/30/2011
pefile	2019.4.18
pyserial	3.5
Python	3.8.10
Webpy	0.62
Linux Kernel	5.4.52
U-boot	2020.1
rk3399_loader	1.24.126
rk3399_bl31	1.35
trust_merger	1.0 (2015-06-15)
boot_merger	1.31
rk3399_ddr-800Mhz	1.25
rk3399_miniloader	1.26
rkdeveloptool	1.2
libssl	1.0_1.0.2n
openssl	1.0.0_1.0.2n
libscanAPI.a	1.0.7.0
pycups	2.0.1
evdev	1.4.0
more-itertools	8.6.0
Pillow	8.3.1
multiprocess	0.70.12.2
argparse	1.4.0

pysub	1.2.1

COTS Hardware

Description	Component Type
ClearDesign	
Dell Latitude Laptop (DesignStation)	5580, 5590, 5500, 5511, 5521, 5540,5550
Lenovo ThinkPad (DesignStation)	E14 G-series
Dell OptiPlex (DesignStation)	XE3 SFF, XE4 SFF
Dell PowerEdge Server (DesignServer)	T130, T140, T150, R440, R450, T440, T630
Cisco 8-Port Switch	SG250-08-K9-NA
Cisco Catalyst 8-port switch	1300-8T-E-2G
Cisco Business 8-Port Switch	CBS350-8T-E-2G-NA
NetGear 8-Port Switch	FVS318G
TRENDnet 8-Port Switch	TEG-S80G
TP-Link 8-Port Switch	TL-SG108E
TP-Link 4-Port Switch	TL-R600VPN
Brother Laser Printer	HL-L2350DW
Brother Laser Printer	HL-L2460DW
ClearAccess	
ELO 15 inch EloPOS	EPS15E2
ELO 15 inch AIO	E-Series (ESY15E2)
ELO 15 inch AIO	X-Series (ESY20X2)
Dell OptiPlex	5250
Oki Data Laser Printer	B432dn
Lexmark Laser Printer	MS521dn
Lexmark Laser Printer	MS531dw
CyberPower Smart App UPS	PR1500RT2U
APC Smart UPS	SMT2200C
APC Smart UPS	SRT1500RMXLA

Zebra Barcode scanner	DS457-SR
ELO Barcode scanner	UM600149
Storm EZ Access Keypad	EZ08-22200, EZ08-22201
Tapes Master – ESD Copper tape	TM-36-COPP-1M-3
ESD acrylic cover	CV-1180-1.4-1
ESD 0.75" polymide film	Kapton S-17213
ESD 1" polymide film	CV-1210-2.0
ESD 2" polymide film	CV-1211-2.0
ESD 4" polymide film	CV-1212-2.0
EMI ferrite	Würth Elektronik 742-416-33S, 742-711-32, 742-712-22, 742-717-22,
EMI ferrite	Laird 28A2029-0A2, 28A2029-0A0, 28A5776-0A2
EMI ferrite	Takachi Electronics TFT152613N
ClearCount	
Dell PowerEdge Server (CountServer)	T140, T150, R440, R450, T440
Dell OptiPlex (CountStation)	XE3 SFF, XE4 SFF
Dell OptiPlex (ScanStation)	XE4 SFF
Dell Latitude Laptop (CountStation, ScanStation)	5580, 5590, 5500, 5511, 5521, 5540, 5550
Lenovo ThinkPad Laptop (CountStation, ScanStation)	E14 G-series
Fujitsu Scanner	fi-6400
Fujitsu Scanner	fi-6800
Fujitsu Scanner	fi-7180
Fujitsu/Ricoh Scanner	fi-7800
Fujitsu/Ricoh Scanner	fi-7600
Fujitsu/Ricoh Scanner	fi-7900
Ricoh Scanner	fi-8950
Cisco 8-Port Switch	SG250-08-K9-NA

Cisco 26-Port Switch	SG250-26-K9-NA
Cisco Catalyst 8-Port switch	1300-8T-E-2G
Cisco Business 8-Port Switch	CBS350-8T-E-2G-NA
Cisco Business 24-Port Switch	CBS350-24T-4G-NA
NetGear 8-Port Switch	FVS318G
TRENDnet 8-Port Switch	TEG-S80G
TP-Link 8-Port Switch	TL-SG108E
TP-Link 4-Port Switch	TL-R600VPN
Brother Laser Printer	HL-L2350DW
Brother Laser Printer	HL-L2460DW
APC Smart-UPS	SMT-1500C
ClearCast	
ClearCast	Model D Revision 5
ClearCast Go	ClearCast Go
Corsair Flash Padlock 32 GB USB	CMFPLA3B-32GB
Corsair Flash Voyager GTX 128 GB USB	CMFVYGTX3C-128GB
SanDisk Extreme Go 64 GB USB	SDCZ800-064G-G46
SanDisk Extreme Pro 128 GB USB	SDCZ880-128G-G46
SanDisk Ultra Flair 32 GB USB	SDCZ73-032G-A46/G46
SanDisk Ultra Flair 64 GB USB	SDCZ73-064G-A46/G46
Shielded HDMI cable	CC-2115-1.5
EMI ferrite	Würth Elektronik 742-711-32, 742-711-42, 742-758-12, 742-758-13
ClearMark	
Lexmark Laser Printer	MS521dn
CyberPower Smart App UPS	PR1500RT2U
ClearVote	
SySTOR 1:15 USB Duplicator & Sanitizer	SySTOR 1:15 USB Duplicator & Sanitizer

Language capability:

The ClearVote 2.5 voting system supports the following languages:

- English
- Spanish
- Chinese
- Korean
- Vietnamese
- Danish
- Dutch
- Flemish
- French
- German
- Italian
- Japanese
- Norwegian
- Portuguese
- Swedish

System Limitations

This table depicts the limits to which the system has been tested and certified to meet.

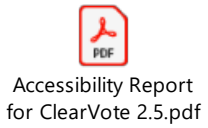
Characteristic	Limit
Election Parameters	
Precincts per election	3200
Splits per election	3200
District categories per election	100
Districts per single category	3200
Districts per election	3200
Contests per election	3200
Choices per election	3200
Choices per contest	300
Vote positions per side	420
Card 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

Functionality

VVSG 1.0 Supported Functionality Declaration

Feature/Characteristic	Yes/No	Comment
System Functionality		
General Election	Yes	
Closed primary	Yes	
Open primary	Yes	
N-of-M contest	Yes	
Precinct splits	Yes	
Ballot rotation	Yes	Rotation by precinct and district
Straight-party contest	Yes	
Cumulative contest	No	
Ranked choice contest	Yes	
Party preference contest	Yes	
Top-2 primary contest	Yes	
Presidential delegate contest	Yes	
Proportional voting contest	No	
Group voting contest	Yes	
Recall contest	Yes	Supported variants: Simple Yes/No
Top-2 IRV contest	Yes	
Cross-party endorsement	Yes	
Write-In voting	Yes	
Nonpartisan offices	Yes	
Partisan offices	Yes	
Tabulation		
Provisional or Challenged Ballots	Yes	via jurisdiction processes
Overvotes	Yes	
Undervotes	Yes	
Blank Ballots	Yes	
Devices Supported		
Ballot marking device	Yes	
Precinct Scanner	Yes	
Central count scanner	Yes	
All-in-one device	No	

XI. Attachment B - Recommendations from Accessibility Examiner



Accessibility testing report ClearBallot ClearVote 2.5

Report submitted to PA Department of State

February 20, 2026

Whitney Quesenbery
Center for Civic Design

This report presents the findings of a video examination and recommendations for improving the accessible voting experience of the ClearBallot Clear Vote BMD

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About the system

This is a report of the findings of a voting machine accessibility review conducted by video conference of the ClearBallot ClearVote BMD. It was reviewed to VVSG 1.0 standards.

This voting system is an update of a previously certified system. The overall user interface is similar to the system previously certified VVSG 1.0. The major difference between this system and the previous ClearAccess is the hardware enclosure.

- A new hardware case is in a vertical “portrait mode” so more contests fit on each screen.
- The system is activated by either inserting a card into a slot on the right side of the encloser or scanning a code using a sensor immediately below the slot.
- The BMD has both touch-screen and a tactile controller, with a standard jack for personal assistive technology, and headphone using a standard jack
- The printer is in a separate enclosure, either a thermal printer or a laser printer.
- The ballot is a facsimile of a hand-marked optical scan ballot.
- The ballot is cast at a separate tabulator (not included in the examination).

Findings

Top positives about this system

The ClearVote enclosure

This enclosure looks robust. It can be set up in both a horizontal or vertical orientation and has an attached stand that allows it to be positioned at an angle. This provides some alternatives to ensure that it is set up for a variety of tables or other supports to ensure that "reach-and-touch" requirements are met.

Audio controls

The interface includes controls on the bottom of the touch screen to pause or play the audio and adjust the audio speed and volume. These buttons duplicate controls for play/pause and volume on the tactile keypad. This makes them visible and available for voters using audio with the touch screen.

Review votes

In addition to reaching the review screen in the normal sequence of screens after the final context, voters have access to the Review Votes button at the top of the screen. This means that a voter who wants to quickly and immediately double check how their selection in a contest was recorded have a way to get to the review screen directly before continuing to the next contest – and without needing to listen to the entire contest again.

Mixed findings

Activation

The system requires a poll worker to activate it: The poll worker logs in, selects the correct precinct or ballot style, and sets the accessibility features needed. Activation on the device itself means that every voter who uses the BMD will be assisted by a poll worker. For voters who may need additional orientation to the device, this is a plus – especially as the language and access features are also available privately during the ballot marking session. However, it also makes the voting process slower and can cause bottlenecks for jurisdictions that encourage wide use of the BMD.

Write-in voting

The write-in interface is one of the most difficult aspects of most BMDs. The ClearVote interface has some of the challenges seen in many systems, but also some unique features.

The interaction was followed through a video showing both screen and tactile control provided by ClearBallot to allow a closer look at the details of the interaction.

Common challenges with other systems include:

- Not being able to edit a write-in once it has been Accepted
- Sequential navigation through the keyboard with few options to allow a voter familiar with the layout to jump more quickly through the letters.

Although the tactile navigation includes some unusual key sequences, it has the advantage of working entirely through the 4 navigation buttons (Up, Down, Previous, Next) and Select button on the tactile controller.

Advantages

- This interaction appears easy to learn, and is consistent for each letter selected.
- Using the Select key for letter selection and forcing the voter to navigation to a special Accept button on the screen reduces the likelihood of accidentally accepting an incomplete or incorrect entry and needing to start over.
- It is easy to correct an entry immediately.

Disadvantages

- We did not see an easy way to have the entire entry read back to confirm it is correct before leaving the write in screen.
- The visual layout of the keyboard is a QWERTY keyboard with all non-alpha keys, including a top row of numbers and a caps-lock key. Although the visual layout is QWERTY, the letters in the audio are in alphabetical order. This may work well for people who are not familiar with a standard keyboard, but it is confusing that the visual and audio do not match – and that there is no visual indicator on the screen.
- After each letter is selected, the alphabet starts over at “A” making it less efficient to use

Hands-free voting

The ClearBallot documentation describes the ClearVote in the documentation as an all-in-one unit, which sounds like it is the only component voters have to interact with. However, the printer is a separate hardware component. More importantly for accessibility, the ballot scanner is not listed as a component at all. Voters using the ClearVote cast their ballots at the same scanner used to cast hand-marked ballots.

This means that there is no segregation of the ballots, increasing ballot secrecy for voters with disabilities. But it also means that is not possible for a voter to complete a complete voting session, including casting the printed ballot, independently. This affects voters without use of their hands as well as blind voters because the ballot must be transported to a different location in the polling place and inserted into the scanner.

Poll workers must be trained in how to assist voters in this part of the voting process without affecting voter privacy.

How the review was conducted

The main portion of this review was conducted using a video conferencing system in which a representative from ClearBallot walked through the use of the system and repeated interactions on request.

The ClearBallot 2.5 Poll Worker Guide was used to confirm or provide additional details about the operation of the ClearVote.

ClearBallot also provided a video that showed the interaction for entering a write-in vote.

The examination team

The team includes accessibility, usability, and elections expertise to ensure a broad background and knowledge base for accessible voting issues.

- Experience working with individuals with a wide variety of disabilities and the impact of disability on daily life.
- Knowledge of the range and use of assistive technologies that voters with disabilities might rely on for access.
- Strong design best-practices knowledge and principles for digital technology and voting systems.
- Poll worker training design and competencies.
- Experience conducting usability evaluations with voters.

The examination team from Center for Civic Design included twopeople

- Whitney Quesenbery, lead examiner and accessibility expert
  Misty Crooks, usability expert

All observations

Voter comments and reviewer observations about each machine are described below. For each are, the observations are organized by the machine function then by the severity.

Positives

Function	Observation	System	Severity
General	Screen and stand require a small footprint, which could allow it to be pushed further back in a voting booth allowing voters more privacy. Screen is adjustable up and down as well as tilt.	CA	Positive
	Best straight party/ PA Method implementation of all the machines this group has tested.	CA	Positive
	“I found this one a lot more logical and faster to use,” said one voter who had previously voted on multiple systems.	CA	Positive
	By page 8 of 14, a voter who was initially very tentative had figured out the system, and was comfortable moving between contests. The voter stated, “This machine would take some practice.”	CA	Positive
	"Not so confusing I can't figure it out."	CA	Positive
Display and Navigation	Large, clear screen. Scrolling animation is very smooth and easy to track.	CA	Positive
	Four print sizes available: Small, Normal, Large, and Extra Large. The middle two sizes met the needs of most of the sighted test voters.	CA	Positive
	Contrast settings include yellow on black and a low contrast, grey scale, with the usual white on black and black on white.	CA	Positive
	In each contest header, the system displays the number of total options and how many additional selections can be made.	CA	Positive

Function	Observation	System	Severity
Display and Navigation	One voter correctly interpreted the voting instructions as "You can vote for up to three;" "You can vote for 1, 2 or 3."	CA	Positive
	No silent or off-screen deselection. When overriding a straight party vote, the system displays an increase in the number of additional selections that can be made. It also announces this change in the audio and states “No other candidates selected.”	CA	Positive
	Before making a selection on the straight party ticket, or any race not pre-marked by a straight party vote, the “Next” button changes to "Skip."	CA	Positive
	Straight party selections are in light blue. Manual selections are in a darker blue background. Once a voter confirms a straight party selection, that option turns darker blue as well.	CA	Positive
	Manually selecting a candidate on a straight party ballot cancels all straight party selections. This was fairly intuitive, and not a problem for voters.	CA	Positive
	“You don't have to touch in the check box. Anywhere in the name box works.”	CA	Positive
	Alert messages for overvotes and undervotes are generally well worded and draw the voter’s attention. Voters did not feel coerced to cast a vote or scolded for doing something wrong. From the messages, you can proceed or go back, instead of disrupting ballot flow.	CA	Positive
Assistive Technology (AT)	The machine can be set up so that accessibility options are on by default for each voter, or the poll worker can customize each session for the voter.	CA	Positive

Function	Observation	System	Severity
Assistive Technology (AT)	When the audio is on, buttons are included on the screen for “Pause, Slower, Faster, Volume Down, and Volume Up.” These buttons stay but are moved to the top when the screen is blanked.	CA	Positive
	High quality instructions/text-to-speech voice. It uses clear speech, has a good range of speeds, and remains understandable at the lowest and highest speeds. When necessary, it announced instructions that were not included on the screen, but were important to low-vision or blind voters.	CA	Positive
	The system uses a standard “Easy Access” keypad with a minimum number of buttons. However, voters found the upper-most square buttons unhelpful.	CA	Positive
	The tactile keypad voting instructions are given at the beginning. These instructions are repeated only if the voter presses the help button. This means once the voter understands the instructions, they do not have to listen to them for each contest and navigation step. The last statement says that voters do not have to vote in every contest, which was well received by voters. On the down side, these instructions are long, and a lot of information is given at once.	CA	Positive
	"You can cut him off, if you know what he's going to say."	CA	Positive
	The keypad user can jump to the review screen by holding down the next button. However, this is only mentioned in the keypad instructions at the beginning or when the voter presses help.	CA	Positive
	The audio always announces "Page [x] of [y],” giving voter information about the progress being made.	CA	Positive

Function	Observation	System	Severity
Assistive Technology (AT)	Voter spontaneously moved to the header to confirm how many votes they had left, since the current selections are announced.	CA	Positive
	On entering a contest with straight party votes, the header includes "The following choices are already selected." It then names the current selections with name and party.	CA	Positive
Write-In Screen	For audio users, the write-in screen includes its own set of instructions. The keypad buttons do change functions, which was confusing for some voters.	CA	Positive
	The write-in screen includes a QWERTY lay out keyboard. One sighted voter stated, "This is a regular keyboard. Yes, this is QWERTY."	CA	Positive
	For audio users, letter selection happens by pressing the keypad up button until they arrive at the desired letter. If they overshoot a letter, they may press the down button to correct it. As each letter is entered, the voice reads it back to them until enough of a word is generated for it to pronounce.	CA	Positive
	One voter correctly used the right arrow button on the keypad to move to the next letter.	CA	Positive
	By the third letter, one blind voter had figured out the process and completed it rapidly.	CA	Positive
	"See, I can do this very quick now. It's very straight forward."	CA	Positive
Printed Ballot & Scanner	The scanner has a large display screen, a deep tray with grooves, and tall tray guides along the side. It also has a quiet but audible ballot accepted tone.	CC	Positive

Problems

Function	Observation	System	Severity
Setup for Voters	On the poll worker set up screen, the text is small and the options are not immediately intuitive. Also, poll workers did not know how to advance to the ballot because the only button that looked like an option took you back to the log in screen.	CA	Annoyances
	When using the on-screen keyboard, some poll workers missed numbers because the visual feedback indicates that they had pressed a key was not sufficient.	CA	Annoyances
	Poll workers must type in a county supplied activation code for each voter, choose the ballot type and style, and then configure any assistive devices options.	CA	Neutral
	Poll workers were concerned about the mechanics of the polling place, since this machine has both the marking device and the printer, and a separate scanner.	CA	Annoyances
Orientation and Navigation	Voters have access to a “Cancel” button that if pressed and confirmed will cancel their ballot. This option exists on the tactile keypad as well by pressing and holding the left arrow button. No ballot should be able to be cancelled without poll worker assistance to be sure all proper steps are taken.	CA	Likely to prevent independent voting for voters with some disabilities
	If you press too long on the screen, it doesn’t read it as a touch. This was a problem for a voter with hand tremor. The initial touch did nothing, so his response was to touch longer.	CA	Problem Solving
	Candidates that were endorsed by two parties lists them twice. All voters looked for a candidate labeled “Republican/Democrat.”	CA	Problem Solving

Function	Observation	System	Severity
Orientation and Navigation	When entering a contest with a straight party selection, the contest header instructions indicate that "You can choose no more." Some voters thought this was bad wording because they could actually choose other options.	CA	Problem Solving
	Voter suggested "Vote for no more than four" rather than "There are four choices" as choices (number of candidates) can be confused with available votes.	CA	Problem Solving
	One voter pressed select as the ballot choices were being read. When asked, she said she was trying to confirm her vote, and wasn't sure how that worked.	CA	Problem Solving
	On the review screen, one sighted voter did not like the bottom scroll down button label that said ‘Touch to see more contests.’ The voter suggested it might say ‘Touch to see more of my choices.’	CA	Problem Solving
	For sighted voters, there is no intuitive way to return to the same place in the review screen after making a change. Voters had to stop and think about how to return, and all had to be asked if there was a button on the screen to do this.	CA	Problem Solving
	There is no audio instruction on how to print from the review screen. It is the Right arrow button, and printing is the next step. Also, audio voters had trouble returning to the review screen after making a change. When giving instructions on the review screen, it could include how to return to it and how to move on to printing.	CA	Problem Solving
	Slight delay in touch screen. At times, voters touch twice because they didn't think the touch worked, then see selection and deselection. This affected several voters who used the touch screen	CA	Annoyances

Function	Observation	System	Severity
Orientation and Navigation	Alerts and write-in screen “pop-up” windows are all located at the top of the screen. Since the screen is so tall, it happened out of view for one low-vision voter, and difficult to read for bi-focal voters.	CA	Annoyances
	At the bottom of the Cancel voting dialog, "Proceed" is on the left, and "Cancel" on the right. On the keypad, "Proceed" is the right arrow, back (Cancel) is on the left.	CA	Annoyances
	When using the tactile keypad, the contests do not wrap around to the top. Voters must press the up button to move back up the list.	CA	Annoyances
	The full contest header “President and Vice President of the United States” was not all on one line. On the review screen it cut off at “of the”.	CA	Annoyances
	“Thank you for voting” should fill the entire final screen with instructions about where to take your ballot.	CA	Annoyances
	Several voters tried to swipe to scroll down the screen. Swiping and gestures were not available for this machine.	CA	Annoyances

Function	Observation	System	Severity
Audio Feedback & Instructions	Some ballot layout configuration issues resulted in voter comments and questions. • The full “President and Vice President of the United States” was not all on one line. It sounded parsed but okay in the ballot, but it stopped reading at “of the” on the review screen. • The audio read text mark-up that could not be seen on the screen, for example “Slash P” and “Slash PP.” Inexperienced blind voters paused but were not stopped by it. • Write-ins are displayed as “Write-In:FIRST LAST” with no space between the colon and the first name. The audio reads this all in one phrase without a pause, then repeats the name. Example: “Write-In:Chris Smith” as ‘Write-in Chris Chris Smith.’ • The entire ballot questions were on the review screen instead of a label. For short questions this is okay, but for long questions like the referendum, voters found it annoying.	CA	Annoyances
	The audio reads the preferred language set up screen and describes which buttons to press on the tactile keypad, but the instructions for the tactile keypad are on the next page. Voters were able to navigate this page, but poll workers may need to make this selection for the voter before stepping away.	CA	Annoyances
	After reading the contest title and instructions, the audio reads the pre-marked, straight party selections. This confused one blind voter who thought he was already in the list of candidates.	CA	Annoyances
	The audio instructions describe the "Up and down, diamond shaped buttons." These are diamonds when combined, but each button is triangular.	CA	Annoyances

Function	Observation	System	Severity
Audio Feedback & Instructions	In each contest, the audio read the name and then the candidate's party. At the typical reading speeds, this pause is long enough to make it difficult to associate the two. There is little to no pause using the fastest speeds.	CA	Annoyances
	For audio voters, it was ineffective to change the tone to indicate a pre-marked straight party candidate vs a selected candidate. Several voters did not notice the change. When one who did was asked if it helped, he said, "I'm going more by name than the tones."	CA	Neutral
	One voter was confused by the similarity of sound of the letters "C," "B," "D," etc. This was with the speed turned up.	CA	Annoyances
	One voter was confused by "is selected" and "deselected." Voter said "I thought I said to deselect."	CA	Problem Solving
	When navigating the list of candidates, the narration says "Choice 2 of 4. You can choose one more." This can lead to confusion between the number of available choices, and the number of selections. It could be worded "You can select one more."	CA	Annoyances
Assistive Devices	As delivered, the machine has a tactile keypad and sip-and-puff option. The sip-and-puff option is USB connection only. A voter with their own non-audio, assistive device with a 3.5mm connection would not be able to use it.	CA	Likely to prevent independent voting for voters with some disabilities
Assistive Devices	The sip-and-puff interaction is complicated, requiring different length breaths. This is an advanced interface, making it difficult for voters who are used to dual switches to use effectively.	CA	Likely to prevent independent voting for voters with some disabilities

Function	Observation	System	Severity
Assistive Devices	Most blind voters found the length of tactile keypad instruction be too long. They would move on before hearing all of the instructions or did not show evidence of retaining all of the instructions. Some suggested more "Just in time" instruction, as is used for write-in voting.	CA	Problem Solving
	One blind voter exclaimed, “That’s a lot to remember!”	CA	Problem Solving
	There should be an instruction at the end of the keypad description to move to the next screen to continue. It does mention how to move to the next page early in the list, but voters did not remember it. Currently, it just stops after the last instruction.	CA	Problem Solving
	The instructions for the keypad emphasize the color, not the shape. Some blind voters did not like this. Because the color may be helpful to low-vision voters, it should not be the primary description. The "right-arrow, white button" is faster to interpret than the "white, right-arrow button."	CA	Problem Solving
	The black and red buttons at the top of the keypad are rectangular in shape, but have raised arrow shapes. When touched with two fingers, they felt rectangular, but several blind voters were confused by the raised arrows, and confused these keys with the arrow keys just below them. One voter accidentally arrived on the Settings screen five times during the session.	CA	Problem Solving
	For all ballot navigation, the up arrow moves to the previous selection, down-arrow moves to the next. In the write-in screen, up-arrow moves to the next letter, down arrow moves to the previous. This reversal caught all voters off guard and they had to figure out which button moved down through the alphabet.	CA	Problem Solving

Function	Observation	System	Severity
Assistive Devices	The tactile keypad is heavy and some voters could not hold it the entire time. They had to place it on the table.	CA	Annoyances
	The tactile keypad has two adjacent keys on each side that are similar to the touch, but have different functions. The red and black rectangular keys have raised arrows that make the keys feel "arrow shaped." These leads to confusion for blind voters.	CA	Annoyances
Straight Party Voting	Ballot worker suggests "Straight Party" screen should have an option for "No straight party." This would also avoid warnings when no party selected.	CA	Annoyances
	When voting straight party, the header information for audio indicates the number of selections already made, and says that "you can choose no more." This is not accurate, because you can over-ride the straight party by voting normally. This will erase all straight party selections.	CA	Annoyances
	"It said I could select one more, but deselect the others." On contest where there were not as many straight party candidates as “vote fors” allowed, the voter expected to be able to add to the straight party selection without deselecting the pre-marked, straight party candidates.	CA	Problem Solving
Alerts	One group of poll workers said, "I don't like 'Warning.' I'd prefer 'Attention.' Warning is too urgent.”	CA	Annoyances
Write-In Process	Using the audio and tactile keypad, there is no way to delete a character.	CA	Likely to prevent independent voting for voters with some disabilities

Function	Observation	System	Severity
	The audio pronounces the name once entered and does not announce a space. One voter did not select a space, but the audio still read the name as ChrisSmith all one word. She did not detect that this was not what she had intended.	CA	Likely to prevent independent voting for voters with some disabilities
Write-In Process	There does not seem to be any way to exit the write-in screen without accepting what is entered. There is no on-screen cancel function. You must accept, then "deselect" from the contest screen. In the audio instructions, there is information that holding down the rectangular key cancels the write-in, but no voter discovered this.	CA	Needs Assistance
	While the write-in screen window was open, one poll worker repeatedly tried to select parts of the screen that were darkened and out of focus.	CA	Problem Solving
	Several voters initially tried to use the select button to confirm letters rather than the right arrow button. This is an expected behavior since the select confirms choices everywhere else in the interface. One voter repeated the error three times before successfully writing in a candidate.	CA	Problem Solving
	While entering a write-in candidate, one voter was confused by the alphabet starting with space. When the audio said "C space", he said, "No, I want to be next to the C."	CA	Problem Solving
	One voter using the audio expected the system to move to the next letter by pausing after selecting it.	CA	Problem Solving
	When using the on-screen keyboard, some voters missed letters because the visual feedback indicates that they had pressed a key was not sufficient.	CA	Annoyances

Function	Observation	System	Severity
	Several blind voters felt that the write-in process was inefficient because you had to start at the beginning of the alphabet each time. The next letter is generally closer to the current letter than to the front of the alphabet.	CA	Annoyances
Write-In Screen	"This is silly that you have to start at the beginning for each letter." The voter wanted the next letter to start where the last was chosen.	CA	Annoyances
Printing/Ballot Verification	On the print confirmation screen, there is a “Poll Worker” button. Many poll workers pushed it thinking it would somehow signal a poll worker. When they found out that it did not, they were concerned voters would press it and then wait for them to come over.	CA	Needs Assistance
	For blind voters using personal AT to review the printed ballot, their device was unable to read the ballot because it is formatted in three columns. For personal AT, voter selection only ballot is required.	CA	Needs Assistance
	There is a lever on the output area of the supplied OKI printer to direct the paper upward. If this is not deployed, the card stock ballot can become stuck in the slot between the gray plastic tray and the white plastic body of the printer, resulting in a paper jam when the printer tries to print the second side.	CA	Needs Assistance
	On the printed ballot, the write-in name is in very small print. It will be too small for anyone without at least normal vision.	CA	Needs Assistance
	The ballot paper is not secure and extends well beyond the body of the printer, and is at risk of being knocked to the ground by those with movement limitations, children, etc.	CA	Needs Assistance

Function	Observation	System	Severity
	One voter said, "I think that since it reviews aurally, I don't need to review it visually." Other voters wanted to be able to do visual confirmation.	CA	Neutral
Scanner	The scanner was not set up for the accessibility election definition, therefore we were unable to observe voters and poll workers using it.	CC	Neutral
Scanner	There is a significant delay between when the paper is inserted into the scanner and when it grabs the paper. If voters let go of their ballot before the scanner grabs it, it will fall out of the machine.	CC	Needs Assistance
	Because some ballots may be two sided, there is no way for voters to hide their ballot before inserting it into the scanner.	CC	Annoyances

Top positives

The expert examination, voter experiences, and poll worker sessions recognized several positives of these voting systems.

Independent voting

Generally, voters were able to complete their ballot on the ClearAccess system independently, once the facilitator provided them with the appropriate accessibility features. No one found the system so difficult or frustrating that they were unable to vote, although several participants identified features that they felt would frustrate less competent voters.

In part, this was because the primary limitation among our voters was low-vision/blindness. One voter with significant tremor was better able to vote using the tactile keypad rather than the touch-screen. We did not have any volunteers with limited hand dexterity for this testing. Had we had such voters, they would probably not have been able to use this machine because the supplied sip-and-puff switch did not work, and it was not possible to attach a dual switch option.

Access features easily learned and helpful

As voters explored the access features, they seemed to learn them relatively easily. Most of the voters use similar assistive devices daily or when they vote.

All five poll worker groups reported that the access features would help voters who already visit their location on Election Day. They also agreed that these features would likely assist other voters with disabilities that do not currently come to the polls on Election Day.

Great audio quality and implementation

The examiners felt voice quality was great and voters commented that they also liked the voice. The phrasing was good and followed natural speech patterns. In most areas, it sounded natural and there was neither too little nor too much space between words.

ClearBallot implemented the audio features well.

- For the most part, the voice read what was on the screen, but where necessary, it provided additional instructions that were important to blind voters. When a voter selected a straight party, it clearly read the pre-marked, straight party votes in each contest. Also, when a voter overrode a straight party vote, the system announced what was and was not selected on the screen. This meant that no candidates were silently deselected.

- While several voters indicated that the initial keypad instructions were very long and provided too much information at once, the advantage of this approach is that they were not repeated at each navigation step. The voice reads only the contest instructions and selections, and if the voter needed the full instructions again, they can press the help button on the keypad.

Helpful contest instructions and selections

The wording of the contest instructions and selections was good.

- For each, it stated how many total options there were and then how many additional selections the voter could make. When voters were using the audio, the voice read this after each selection so voters knew the status.

- If voters overrode a straight party vote, the numbers would reset and indicate how many additional selections could be made. This meant that even if deselections were made out of the voter's view, information about this change was provided to the voter.

Excellent straight party method implementation

ClearAccess implemented the PA straight party method intuitively.

- The system uses a light blue to indicate pre-marked straight party votes in each contest. Manual selections are dark blue. If a voter confirms a pre-marked, straight party selection by re-selecting the candidate, the color changes to dark blue.

- The system uses audio cues to help voters know if they are focused on a pre-marked selection, confirmed selection, or an unselected candidate.
- The contest header indicates how many additional selections can be made, if any.
- If the voter changes a straight party vote, the counter showing the number of additional selections counter changes as well.

Easy flow through the ballot

At each step, navigation seemed intuitive for all voters.

- If a contest has not been voted, the “Next” button becomes “Skip,” indicating they could leave a contest blank.
- Overvote and undervote alerts were worded well and they allowed the voter to proceed or return to voting, rather than completely interrupting their process.

Additional positive observations can be found in the “All Observations” section of this report.

Top problems

While the ClearBallot Clear Access ballot marking system, as tested, had a well-thought-out and well implemented system to allow blind individuals the ability to vote privately and independently, the same could not be said for voters with physical disabilities. As implemented, any voter who could not use the touch screen or tactile keypad to navigate this machine **would be completely unable to use the system independently**.

The following discusses the problems that surfaced during the expert examinations and voter/poll worker observations with the ClearBallot Clear Access ballot marking system.

Testing identified four problems that could reduce the ability of people with disabilities to vote independently and privately on the CA voting machine.

1. Poor assistive device implementation

What Happened?

While the tactile keypad and audio performed well, the other assistive device options were poorly implemented or not available.

- **Sip-and-puff did not work effectively.** The only device ClearBallot provides is a USB connected sip-and-puff switch from Origin Instruments. During the first round of testing, the examiners were unable to get the device to work. In a retest of the sip-and-puff the examiners were able to make the device work, but found it difficult to use it to complete the ballot.

- **The sip-and puff interface is complicated**. Rather than using the sip-and-puff as a dual-switch device, the developers chose to create complex breath actions: short sips/puffs move forward and back, with a long puff to select the current item, double sips/puffs move between contests, triple sips/puffs access settings and instructions. This would be a good solution for an expert sip-and-puff user, but makes this single device not very useful for voters who cannot use the tactile keypad.

- **No other personal assistive technology.** The only two inputs available on the ClearAccess voting machine were a USB port and a 3.5mm audio jack. Although this meets VVSG 1.0, it means that without a 3.5mm input jack, most personal AT, such as dual-switch buttons, cannot be used. During the retest, we tried using the a Swifty adaptor to connect dual switches, but were unable to get this alternative to work.

- **Ports not easily accessed.** The ClearAccess tablet has an aftermarket case that creates a bezel around the screen and secures most of the ports and cords. The downside to this is that it makes the exposed USB port and 3.5mm audio jack very difficult to get to. The ports are located on the bottom of the tablet, within a few inches of the tabletop.

Why is this a problem?

Poor assistive device implementation is a problem for two reasons.

Switch access is critical for some voters with disabilities.

- The intent of accessible voting features is to allow the widest possible range of voters with disabilities to vote privately and independently. This includes both voters with low/no vision and those with physical disabilities. The use of a single access method (sip-and-puff) will enable some voters, but will limit many others, even if implemented properly.

- Voters with physical limitations include those who access personal electronics with "accessibility switches." The industry standard for such switches is to use 3.5mm phono plugs to connect to devices. These switches are available to accommodate an enormous range of disabilities and abilities, from simple thumb switches to eye-blink switches, but require that voters be able to bring their own technology to the polling place.

  The ability to connect personal assistive technology through a standard port is required in the VVSG 1.1. Locating this port where a

voter or their personal assistant can connect it easily also adds to the usability of this accessibility feature.

- These switches are not a security threat. From the point of view of the voting machine, all of these are simply two individual switch closures, regardless of the movement used to activate the switches. Similar to the signal sent from an individual switch on the tactile keypad.

- Vendor provided assistive technology should just work: in the expected way, connecting easily, and without 'tinkering' by the voter. If an expert is unable to get a device to work, then a poll worker or voter will be more frustrated. It makes the poll worker feel inadequate and the voter insecure when voting machines do not work properly on Election Day.

Recommendations

The sip-and-puff device should work correctly the first time and every time. Any anomalies should be fixed before deployment.

Ideally, ClearBallot should provide a way for other 3.5mm dual-switch assistive devices to be used.

A note about exposed USB ports. While out of the scope of this report, it should be noted that the USB port intended for assistive devices would be open and exposed during voting. Vendor representatives indicated that this should be sealed and resealed with a sticker seal after each use. This seems like an unnecessary burden on poll workers, and a procedure unlikely to be followed. This security risk is unnecessary if the simpler 3.5mm jack is used instead of a USB port.

2. Tactile keypad issues

Examiners and voters found four problems with the tactile keypad.

What happened?

The EZ Access research-based, standard design tactile keypad included eight buttons: two small, rectangular buttons: one black and one red with a raised arrow shape on the upper surface of each; a blue, diamond help button in the top-middle; two white, right and left arrow-shaped buttons; two yellow, triangle-shaped up and down buttons; and a green, round selection button.

- **The two sets of buttons with raised arrows confused voters.** The EZ Access keypad used by this machine is an industry standard keypad, but has some design issues in the context of voting. Because both the right and left, white arrow buttons and the rectangular red and black buttons had raised arrow symbols on their upper surface, and because these buttons differed only slightly in size, they could be easily confused. Voters indicated that if they felt the shapes with two fingers, they could discern the differences, but when just using one finger or thumb on the top of the buttons, it was difficult to tell which one should be pressed. One voter mistakenly pressed the top right button instead of the middle arrow button five times before she learned the button placements.

- **No Braille labels.** The confusion over the keys might have been lessened if there were Braille labels specific to how the keypad is used in the ClearAccess interface. As implemented, only the blue diamond-shaped Help key was labeled in Braille (a letter H). While only 10% of people who are blind are able to read Braille, its presence does not disturb non-Braille readers and helps those who can use it.

- **Too many instructions.** At the beginning of each audio/tactile keypad voting session, the machine reads the keypad instructions. They are very detailed, and complex, including both the primary and secondary functions of each button rather than focusing first on basic navigation instructions. For example, the white, right and left arrow buttons in the middle of the keypad allow the voter to move the next or previous contest. But, if the right arrow button is pressed and held, the voter is taken to the top of the ballot review screen. Worse, if the white, left-arrow button is held for more than one second, the voter can cancel the voting session.

In addition to their primary and secondary functions, most buttons had a third function, based on key combinations. Pressing and holding the top-right button and then pressing the right or left arrow buttons, turns the volume up and down. These multiple actions are possibly too complicated for the limited interaction of a voting system, though they might be learned through advanced training.

Several voters indicated that instructions should be provided that are relevant to the current task rather than providing all of the instructions at the beginning of the process, and when the voter presses the "Help" button.

- **Button descriptions could be better.** The button descriptions and their location did not help blind voters tell them apart, such as describing the top button as having a raised arrow on the button cap. Descriptions of where the buttons are located on the keypad would also be helpful. Blind voters commented that it isn't helpful to describe the color of the button to them. Examiners pointed out that the keypad could be used by many different voters with disabilities, and they understood.

Why is this a problem?

Voters only need the minimum number of instructions to successfully navigate the ballot. When instructions include too much detail or are too long, it is difficult to retain all that has been said. This is especially true when the most important navigation functions are buried in the middle or at the end of the list. Voters have either stopped listening or are fatigued from trying to remember it all.

Cognitive overhead. Voters had to concentrate to determine how to use the keypad. Whether it was trying to understand and remember all of the instructions or choosing the correct similarly-shaped button, significant effort was required to think through the process of voting. When voters have to concentrate on how to perform the tasks, they are not as able to determine on who or what they would like to vote for.

Recommendations

Voter's tactile keypad experience can be improved in three ways

- Remove the top two red and black buttons, or at a minimum, remove the raised tactile arrows from the upper surface of these buttons. The confusion of which button to press may outweigh any benefits from secondary functions.

- Rewrite the instructions page to include only the basic and necessary navigation functions for each button. Provide contextual help on pages where it makes sense, and mention how to access secondary button function instructions, but do not force voters to listen to it all at once.

- When writing button descriptions, use shape words first, then color words. So instead of the "green, round button" it becomes the "round, green button." This helps blind voters zero in on the correct button faster and if a voter with a different ability is using the keypad, they can also use the color word to find the correct button.

3. The write-in process

The write-in screen and process presented several problems for voters.

What happened?

When visually choosing to write in a candidate on the CA, the voter selects the write-in option and is presented with a pop-up screen. It has a text box, where the write-in name will appear and a full QWERTY keyboard. Below this is an "Accept" button that confirms your write-in entry and takes the voter back to the ballot. This all makes sense for a sighted voter because the layout is clear. When using the audio and the tactile keypad, the process is much less clear.

The problems are partly caused by the design decision to add some functions not available in other voting systems, such as editing within the name being entered rather than only at the final position. It is not clear that this additional functionality is worth the confusion it causes.

- **Tactile keypad buttons change function.** Upon entering the write-in screen, audio voters listen to a set of instructions specifically for the write-in process. This is very good implementation of task-specific help. The problem arises because the functions of the buttons change.

  For regular ballot navigation, the left and right arrows are used to move between contests, the up and down arrows move up and down within a list of candidates, and the round, green button makes a selection. However, in the write-in screen, the list of letters is treated like a list of voting options, navigated with the up and down arrow keys.

  - Counter-intuitively, the up arrow moves to the next letter and the down arrow to the previous letter in the alphabet. This is reversed from their function throughout the rest of the interface.
  - The right and left arrow keys move within the letters entered for a candidate's name.
  - The round, green button confirms the write-in entry and returns to the ballot.

  In addition, the action of selecting each letter after the first starting from the beginning of the alphabet ("Space" "A" "B"), rather than maintaining the position in the alphabet, is confusing. It was not possible to wrap from the top of the alphabet to the bottom, nor from the bottom to top. Thus, selecting "W" required moving through all of the letters from A to V rather than just through Z, Y, and X. Voters expected to be able to start at the same character as entered because it is likely closer to the next desired letter than starting from the beginning. This would be an even greater problem for voters using the sip-and-puff switch or dual-paddle switches, if provided. For these voters, one switch action advances to the next letter, and the second action selects the letter. There is no option to back-up, so if the user over-shoots a letter, there is no alternative to restarting the name entry from the beginning.

- **Editing Problems.** The ClearAccess system did not appear to map the delete letter button to the tactile keypad, nor was it an option when scrolling through the alphabet. The only option available was to accept the improperly spelled entry, return to the ballot, and then re-select the write-in option to clear the text box and start again. This is not included in the instructions and voters in the exam did not know to do this.

- **Does not voice the "Space."** The "space" character between names is not voiced each time it repeats the name. One blind voter did not enter a space, yet the system still pronounced the entered name "ChrisSmith" as "Chris Smith." She was not aware until the facilitator told her that the name did not contain a space.

- **Formatting issues.** Once a candidate name has been entered, the contest screen layout has no space between the write-in label and the name. This may have confused the text-to-speech engine, so that the name displayed "Write-in:Chris Smith" was voiced as "Write-in Chris Chris Smith."

- **Write-in keyboard includes entire ASCII character set.** It appears that the designers are using the complete Windows 10 on-screen keyboard for the write-in process. For visual users, this is not an issue, but for blind voters navigating through the alphabet using the tactile keypad or sip-and-puff switch, it would mean scrolling through "&," "}" and the rest of the printable characters to return to the top of the alphabet. Many of these characters are unlikely to be used in a name and could be omitted.

Why is this a problem?

While it is arguable that the write-in process has very little impact in most contests, all of our voters and poll workers were very interested in the usability of the write-in process. And all functions of a voting machine should work effectively for each voter. It does not always have to be the same method, but the outcome should be the same. Not being able to effectively edit a write-in name is a major problem for two reasons.

- Keypad button functions should be consistent throughout the voting process. All blind voters commented that it was confusing or strange to use the up-arrow button to move through the alphabet. Also, voters continually pressed the round select button to confirm a letter entry because that was the function of the button in the main ballot. They were confused when that button took them back to the ballot. Some voters figured it out, but others needed help from the facilitator to know how to re-enter the write-in screen. These same voters would have needed help on Election Day, and poll workers would have to know and understand this issue to give a blind voter adequate assistance.

- Limited instructions combined with editing problems can lead to voter confusion, and ultimately may result in not being able to cast a vote as intended. Even if they can figure out a method to get the system to voice what is actually in the text box, it takes an inordinate amount of mental resources. Resources that some voters cannot spare and should be reserved to deciding who to vote for.

- The unnecessary inclusion of the entire ASCII character set makes an accidental overshoot of the desired letter very burdensome for the disabled voter.

Recommendation

Before a county deploys the ClearAccess the vendor should:

- Re-map and re-write the on-screen instructions to align with their functions for main ballot navigation.
    - Map the down-arrow so it pages through the alphabet to the next letter. Then, map the up-button to go the opposite way through the letters.
    - Make the alphabet wrap from the last option to the first option and vice-versa. This is vital to two-switch access.
    - Include only characters that are found in names in the write-in keyboard. While some accent symbols should be included, “*, &, and %” are not necessary.

    - Map the round button to confirm a character and move to the next character, and make the next character entry start where the previous character was.

    - Make the right-arrow key confirm the entire write-in entry, and return to the ballot.

- Provide a way for voters using the keypad to delete a character both from the end of the write-in and from the middle of the name.

- Include any and all spaces and special characters in the text box when reading the entry to the voter. For example, the audio should pronounce and spell "Chris Smith" ("C-H-R-I-S 'space' S-M-I-T-H"). This way there is no confusion for a blind voter that the entry is as intended.

4. Paper ballot handling

One of the goals of the voting machine upgrade is to allow all voters to vote independently and privately, including verifying their ballot. All paper ballots introduce barriers for voters with low-vision, no-vision, and with limited dexterity.

Most voters appreciated the printed ballot, which allowed a second chance to review the vote before casting. The implementation of the printing and paper-handling of these paper ballots had some issues for voters and poll workers.

Reading the paper ballot

For the ClearAccess ballot marking system, the ballot is printed using a separate, off-the-shelf OKI printer on 8.5 x 17-inch cardstock. The printer sits next to the voting machine and the blank cardstock sits in the manual feed tray. The CA printed ballot is in an optical scan format, which looks identical to a pre-printed ballot used for absentee or provisional voters, and prints each contest in a three-column table.

Having the ballot marking device print an optical scan ballot means that voters do not have to handle a blank, pre-printed ballot before making choices.

However, it also means that there is no feature to allow a voter to "read back" the ballot by reinserting the printed, completed ballot into the voting system.

Using a traditional optical scan ballot is a problem for two reasons.

- **Verification is not independently possible.** Blind and low vision voters often use personal assistive devices that read documents to them. Because all candidates and choices are listed on the regular ballot and laid out in three columns, assistive technology could not read it back and did not know which candidate or option the voter selected. All voters that tried to use this technology were unable to verify their ballot. The readers could not understand the layout. Although the AT was able to identify that the information was in three columns, it could not identify the top or bottom of individual contests, so simply read each line across the page, jumbling up to three contests together.

- **Ballot stock is too big for the printer.** Using an 8.5 x 17-inch ballot meant that the blank cardstock could not be stored securely inside the printer. Instead, it had to sit in the manual feed tray where it is easy to disturb, knock to the floor, or otherwise remove. Also, when stock runs low, the OKI printer provided had trouble picking up the paper, and jammed twice.

Recommendation

- Always print ballots in a maximum of two columns, with plenty of space in between the columns and between contests. The printout should be a "Voter Selection Only" (VSO). This allows personal AT to simply read the names on the print-out, rather than attempt to identify the filled ovals on the ballot. This format allows voters with personal assistive technology to read back their choices.

- Find a way to secure or cover the blank ballot cardstock, and ensure poll workers keep the trays filled so that printing errors do not occur.

Interacting with the ClearCast ballot scanner

As mentioned above, the ClearCast optical scanner was present for voter and poll worker sessions, but it was not set up for the accessibility election. This

meant that no voters were able to cast their ballot after printing it. However, examiners were able to evaluate a scanner set up with a different election.

The scanner had both positives and negatives. In general, the ballot scanner does not produce any major accessible voting barriers.

Some features stood out and could be considered a positive for voters with disabilities.

- The ClearCast scanner tray is just wide enough for the ballot and has tall guides along the sides to minimize the chance that the ballot will be improperly inserted.
- Voters may insert the ballot in any orientation. This may lessen the interaction a poll worker will have to have with a voter with disabilities to cast their ballot.
- The scanner has a large touchscreen that indicates when a ballot as been accepted and cast successfully.
- There is a faint but audible tone to indicate ballot insertion and a successfully cast ballot.

Examiners identified two negatives with the scanner.

- Since the ballot is printed on both sides, privacy is decreased while standing in line before scanning or being helped by a poll worker.
- There is a significant delay between when the ballot is inserted and when the scanner feeds it into the machine. If voters let go thinking that it will be accepted immediately, the ballot can fall to the floor.

While the voter does not spend as much time interacting with the ballot scanner as the touchscreen machine, there are barriers for voters with disabilities that can limit voter privacy and independence. If a voter must ask a poll worker for ballot scanning assistance, this increases the likelihood that the poll worker will see how the individual voted.

Recommendations

- Make the cues more obvious that the ballot is cast. Use large print words or simple images on the screen to indicate the scanning steps and show that the ballot scanned successfully. The audio cue should be louder and the space between the two tones should be filled with a repeated tone so that low visions or blind voters know it is still working.

- Counties should purchase privacy sleeves to cover the ballot after the voter has reviewed it and until it is scanned. This will minimize invasions of privacy and will allow poll workers to assist more confidently.
- Train poll worker to assist voters in ways that do not compromise the voter's privacy. This might include having standard instructions for poll workers to use to guide a voter in casting their own ballot, or narrating the poll worker's actions so that the voter understands what the poll worker is doing.

Recommendations for deployment

The participants – and examiners – saw the systems being tested for the first time during the examination. Many voters will also try using a new system for the first time in the voting booth, so our test was realistic for Pennsylvania voters.

The problems we encountered also suggest ideas for how election officials can support voters and poll workers as they introduce the new system and design their processes and procedures.

The recommendations here are based on observations of how both poll workers and voters used the system and direct suggestions they made.

Advanced training and hands-on practice

The need for an introduction and a chance to try out the system before Election Day was the strongest recommendation from every poll worker participant.

Poll workers felt strongly that any new system – particularly those with digital interfaces – would be intimidating to voters and fellow poll workers who were not used to computers. They recommended:

- Longer training sessions for poll workers to give them more time to familiarize themselves with a new system.
- Opportunities for hands-on experience, including scenarios for different situations they might have to handle.
- An aggressive voter education program to give voters a chance to try out the new system.
- Outreach to voters with disabilities, including those who regularly vote with assistance to let them know about the capabilities of a new system that might help them.
- Have voting machine hands-on demonstrations at disability events so that voters can get to know the machines, practice voting, and be prepared for what they may need on Election Day.
- Instructions or a practice system in the polling place, especially in districts with many older people.

Training for poll workers to support voters with disabilities

Poll workers may not be familiar with how to help people with disabilities. Most of the poll worker participants said that they had no blind or disabled voters in their polling places, although one pointed out that the features on these systems might enable their "assisted voters" to try voting independently.

In addition to a good training module on ways to help voters with disabilities, the training should focus on how to give instructions before and during a voting session to avoid compromising their privacy. For example:

- A "what if" troubleshooting guide could include specific questions to ask and prompts that poll workers can use to help a voter with problem solving without looking at the screen.
- Give poll workers guidance on where to stand while supporting voters. For example, standing behind the ClearAccess touchscreen and facing the voter would make it clear that they are not looking at the screen.
- Using the procedures for initiating a voting session, including the screens to select a language or acknowledge that assistive technology has been activated, to make sure that the voter has found the basic navigation keys on the keypad. On the ClearAccess, the setting and preferences buttons are at the top of the screen at all times. The poll worker can review these with the voter (reading the instructions to be sure they are consistent and accurate).

Poll worker procedures

Poll worker procedures can also help bridge any information gaps for voters, with instructions embedded in the voting process.

- Tell voters how to insert their ballot: identify that the ballot must be placed in the center of the scan bed, and tell them the ballot is inserted directly into the machine, not just slid forward.
- Remind voters to check both the review screen and their paper ballot before casting.
- Tell voters that if they make a mistake, they can get a new ballot.

- Instruct voters that their ballot can be inserted into the scanner in any orientation. Using the privacy sleeve is the most secure. However, inserting the ballot upside down, with the print toward the floor, is sufficient.

Support for voters using the tactile keypad or dual switch and audio ballot might include:

- A keypad they can try out before entering the voting booth.
- Instructions for how to use the keypad in Braille, audio, and large print.
- Test all assistive aids with local voters.

As a voter approaches the voting station, poll workers can help voters adjust the voting system or attach personal assistive technology:

- Help voters get positioned at the voting system so they can reach all controls. The CA screen can be adjusted to change its angle and height for a closer approach, adapting to standing or sitting postures, and avoiding glare.
- Provide help plugging in personal headsets with verbal instructions or by doing it for the voter. The jack on this machine is locate under the bottom of the touchscreen behind the black, plastic bezel. It can be difficult for voters to access, so poll workers should practice inserting and removing a headphone plug.
- The sip-and-puff is currently the only additional assistive device that comes with the ClearAccess machine, and its input is USB-based. Poll workers will need training on how to use this device.
- Make sure voters are oriented and know where all parts of the voting system are, including the privacy shields or covers. The ClearAccess machine includes options to blank the screen during the audio ballot, but then poll workers could bring back the visual mode if the voter has a question.
- Remind voters how to cast their ballot and how to know when they are finished.

Polling place setup

Ensure all polling locations have at least one accessible voting booth with a chair that is easily removed if a voter uses a mobility device.

Voters with disabilities may have assistive technology or personal notes that they need to place within reach. They may also need room to place the printed ballot on a flat surface when using simple personal technology, such as magnifiers or text readers to verify it.

For all voting machines, the path to the touch screen and the scanner should be as easy as possible, ideally a straight line with no obstructions. The path should include ample room to turn a wheelchair if the machine is positioned with the screen facing the wall. The ADA standards suggest a minimum of 60x60 inches for this.

Use assistive technology to support blind and low-vision voters in verifying their ballot, for example, a magnification unit or a simple OCR scanner.

Voting booth setup for this system

Two issues were identified specifically for this system during the examination and usability testing related to how the system and attached devices are placed. The system fits very tightly in the accessible voting booth supplied by the vendor for the exam.

- **Cable management for assistive devices.** The tactile keypad is normally stored behind the screen, connected on a semi-permanent cord. The headphone is plugged in at the bottom of the touchscreen. The printer could be set up to the right or left.
  Recommendation: The cords need to be placed so that they don't interfere with the printed ballot or the voter's ability to find and take their printed ballot.
- **Privacy.** The footprint for this system is relatively small so it can be pushed to the back of the booth. It is easy to read the crisp, clear screen display over the shoulder of someone sitting down, or from the side, especially when large text is used.
  Recommendation: Position the booth so the voter's back is to a wall, so

no one can walk behind them, and with sufficient space to the left and right that people cannot “peek” from the side. However, be sure that there is a good path for a manual or motorized wheel chair to get to the voting booth easily (see above).

XII. Attachment C – Acceptance Testing Attestation

pennsylvania
DEPARTMENT OF STATE

Voting System Implementation Attestation

System Name: Clear Ballot ClearVote 2.5

County: _____

Date Installed/Upgraded: _____

The below hardware/software was installed and verified on the system implemented:

System Component	Software or Firmware Version	Hardware Version	Model	Comments
ClearDesign				(Please specify the implementation, single device (desktop/laptop), Client/server)
ClearAccess				
ClearMark				
ClearCount				
ClearCast				
ClearCast Go				

Further to the key hardware/software components listed above, any of the COTS software installed on the voting system adheres to the EAC certificate of conformance for the ClearVote 2.5 system. Any ancillary components sold under this contract, such as switches, ballot boxes, and charging carts, are EAC-certified components of the ClearVote 2.5 voting system. (Attach a list of all ancillary components sold under this contract.)

Clear Ballot also has validated that the system components have been installed and hardened in accordance with the EAC-certified system hardening instructions, and that no software other than the voting system software has been installed on any of the components.

Clear Ballot and the county confirm that the system implementation adheres to the conditions of certification identified in the Secretary of the Commonwealth's system certification report dated "XX/XX/XX" (the "Report"), and that any deployment of the system for election activities will follow all conditions set forth in the Report.

Vendor Representative Signature: _____

Vendor Representative Name:_____ Title:_____

Telephone:_____ Email:_____

County Representative Signature:_____
County Representative Name:_____Title:_____

XIII. Attachment D – Minimum Training Requirements

Clear Ballot must provide training and training materials as set forth below prior to the first use of the voting system in a primary or general election.

A) A demonstration of and training on the setup and operation of the Voting System to the purchasing county's board of elections' members and staff and the county's precinct election officials.
B) A training session on the Voting System's election management system and/or EPBs for the purchasing county's board of elections' members and no less than two and no more than six staff members chosen by the board of elections. The training sessions must afford the board members and its staff the opportunity to learn how to setup and program an election, and if applicable design and layout ballots independently of Clear Ballot's assistance and support.
C) A training session on the following subjects for the purchasing county's board of elections' members and no less than two and no more than six staff members chosen by the board of elections:
    a. programming of all voting units and ancillary devices;
    b. tabulating results during the unofficial and official canvass;
    c. ensuring accuracy and integrity of results;
    d. preparing polling places and setting up the system for election day operation;
    e. Training on accessibility options of the voting system;
    f. Election day operating procedures;
    g. auditing procedures;
    h. conducting a recount;
    i. preserving records;
    j. printing, designing, and formatting election reports;
    k. troubleshooting common issues;
    l. safeguarding and preventing tampering and unauthorized access to all parts of the Voting System; and
    m. Post-election care, maintenance, and storage.
D) Any and all system manuals necessary to allow a purchasing county to operate the Voting System independently of Clear Ballot's assistance and support.
E) Training materials for a purchasing county's board of elections to use when training its precinct election officials on how to setup, operate, and close down the Voting System on Election Day.

XIV. Attachment E – Escrow Obligations

Clear Ballot must maintain an escrow agreement covering all source codes of the Voting System and/or EPB for a period of ten years from the date of delivery to and acceptance by a purchasing county board of elections. The Pennsylvania Secretary of the Commonwealth shall have the right to access the source codes in escrow subject to the conditions specified below in Section D(8)(d). Clear Ballot must pay all costs associated with 1) placing the codes in escrow and 2) verifying that Clear Ballot has placed the codes in escrow (note: the escrow agent conducts this verification and charges a separate fee for this service).

a. Source code. Simultaneously with delivery of the Voting System and/or EPB software to purchasing jurisdictions, Clear Ballot shall deliver a true, accurate and complete copy of all source codes relating to the software to an escrow agent.
b. Escrow. To the extent that Voting System and/or EPB software and/or any perpetually licensed software include application software or other materials generally licensed by Clear Ballot, Clear Ballot agrees to place in escrow with an escrow agent copies of the most current version of the source code for the applicable software that is included as a part of the Services, including all updates, improvements, and enhancements thereof from time to time developed by Clear Ballot.
c. Escrow agreement, An escrow agreement must be executed by the parties, with terms acceptable to the Commonwealth prior to deposit of any source code into escrow. Clear Ballot shall provide a copy of the escrow agreement to the Department for review prior to execution of the agreement and depositing of any source code.
d. Obtaining source code. Clear Ballot agrees that upon the occurrence of any event or circumstance which demonstrates with reasonable certainty the inability or unwillingness of Clear Ballot to fulfill its obligations to Commonwealth under this Contract, Commonwealth shall be able to obtain the source code of the then-current source codes related to Voting Systems software, EPB software, and/or any Clear Ballot property placed in escrow from the escrow agent.