COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF STATE

REPORT CONCERNING THE EXAMINATION RESULTS OF UNISYN VOTING SOLUTIONS OPENELECT 2.2.3 WITH OPENELECT® VOTING OPTICAL (OVO), FREEDOMVOTE ® TABLET (FVT) FREEDOMVOTE® SCAN (FVS), OPENELECT® VOTING CENTRAL SCAN (OVCS), AND OPENELECT® CENTRAL SUITE (OCS)

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EXAMINATION RESULTS OF UNISYN VOTING SOLUTIONS OPENELECT 2.2.3 WITH OPENELECT® VOTING OPTICAL (OVO), FREEDOMVOTE ® TABLET (FVT) FREEDOMVOTE® SCAN (FVS), OPENELECT® VOTING CENTRAL SCAN (OVCS), AND OPENELECT® CENTRAL SUITE (OCS)

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 Unisyn Voting Solutions (Unisyn), the Department of State's Bureau of Elections (Department) scheduled an examination for March 5th, 2024, of the OpenElect 2.2.3 voting system. The voting system presented for certification in Pennsylvania included the OpenElect Central Suite Election Management System (OCS) election management software used in conjunction with the following components:

1) OpenElect Voting Optical (OVO), a full page dual-sided optical scanner for use in precincts that scans, validates, and tabulates voter ballot pages and provides a summary of all ballot pages cast;
2) OpenElect Voting Central Scan (OVCS), a ballot scanning and tabulating system that can be configured with COTS bulk scanners for central count tabulation applications;
3) FreedomVote Tablet (FVT), an ADA-compliant ballot marking device to assist voters with varying levels with printing marked ballots;
4) OpenElect FreedomVote Scan (FVS), a full page dual sided optical scan precinct scanner

equipped with a large screen for review that scans, validates, and provides a summary of all pages cast.

The 2.2.3 release of OpenElect includes an additional precinct scanner with a screen providing for a full review of ballots before tabulation (FVS).

The Secretary appointed Pro V&V, Inc. as professional consultants to conduct the examination of OpenElect 2.2.3. The examination process included a public demonstration, functional examination, and security testing. Department staff consulted with Whitney Quesenbery as the accessibility examiner to discuss pertinent changes from previously certified releases in consideration of the minimal changes to form factor or accessibility.

The functional examination was performed in Room 114A of the Commonwealth Keystone Building, 400 North Street, Harrisburg, PA 17120. Jack Cobb and Ryan Wilson of Pro V&V's Voting Systems Test Laboratory (Functional Examiners) conducted the functional examination of OpenElect 2.2.3 pursuant to Section 1105-A(a) of the Election Code, 25 P.S. § 303l.5(a). The examinations commenced on March 5, 2024, 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;
- McDermott Coutts, representing Unisyn Voting Solutions.

Additional staff members from the Department also attended 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/en/agencies/dos/resources/voting-and-elections-resources/voting-systems.html). Security testing of the OpenElect 2.2.3 system was performed at Pro V&V facilities located at 6705 Odyssey Drive Suite C, Huntsville, Alabama prior to the functional examination.

II. THE OPENELECT 2.2.3 VOTING SYSTEM

The OpenElect 2.2.3 Voting System is 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 Devices as the ADA component. The following is a description of the OpenElect 2.2.3 components summarized from Section II (System Overview) of the Test Report for Examination of OpenElect 2.2.3 (TR-01-03-PA-001-UNI2.2.3-01.00) prepared by the Functional Examiner and System Overview document submitted by Unisyn as part of the Technical Data Package (TDP).

A. OpenElect Central Suite (OCS)

The OCS System contains a suite of applications that supports elections on the OVO, FVS, FVT, and OVCS systems. The Election Management System (EMS) consists of the following components running as either a front-end/client application or as a back-end/server application:

- Ballot Layout Manager (BLM) – uses a database to create and store precinct and district information and an interface to create, check, translate, and produce the ballot styles needed by a jurisdiction for an election. The BLM output is printer ready artwork of all ballots in all languages and the Unisyn election definition file.
- Election Manager (EM) – converts the Unisyn election definition file to a Unisyn-specific XML format and prepares compressed, encrypted election files for output to CD or USB. The EM allows the jurisdiction to add voting device specific options for elections, i.e., whether to check the contests for undervotes, and whether to allow or disallow certain features such as sounds, party icons, reports, etc. The EM also creates and manages Supervisor and Maintenance technician logins and passwords.
- Tabulator Client (TC) – retrieves vote files and ballot images from a Transport Media (TM) device (USB), stores them on its disk, and transfers the files to the Tabulator and notifies the Tabulator that a new file is present.
- Tabulator (TAB) – receives and validates uploaded voting data and provides a status

of uploaded files as well as handling Rank Choice Voting (RCV) functionality. It also updates the database with adjudicated ballots from the Auditor application. The Tabulator maintains the Tabulator database, which stores the results from all precincts.

- Auditor – accesses ballot images and data from the OVCS and TC PCs to allow jurisdiction personnel to evaluate ballots with questionable or erroneous marks and change votes in accordance to the voter's perceived intent. The Auditor can also be used to process write-in votes. All changes uploaded to the Tabulator database and actions are password controlled.
- Tabulator Reports (TR) – accesses data from the Tabulator database to generate the necessary reports.

B. OpenElect Voting Optical (OVO)

The OVO is a full-page dual-sided optical scan precinct scanner that scans and validates voter ballot pages and provides a summary of all ballot pages cast. The election is loaded from an Election TM. On Election Day, an OVO at each poll location scans and validates voters' ballots and provides precinct tabulation and reporting. The OVO runs Logic Tests and Training Elections in addition to General and Primary Elections.

The OVO unit can also paired with FVT units for early voting to scan and tabulate early voting ballots and election support at voting centers. Additionally, OVO units can be used at election headquarters to read absentee, provisional or recount ballots in smaller jurisdictions.

The OVO consists of the following components:

- Personal Computer (PC) - Computer component (with a touch panel display) has the OVO application installed that manages data and provides a user interface for voting and maintenance. A new election loaded via a Transport Media (TM) sets passwords, parameters, and ballot styles for that election. (Valid ballots for a poll location are

reinitialized or set on Election Day startup by scanning a ballot header card).

- Transport Media (TM) – 1 GB or larger USB thumb drive that provides the means of transporting audit, optional ballot page images and results files from the precinct on Election Night to Election Headquarters where the central count system resides.
- Ballot Reader - Dual-sided scanner connected to the PC to scan data from marked ballot pages. The Ballot Reader ejects accepted ballot pages into an attached ballot box or rejects unaccepted ballot pages back out to the voter.
- Printer - 58 mm thermal receipt printer connected to the PC to print voter receipts and reports at the OVO.
- UPS - Uninterruptible power supply is provided as part of the system.

C. OpenElect Voting Central Scan (OVCS)

The OVCS units reside at election headquarters designated to read absentee, provisional or recount ballots in large jurisdictions or read the entire election's ballots at a central count location in smaller jurisdictions. The OVCS also captures Write-In data images and produces a Write-In image report for manual processing upon request.

The OVCS system consists of the following components:

- PC Desktop - A desktop PC configuration with the following minimum characteristics:
- PC: 1.8 GHz Processor, 2 GB RAM, 250GB (or larger) Hard Drive, USB Ports, Network Interface Port (Ethernet), CDRW/DVD, Video Port
- 16:9 LCD
- Keyboard and Mouse
- Bulk Scanner – A dual-sided scanner (Canon model DR-M160II, model DR0G2140 or model DR-X10C) that is connected to the PC to scan data from marked ballots.

D. FreedomVote Tablet (FVT)

The FVT is a tablet ballot marking device that enables voters to make their vote

selections and to print their voted ballot. It can be used on Election Day or during an early voting period. The FVT is ADA compliant. It assists voters, with varying levels of ability, through the voting process, ballot review, and printing functions. The FVT presents each contest of the ballot style to the voter in visual and/or audio formats.

It facilitates special needs voters through a variety of methods including wheelchair access, sip and puff, zoom-in ballot function and audio assistance for the visually impaired. The voter with limited vision can navigate through the ballot using an audio ballot and the ADA keypad or touchscreen to input their selections. Once the ballot is printed, it is taken to the OVO/FVS to be cast. Each FVT can support multiple languages for both visual and audio ballots, allowing the voter to choose their preferred language.

The FVT consists of the following components:

- Tablet – The Android tablet has a 13.3 in. touchscreen and comes with pre-installed software that provides user interfaces for voting and maintenance. Election files generated by the EM are loaded manually via a USB. The election files will allow the jurisdiction to determine the FVT's mode such as early voting or training, sets passwords, parameters, audio, and ballot styles for that election.
- Barcode Reader - 2D USB Barcode reader will read the 2D barcodes produced by the EM such as the initialize barcode and administrative/maintenance barcodes. It will also read the 'populate' barcode produced by other qualified systems.
- USB Hub – A four port USB hub is installed in the FVT case to connect the printer, barcode scanner, and keypad to the tablet.
- Printer – 82.5 mm thermal receipt printer is connected to the Tablet to print BMD ballots and reports.
- Optional ADA Devices – 10-key keypad with a Sip and Puff Interface, Headphones, Sip and Puff Device.

III. EXAMINATION APPROACH, PROCEDURES, AND RESULTS

A. Examination Approach

To determine whether OpenElect 2.2.3 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 Examiner developed test protocols for the examination. The Examination was broadly divided into three categories; a Functional Examination, Security Testing, and Accessibility Examination.

B. Functional Examination

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

2) Functional Configuration Audit

3) System Integration Test

The **Physical Configuration Audit** (PCA) compared the voting system components submitted for evaluation to the manufacturer's technical documentation and the defined configuration for use in the Commonwealth of Pennsylvania. The PCA 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 pertinent 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;

As part of the PCA, a verification of the Trusted Builds of the software installed on each system component, was performed to ensure that 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 **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. This testing included all proprietary components and COTS components (software, hardware, and peripherals) in a configuration consistent with the system's intended use. For software system tests, the tests were designed according to the stated design objective without consideration of its functional specification. The system level hardware and software test cases were prepared independently to assess the response of the hardware and software to a range of conditions and validate the 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(17), requiring an electronic voting system which provides for central-count tabulation to (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;
- 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(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.

Specifically, the FCA for the OpenElect 2.2.3 campaign consisted of executing the following test cases for each listed component:

OVCS – Canon DR-M160II:

- 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

OVCS – Canon DR-G2140:

- 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

OpenElect Central Suite (Election Management System):

- Evaluation of Election Management System (EMS)
- PA-UNI223-TC-001Adjudication of General Election
- PA-UNI223-TC-002 Adjudication of Open Primary Election
- PA-UNI223-TC-003 Write-in Extraction and Management

FreedomVote Scan:

- 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
- PA-UNI223-TC-004 FVS Undervote Checking

OpenElect Voting Optical:

- 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
- PA-UNI223-TC-005 OVO Undervote Checking

FreedomVote Tablet:

- 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)

System Integration is a system level test for the integrated operation of both hardware and software. System Integration 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. 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. During System Integration testing, one General Election and one Primary Election were exercised on the voting system. System Integration evaluated the following sections of the election code for use:

- 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.

C. Security Testing

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). The submitted modifications to the OpenElect 2.2.3 System did not include security specific modifications; however, modifications related to security were included in OpenElect 2.2 (the baseline for the OpenElect 2.2.3 system), which included a new Precinct Count Optical Scanner, and an Engineering Change Order (ECO) related to the introduction of the EOS 5.0 Operating System. A complete security evaluation was performed on the baselined system. The security tests were based on the PA Voting System Security Standard, published as Attachment E to the Directive for Electronic Voting Systems.

The Security Examiner (Pro V&V Labs) conducted security tests that covered the following areas of testing : Security Specification Conformity and Penetration Testing.

To evaluate the OpenElect 2.2.3 Voting System for **Security Specification Conformity** results from EAC certification testing performed on the OpenElect 2.2 Voting System were reviewed. In addition, results from the evaluation of Unisyn ECO 17120 which introduced the EOS 5.0 Operating System for usage on the Dell Latitude 5520 laptop, and Unisyn ECO 2310 which added support for EOS 5.0 usage with the Dell Latitude 5540 laptop, were evaluated. A complete security evaluation was performed on the baseline OpenElect 2.0 Voting System.

The focus of **Penetration Testing** was to seek out and exploit vulnerabilities in the voting system 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.

D. Accessibility Examination

The Department of State, in consult with the Whitney Quesenbery of the Center for Civic Design, found that the conclusions taken from the OpenElect 2.0A2 Accessibility Examination can also be extended to OpenElect 2.2.3, since there were only minor hardware or software changes to any accessibility features. The only new equipment not included in any Accessibility Examination is the FreedomVote Scan, which functions largely as a redundant review screen before the accessible ballot is tabulated. Accessibility Examiner reviewed the changes and issued observations that will be included with the original observations from the Accessibility Examination of OpenElect 2.0A2.

The accessibility examination for OpenElect 2.0A2 was designed to provide insights about each voting system'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:

Expert review 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.

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.

Election officials and poll workers tested the accessibility features to evaluate how they would be activated during an election. They commented on the system based on their experience.

The testing team constructed a typical PA ballot, with a mix of contest types and variation in the number of candidates to be voted for each contest. The Accessibility Examiner conducted an expert review, observed 8 voters with disabilities, and worked with 7 poll workers in a guided review of the systems. Four voters used the FVT. All voters used the OVO to scan and cast their ballots.

IV. EXAMINATION PROCESS AND PROCEDURES

The procedures and processes used during the examination of OpenElect 2.2.3 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 Procedures

Unisyn 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 PROV&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 Function Examiner with assistance from a Unisyn representative by using the process listed in the manufacturer's Technical Data Package (TDP). The Functional Examiner further compared and confirmed that all the captured hash codes matched the hash codes for the EAC certified system executables before executing the test scripts or continuing with the examination.

The public demonstration and functional examination portions of the testing commenced on March 5th, 2024, 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 2 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 during the examination. The documentation review portion of the Physical Configuration Audit was completed prior to the public examination at ProV&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. The Functional Examiner then established a configuration baseline of software and hardware to be tested and confirmed whether the manufacturer's documentation is sufficient for the user to install, validate, operate, and maintain the voting system. During execution of the PCA, the components of the OpenElect 2.2.3 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.

2. Functional Configuration Audit

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. The Functional Examiner executed test cases for the OpenElect Voting Central Scan, Central Suite, Voting Optical, FreedomVote Tablet, and FreedomVote Scan.

3. System Integration

The Functional Examiner created the election definition using OpenElect Central Suite-Ballot Layout Manager and Election Manager, and Transport Media (TM) was used to transfer those elections to FreedomVote Scan (FVS), OpenElect Voting Optical (OVO), and FreedomVote Tablet (FVT) units. The polls were opened, and zero reports were printed and verified. Hand-marked paper ballots and ballots marked electronically via the FVT Ballot Marking Device (BMD) were cast and tabulated through the FVS and OVO precinct count optical scan tabulators. All ballots created (hand-marked, and BMD) were then tabulated through the OpenElect Central Scan tabulator using two COTS central scanners, the Canon DR-G2140 and the Canon DR-M160II. 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 was then performed on both General and Open Primary elections, in Tabulator

Runs specific to adjudication, to demonstrate the adjudication capabilities of the OpenElect 2.2.3 voting system.

Examiner used English, Spanish, and Simplified Chinese ballots for the Primary Election.

B. Security Examination Procedures

The Security Testing was done at ProV&V lab facilities in Huntsville, Alabama. The Security Examiner received the hardware devices from Unisyn and already had the software and firmware since ProV&V was the Voting System Test Lab (VSTL) which tested the system for EAC certification testing. The Examiner installed the Trusted Build prior to the evaluation 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 OpenElect 2.2.3 system in the following manner. The Security Examiner did a review of the EAC testing reports of the system and executed tests for a cross section of Voluntary Voting System Guidelines (VVSG)1.0 requirements to reconfirm compliance. 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 the Contractor'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: Security Specification Conformity 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 PCA. This assessment utilized testing conducted by Pro V&V on the baselined system; only modifications were evaluated to determine impact on the previous test results.

The Security Examiner followed the below approach for Penetration Testing:

1) System Decomposition and Enumeration
2) Hardware Asset Enumeration
3) Software Asset Enumeration
4) Data Asset Enumeration and Classification
5) Security Control Enumeration
6) Risk Assessment
7) Identification of opportunities for attack simulation
8) Research technical vulnerabilities and exploits
9) Feed results into penetration testing exercises

The objective of the Security Specification Conformity 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. Due to the lack of modifications introduced into the OpenElect 2.2.3 Voting System, review of the previously conducted OpenElect 2.2 voting system test campaign was deemed sufficient. To meet the objectives of the OpenElect 2.2 test campaign, the modified components were evaluated to determine the effectiveness of their physical security measures and to determine if the modification adversely impacted results from the baseline test campaign.

The test methods for performing the security testing were execution and review. Prior to performance of security testing, the examiner verified that security hardening scripts have been properly applied to system components per the system documentation. The examiner reviewed the submitted TDP to verify that documented access and physical controls are in place. Following the documented procedures, the examiner configured the voting system for use and functionality to verify that the documented controls were in place and adequate and met the stated requirements.

Physical security was tested by setting up the system as described in the TDP and then examining the effectiveness and comprehensiveness of physical security measures. Administrative Security was tested by examining the system's documented security instructions and procedures for effectiveness and breadth. Logical Security was tested by performing a review of the SCAP checklist against the FVS precinct count tabulator.

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, being used; and voting system use procedures.

Penetration Testing scenarios were selected and prioritized based on threat / vulnerability pairs derived from conducting a 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 OpenElect 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.

C. Accessibility Examination Procedures

Whitney Quesenbery of the Center for Civic Design, serving as the accessibility examiner, reviewed the changes between the previously certified version and OpenElect 2.2.3. Accessibility Examiner reviewed the video of the public demonstration portion of the examination to understand the voter facing changes. Department staff also had discussion with the Accessibility Examiner; Quesenbery provided her insights which will be included in the Examination Results portion of this report as a supplement to the initial finding from the examination of OpenElect 2.0A2.

The accessibility examination portion for OpenElect 2.0A2 commenced on August 27, 2018, at Room G24A/B of the Commonwealth Capitol Complex - Finance Building. The examination lasted approximately three days followed by a debrief meeting on August 30, 2018, with DOS and CCD to discuss initial findings. The examination included expert review by the Accessibility Examiner, sessions with 3 poll worker groups from Dauphin County, PA, and sessions with 7 voters with disabilities using different accessible devices for voting. The voter sessions each took approximately an hour. The poll worker sessions took approximately an hour to 90 minutes each. Unisyn supplied the hardware and supplies for the Accessibility Examination. The equipment was prepared for the examination by loading the required election definition using transport media. The test examined the FreedomVote Tablet (FVT) ballot marking device and the OpenElect Voting Optical (OVO) ballot scanner.

The typical accessible voting experience involves the voter making selections on the FreedomVote Tablet to mark and print their ballot and then scanning their printed ballot on the OVO or FVS to cast the ballot. The Accessibility Examiner identified the accessibility features of each component as listed below:

1. FVT accessibility Features

- ADA compliant voting booth/stand
- 13” touchscreen in portrait orientation (with gestures including swipe up, down, left right)

- Audio ballot with MP3 sampled audio and text-to-speech audio.
- Tactile keypad with different-shaped, braille encoded buttons.
- Binary input/dual switch jack on tactile keypad
- Audio output jack

Voter-adjustable settings include:

- Screen reader toggle switch
- Audio volume and tempo
- Text size
- Screen brightness
- High contrast mode

2. OVO accessibility features

Some features of the OVO are helpful for accessibility:

- Small screen display (for visual instruction and confirmation)
- Engraved chevrons/arrows on the scanner pointing towards opening to insert paper to assist with voter orientation.

The machine features listed above are not exhaustive.

The Accessibility Examiner prepared voting scenarios for each voting session to allow comparison of results between each session. The scenarios were constructed to provide a structured opportunity to explore how the system works in all interaction modes, using:

- visual touch screen with default settings;
- visual touch screen with text size and contrast changes;
- audio and the tactile keypad;
- audio and the visual touch screen; and
- audio or visual display with the dual switch.

Both the ballot contents and the instructions for marking the ballot were designed to exercise different types of interactions (navigation in ballot, navigation in contest, undervotes, overvotes, straight party, navigation within the review/summary screen, making changes to a contest from the review/summary screen). The ballot included both very short contests, and those long enough to potentially fill more than one screen, even at the default text size.

3. Expert Review by Accessibility Examiner

During the OpenElect 2.0A2 accessibility examination, the Accessibility Examiner used the same ballot and instructions to be used for voter and poll worker review, for their expert review, so they would be familiar with the interaction voters would experience.

Sessions with voters

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.

Sessions with poll worker groups

Each poll worker session took approximately one hour, depending on the group size and provided the most activity variability. 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 roll-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.

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

On March 26th, 2024, the Functional Examiner issued his draft report for the testing of OpenElect 2.2.3 with the recommendation that the system was in compliance with all pertinent sections of the Pennsylvania Election Code. The Examiner's report for OpenElect 2.2.3 (TR-01-03-PA-001-UNI2.2.3-01.00) included details of the test cases, execution, and successful completion. The following Section contains a summary of all results of the examination as explained in fuller detail in the Examiner's Report.

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 OpenElect 2.2.3 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

During execution of the PCA, the components of the OpenElect 2.2.3 were documented by component name, model, serial number, major component, and any other relevant information needed to identify the component. A hash validation of the installed software was performed to ensure that the Trusted Builds of the OpenElect 2.2.3 voting system were installed. Installed software which did not match the available hash validation files, were updated with the Trusted Build software. Unisyn Voting Solutions shipped a collapsible ballot box (Model: BB 2003-10553 Rev A) for use in this testing effort, however it appeared to have been damaged during shipping and was unable to be setup and used for testing. As such, the collapsible ballot box was not included in the PCA. It should be noted however, that the collapsible ballot box was tested during the OpenElect 2.2 and OpenElect 2.2.3 EAC certifications.

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

OpenElect Central Suite (OCS):

- Server Laptop – Dell Latitude 5540 – S/N: GCF9GX3
- Installed Applications: Auditor, Ballot Layout Manager, Cast Vote Record utility, Election Manager, OCS Installer, OVCS Central Scan, Tabulator Client, Tabulator Monitor, Tabulator Reports, Write-In Extractor utility, Write-In Manager utility
- Client Laptop – Dell Latitude 5520 – S/N: 5XJBCL3
- Installed Applications: Ballot Layout Manager, Cast Vote Record utility, Election Manager, OCS Installer, OVCS Central Scan, Tabulator Client, Tabulator Monitor, Tabulator Reports
- Network Switch – Netgear ProSAFE GS 108 Gigabit Switch (GS108v4) – S/N: 3TX22B7ND0B45

OpenElect Central Scan (OVCS):

- Server Laptop – Dell Latitude 5540 – S/N: GCF9GX3
- Client Laptop – Dell Latitude 5520 – S/N: 5XJBCL3
- Scanner – Canon DR-G2140 – S/N: JS300074
- Scanner – Canon DR-M160II – S/N: GX328990

FreedomVote Scan (FVS):

- FreedomVote Scan – Model: FVS 2003-10519 Rev A – Precinct Count Optical Scanner – S/N: UVS043217
- Plastic Ballot Box with Hybrid Lid – S/N: N/A

OpenElect Voting Optical (OVO):

- OpenElect Voting Optical - Precinct Count Optical Scanner – S/N: UVS019001

FreedomVote Tablet (FVT):

- FreedomVote Tablet (FVT-B) – Ballot Marking Device – S/N UVS217252
- Accessories:

- Headphones – Make: Koss Model: KPH7
- Sip & Puff device – Make: Origin Instruments Model: AirVoter S/N: 005955

Functional Examiner concluded that 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) election code requirements were met by OpenElect 2.2.3 voting system and were addressed as part of the PCA and documentation review.

2. Functional Configuration Audit

The test cases for the OpenElect Central Suite, OpenElect Voting Central Scan (Canon DR-M160II & Canon DR-G2140 scanners), FreedomVote Scan, OpenElect Voting Optical, and FreedomVote Tablet 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(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. Functional Examiner also validated that all the votes were counted appropriately on OVCS, OVO, and FVS.	OpenElect Central Scan -Canon DR-M160II -Canon DR-G2140 OpenElect Voting Optical FreedomVote Scan FreedomVote Tablet
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	OpenElect Central Scan

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.	-Canon DR-M160II -Canon DR-G2140 OpenElect Voting Optical FreedomVote Scan FreedomVote Tablet
25 P.S. § 3031.7(7) - Attempt to Over Vote Contests and Questions Functional Examiner tested to confirm that FreedomVote Tablet prevented overvotes, OpenElect Voting Optical warned voters for overvotes if configured, and OVO, FVS, and OVCS did not count any votes for a contest that was overvoted.	OpenElect Central Scan -Canon DR-M160II -Canon DR-G2140 OpenElect Voting Optical FreedomVote Scan FreedomVote Tablet
25 P.S. § 3031.7(10) - Ballot Review and Change Functional Examiner tested to confirm that FreedomVote Tablet allowed the voter to make changes until a ballot is printed. Tabulation devices allowed for the voter to scan the new ballot received after they spoiled the original ballot	OpenElect Voting Optical FreedomVote Scan FreedomVote Tablet
25 P.S. § 3031.7(16) & (17) - Public Counter, No Reopening of Polls, Media Security with Tamper Proof Locks and Zero Proof and Tally Reports Functional Examiner validated that the voting device is able to produce a “Zero Proof” and “Tally Report”.	OpenElect Central Scan -Canon DR-M160II -Canon DR-G2140

The voting device has a visible public counter and the counter increments correctly.	Open Elect Voting Optical FreedomVote Scan
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. Functional Examiner validated that the observer was not able to determine the voter's selection 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.	FreedomVote Tablet

3. System Integration Test

System Integration is a system level test for the integrated operation of both hardware and software. System Integration 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. 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 tamper-evident seals. During System Integration testing, one General Election and one Primary Election were exercised on the voting system, as described below:

A general election 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. This election contains twenty contests compiled into four ballot styles (excluding language styles). 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 are as follows:

- 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.

A closed primary election 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 supported in a primary election by the Commonwealth of Pennsylvania are defined in this election. The voting variations are as follows:

- Partisan contest
- Non-Partisan
- 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 three languages (English, Spanish, Simplified Chinese), and support for common primary specific voting variations.

System Integration is a system level test for the integrated operation of both hardware and software. System Integration 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. 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 tamper-evident seals.

During execution of the test procedure, it was verified that the OpenElect 2.2.3 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 OpenElect 2.2.3 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 Election.

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.

B. Security Testing Results

OpenElect 2.2.3 system is an upgrade to OpenElect 2.2. The Security Examiner reviewed test reports for OpenElect 2.2.3. Since no security modifications were introduced into the OpenElect 2.2.3 Voting System, the Security Examiner determined that the review of previous test results was sufficient for establishing conformity to the defined security specifications. Security Examiner also performed penetration testing on the baseline OpenElect 2.2 voting system. Security Examiner performed risk assessment with the primary objective being to use the analysis to identify, select, and prioritize penetration testing scenarios. Areas highlighted by the risk assessment matrices served as identification of critical targets for penetration testing as they presented the biggest areas of risk for the system. The results of the risk assessment were used to conduct the penetration test to ensure the implemented security controls were sufficient to mitigate those risks identified. Security Examiner provided opinions and recommendations for

secure implementation of the system which are identified as conditions for implementation in this report.

The Examiner states in Section IV: Conclusion of their penetration/test report that "The OpenElect 2.2.3 Voting 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 OpenElect 2.2.3 system be considered safe and secure for use by voters at elections."

C. Accessibility Examination Results

The tests included examiner review, sessions with voters and poll workers. A summary of the test details and findings is discussed in this section.

1. OpenElect 2.0A2

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 understand how the system and accessibility features works and to note anything they want to watch for during other testing.

Voter Sessions

The following voter population was represented in the test sessions:

- 1 blind from birth;
- 1 cognitive disability;
- 1 deaf/no usable hearing;

- 1 dexterity/limited use of hands;
- 1 dexterity no use of hands + using a power wheelchair;
- 1 dexterity/no use of one hand + low vision (Caregiver);
- 1 mild cognitive disability + mobility/power wheelchair;
- 1 mobility/artificial limb (Caregiver);
- Age Ranges: 35 thru 70. All but one (a 70-year-old) were in the 35-60-year-old age range;
- Counties: Allegheny, Dauphin, Philadelphia, or York.

The voters had a range of voting habits and included people who have voted with assistance and without. The mix of voters and the range of disabilities provided enough range to test most of the accessibility features.

Poll worker Sessions

Poll workers were invited to come in teams. Each team had an election judge, and one team included a county election official. There were three poll worker sessions with a total of seven participants. These Poll workers:

- were from Dauphin County;
- had between five and twenty-four years of experience and included one election judge;
- had limited experience serving voters with disabilities.

The Accessibility Examiner compiled the findings from the examiner review, voter sessions and poll worker sessions into positives, annoyances, problem solving, needs assistance and showstoppers.

The Accessibility Examiner noted in the summary section of the report that, the Unisyn systems are an advance in independence and privacy for Pennsylvania voters with disabilities, and identified several positive aspects of the system including the following:

- Access features were easily learned by voters and poll workers and poll workers reported the features would help their voters.
- Sufficient default text size for almost all voters and the ability to make significant changes in font size available in the setup controls.
- Accessible voting booth was at a good height for voters sitting in a conventional chair or using mobility devices including powered and manual wheelchairs.
- Ballot summary/review screen and process are generally intuitive and helpful.
- Touchscreen gestures (scroll up and down, swipe left and right) on the FVT were not confusing and a welcomed surprise.
- OVO scanner has features that could make it accessible to voters.

Top 5 Accessibility Issues:

The following are the top five accessibility issues identified. Attachment B of this document lists these issues in fuller detail and describes all the observations from the Accessibility Examination.

- Confusing navigation and highlighting -Inconsistent navigation tools and insufficient highlighting caused some challenges and delays in voting. Voters may inadvertently skip a contest because the button that scrolls through pages of candidates is also sometimes used to switch contests.
- Reviewing undervoted contests - The FVT used dark red backgrounds, deficient text formatting, and insufficient communication to call attention to under-voted contests. This color was interpreted by voters as an indication of an error they must fix, was hard to read, and did not provide enough contrast with the black text. All of our test voters interpreted the color to indicate that full voting was compulsory.
- Compulsory behavior - The FVT systems require a voter to view all candidates, view all races, and view the entire ballot summary before they can move to the next step. This compulsory behavior is, at best, annoying and slow and, at worst, inappropriate.
- OVO scanner - The scanner had both positives and negatives for voters with disabilities,

especially those with low or no vision, in the effort to independently insert their ballot.

The Accessibility Examiner noted that both test voters and poll workers stressed the need for a strong education program to introduce the new systems, including opportunities for hands on training or practice as a new system is rolled out. The examination team also stressed the need for well thought out deployment of any new voting machines (recommendations listed in Attachment B) and effective poll worker training.

2. OpenElect 2.2.3

After discussion between the Department and Accessibility Examiner, a determination was made that with straight-party voting and the Pennsylvania Method no longer in use, the deselection issues noted during the accessibility examination of OpenElect 2.0A2 are no longer relevant. With the minimal scope of hardware and software changes, there is no need for another accessibility examination and the findings from OpenElect 2.0A2 will suffice for the examination of OpenElect 2.2.3.

VI. OBSERVATIONS

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

- Unisyn OpenElect 2.2.3 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 device FVT presented as part of the OpenElect 2.22.3 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.
- The OpenElect Voting Interface –Voting Center (OVI-VC) was not presented for examination and is not included in the Secretary's Certification for the Commonwealth of Pennsylvania.
- Observations/Findings identified during the Accessibility Examination for OpenElect 2.0A2 as identified in Appendix B.

The FVT can accommodate 4 to 5 voters using assistive devices or 8-12 voters an hour when used as the primary voting system depending on the size of the ballot. The OVO and FVS precinct scanners can serve 120 voters per hour depending on the length of the ballot. The FVT prints 75-100 ballot cards with one roll of paper. After that new paper roll will need to be inserted to continue the printing process. OVO and FVS precinct tabulators allow a maximum of 5,000 ballots cast per session after which the units will need to have another TM inserted to continue the tabulation process. The Unisyn recommended batch size for OVCS is 100 ballots.

All testing of OpenElect 2.2.3 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 OpenElect 2.2.3.

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. 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. § 3031.1, 3031.2, 3031.3, 3031.4, 3031.5, 3031.6, 3031.8, 3031.9, 3031.10, 3031.11, 3031.12, 3031.13, 3031.14, 3031.15, 3031.16, 3031.17, 3031.18, 3031.19, 3031.20, 3031.21, and 3031.22.

The Function 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 OpenElect 2.2.3 demonstrates compliance with all 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 March 2024 and the reported findings of the Examiners as set forth in their reports, the Secretary of the Commonwealth certifies OpenElect 2.2.3 for sale and use in Commonwealth elections subject to the following conditions:

The Secretary's certification for OpenElect 2.2.3 is predicated on the EAC final certification decision dated 8/22/2023. The final EAC certification report is appended to this certification report as Attachment A.

A. Pennsylvania counties using the OpenElect 2.2.3 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 25th, 2023, and any future revisions or directives. In particular, Pennsylvania counties must adhere to item four (4) of the directive when setting up and positioning the FVT 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)). The FreedomVote Tablet BMD screens have large size and high-resolution display and are very clear and can be viewed at wide angles without distortion. Jurisdictions must make a note of this while setting up polling places and purchase privacy booths or orient the FVT screen away from the center of the voting area to protect the privacy of the person using it.
B. Equipment Reporting by jurisdictions. 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 OpenElect 2.2.3 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 the OpenElect 2.2.3 shall be connected to any modem or network interface, including the Internet, at any time, except when a standalone local area wired network configuration 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 OpenElect 2.2.3, including wireless LAN cards, network adapters, etc. must be uninstalled or disabled prior to delivery or upon delivery of the voting equipment to a County Board of Elections.

D. Because OpenElect 2.2.3 is a paper-based system, counties using the OpenElect 2.2.3 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 via a manual count of the voter marked paper ballots exclusively. Counties must include in the sample ballots marked by ADA compliant components. Counties are advised to consult 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 25th, 2023, and any future revisions or directives that may apply to audits of electronic voting systems.

E. All jurisdictions implementing the OpenElect 2.2.3 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. Jurisdictions must include audio ballots and accessible devices during L&A 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. OpenElect 2.2.3 is a paper-based system and hence, implementation of the system for precinct or central count scanning is scalable. Jurisdictions should calculate the number of voting booths necessary to accommodate the number of registered voters in a precinct to avoid long lines. Jurisdictions must include the FVT as an ADA compliant device in configuring a precinct polling place. Jurisdictions must also take into consideration the OVO and FVS scanning speed, ballot box and Transport Media capacities on polling

place components when deciding on the number of voting booths.

G. All jurisdictions implementing the OpenElect 2.2.3 must implement administrative safeguards and proper chain of custody to facilitate the safety and security of electronic systems pursuant to the Guidance on Electronic Voting System Preparation and Security, October 2020.

H. Jurisdictions implementing the OpenElect 2.2.3 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.

I. All jurisdictions implementing OpenElect 2.2.3 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 to avoid any password compromise. The passwords and permissions management must at a minimum comply to the password requirements outlined in NIST 800-63. This publication can be accessed at https://pages.nist.gov/800-63-3/sp800-63-3.html.

J. Jurisdictions implementing OpenElect 2.2.3 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.

K. All jurisdictions implementing OpenElect 2.2.3 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).

L. All jurisdictions implementing OpenElect 2.2.3 must work with Unisyn to ensure that only the certified system configuration is installed on purchase or anytime 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. A sample format that can be used for the attestation is added as Attachment C to this document.

M. Unisyn must work with the jurisdictions implementing OpenElect 2.2.3 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.

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

O. Jurisdictions implementing OpenElect 2.2.3 must work with Unisyn 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.

P. Jurisdictions using the services of Unisyn or a third-party vendor for election preparation activities must work with Unisyn or the vendor to ensure that systems used for ballot definition activities are considered part of the voting system and use certified voting system components. The systems used for ballot definition must be configured securely following conditions outlined in this report and following any Directives and Guidance issued by the Secretary. Any data transfer between the vendor and county must be done

using encrypted physical media or 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.

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

R. Jurisdictions using barcodes for FVT activation must ensure that poll workers are trained to maintain strict chain of custody of the activation and administration/maintenance barcodes.

S. Unisyn must ensure that any implementations in Pennsylvania counties must appropriately indicate that the FreedomVote Tablet BMD is printing the ballot and the final messaging on the FVT 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 Unisyn support personnel and verified by county election officials.

T. Jurisdictions must have appropriate instructions on the FreedomVote Tablet BMD to ensure that the voter reviews the entire ballot before printing the ballot.

U. Jurisdictions must work with Unisyn 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.

V. Jurisdictions must work with Unisyn 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.

W. Jurisdictions must work with Unisyn 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:

    - The audio ballot must fully inform the voter what has happened on the system and how to select/deselect their choices;

- The feedback messages must explain to voters what is happening, including the number and names of candidates being deselected; and
- The audio ballot must provide feedback on the reason for the changes in any selections and the interaction with straight-party choices.

X. The electronic voting system must be physically secured while in transit, storage, or while in use at their respective locations. Unmonitored physical access to devices can lead to compromise, tampering, and/or planned attacks.

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

Z. 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 Unisyn 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 that can be removed by authorized personnel when the port is needed.

AA. Jurisdictions using standalone installation of the EMS server on portable devices must protect the laptops to prevent lost or stolen device.

BB. 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 and reported in a timely manner.

CC. Jurisdictions implementing OpenElect 2.2.3 must ensure that the USB devices and any other removable or transportable media used for election activities is maintained with strict chain of custody. There must be a process to manage the removable/transportable media inventory to avoid misplaced and lost media. The devices must either be replaced or reformatted before use in each election. Appropriate steps must be taken to ensure that the format is a full reformat of the USB devices.

DD. Jurisdictions implementing OpenElect 2.2.3 must work with Unisyn to ensure appropriate levels of training for election officials is planned on implementation. Counties must ensure that the trainings adhere to the “Minimum Training Requirements”

specified in Attachment D of this document.

EE. Jurisdictions implementing OpenElect 2.2.3 must include voter and poll worker training as part of the implementation plan. The training must include hands on practice for both voters and poll workers. 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 OpenElect 2.2.3 must consider the following during voting booth set up for serving voters requiring assistive devices:

- 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 to use personal technology such as magnifiers or text readers to verify it.
- The path between FVT and the OVO or FVS 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.

Refer to Attachment B, listing detailed recommendations for deployment noted by the Accessibility Examiner.

GG. Unisyn 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 publicly available social media platform. The videos must have audio instructions and must be closed captioned:

i. video (in an electronic format) for voters that demonstrates how to cast a vote 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. Must be provided in additional languages for any jurisdictions required to meet thresholds in the Voting Rights Act.

HH. Unisyn must adhere to the following reporting requirements and submit the following to the Secretary:

i. 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;

ii. Ownership, Financing, Employees, Hosting Location. Any changes of information on the Unisyn'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, Unisyn 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; and

iii. Security Measures and any updated security testing or risk/vulnerability assessments conducted by Unisyn or a third party.

II. Unisyn must adhere to the "Source Code and Escrow Items Obligations" specified in Attachment E of this document.

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

KK. Jurisdictions implementing the OpenElect 2.2.3 and Unisyn must work together to implement 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). Unisyn must ensure that future releases of the voting system with enhanced security and accessibility features are presented for approval to the Secretary.

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

MM. In addition, pursuant to the Directive Concerning the Use, Implementation and Operation of Electronic Voting Systems by the County Boards of Elections issued on September 25, 2023, and section 1105-A(d) of the Pennsylvania Election Code, 25 P.S. § 3031.5(d), this certification and approval is valid only for OpenElect 2.2.3. If the vendor or a County Board of Elections makes any changes to the OpenElect 2.2.3 Voting System subsequent to 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 OpenElect 2.2.3 Voting System in the Commonwealth of Pennsylvania.

NN. Jurisdictions implementing OpenElect 2.2.3 must review the Secretary's certification report for OpenElect 2.0A2 issued on December 14, 2018, for a detailed review of the accessibility examination approach, process and procedures and results. The accessibility examination of this release was limited to only an expert review of prior examinations, and any findings from the initial examination remain the same for the OpenElect 2.2.3 voting system.

OO. Jurisdictions implementing OpenElect 2.2.3 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.

VIII. RECOMMENDATIONS

A. All jurisdictions implementing OpenElect 2.2.3 should take appropriate steps to ensure that voter education is part of the implementation plan.

B. All jurisdictions implementing the OpenElect 2.2.3 should ensure that precinct election officials and poll workers receive appropriate training and is comfortable using the system.

C. All jurisdictions considering purchase of the OpenElect 2.2.3 should review the System Limits as mentioned in the EAC certification scope added as Attachment A to this report.

D. The Secretary recommends that Unisyn and counties work with the Department on any changes to their voting equipment including, but not limited to, purchase and upgrades.

E. 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. Secretary recommends configuring the election with only one contest being displayed on each screen presented to the voter on the FreedomVote Tablet BMDs. This is to ensure that all screens presented to the voter is similar and voters don’t need to adapt to the situation that 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 OpenElect 2.2.3 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 OpenElect 2.2.3 for use in this Commonwealth.

X. Attachment A - EAC Certification Scope

Attachment A - OpenElect 2.2.3 Cert

United States Election Assistance Commission

Certificate of Conformance

Unisyn OpenElect 2.2.3

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 2.0* 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: OpenElect

Model or Version: 2.2.3

Name of VSTL: Pro V&V

EAC Certification Number: UNS10121966-2.2.3

Date Issued: 08/22/2023

Executive Director

Scope of Certification Attached

Manufacturer:	Unisyn	**Laboratory:**	Pro V&V
System Name:	OpenElect 2.2.3	**Standard:**	*VVSG 1.0*
Certificate:	UNS10121966-2.2.3	**Date:**	*8/22/2023*

Scope of Certification

This document describes the scope of the validation and certification of the system defined above. 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 particular component of a certified system is itself certified for use outside the certified configuration.

Representation of EAC Certification

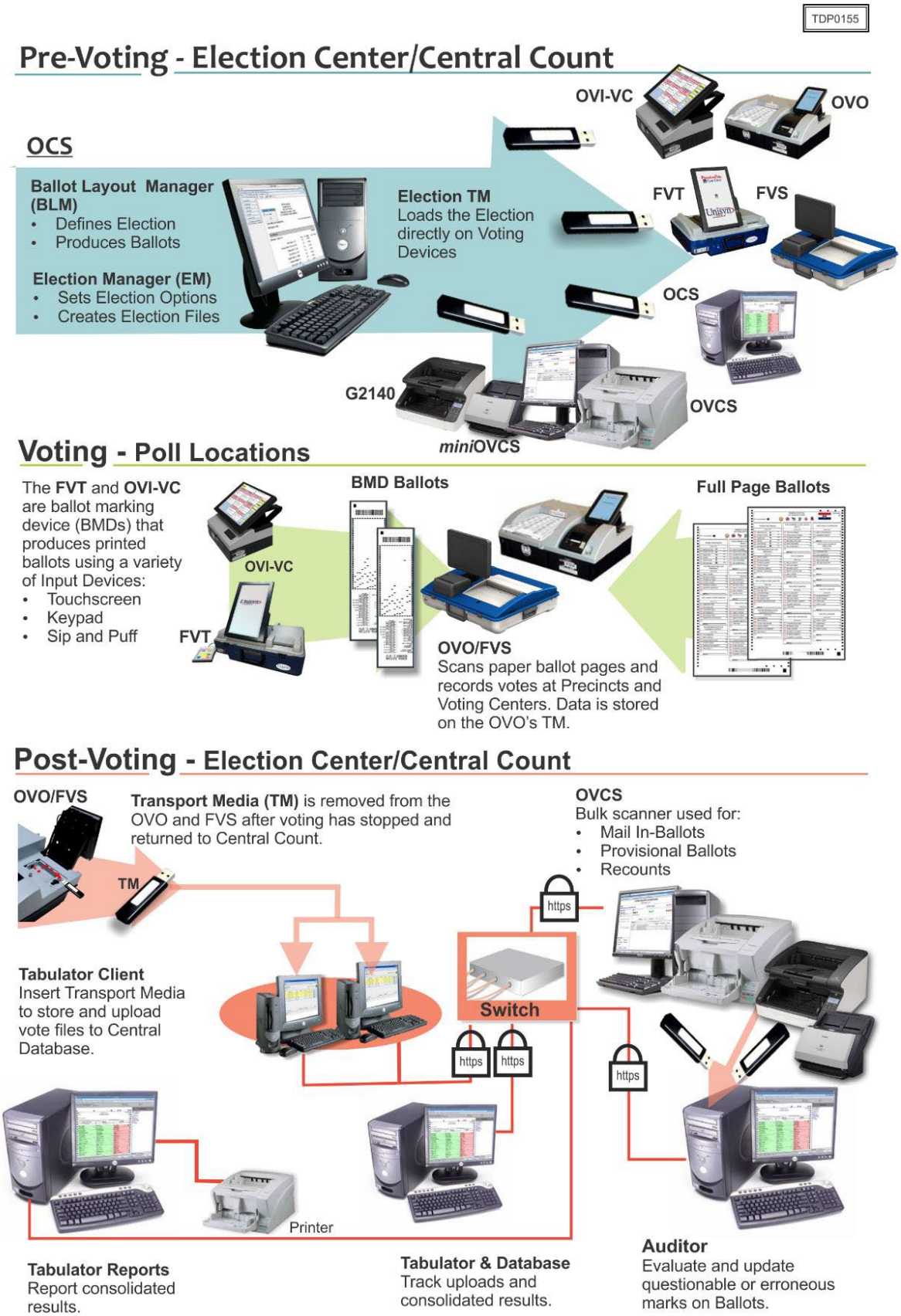
Manufacturers may not represent or imply that a voting system is certified unless it has received a Certificate of Conformance for that system. Statements regarding EAC certification in brochures, on Web sites, on displays, and in advertising/sales literature must be made solely in reference to specific 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

The Unisyn OpenElect Voting System 2.2.3, herein referred to as OVS 2.2.3, is a modified system based on the earlier certified OVS releases. The OVS 2.2.3 Voting System is a paper-ballot based optical scan voting system consisting of five major components:

1. OpenElect Central Suite (OCS)
2. OpenElect Voting Optical (OVO)
3. OpenElect Voting Interface (OVI-VC)
4. OpenElect Voting Central Scan (OVCS)
5. Freedom Vote Tablet (FVT)
6. Freedom Vote Scanner (FVS)

System Diagram



OpenElect Central Suite (OCS)

The OCS consists of the six components running as either a front-end/client application or as a back-end/server application: Ballot Layout Manager (BLM), Election Manager (EM), Tabulator Client (TC), Tabulator, Auditor and Tabulator Reports (TR).

OpenElect Voting Optical (OVO)

The OVO device is a precinct-level optical scan ballot counter (tabulator) designed to perform the following major functions: ballot scanning, tabulation, and second chance voting.
The OVO is a full-page, dual-sided optical scan ballot system which scans and validates voter ballots and provides a summary of all ballots cast. The election is loaded via a USB thumb drive. On Election Day, an OVO at each polling location scans and validates voters' ballots and provides precinct tabulation and reporting. The OVO unit is also paired with the OVI-VC and/or the FVT for early voting to scan and tabulate early voting ballots. OVO units can also be used at election headquarters to read absentee, provisional, or recount ballots in smaller jurisdictions.

OpenElect Voting Interface (OVI-VC)

The OVI-VC supports both ADA and Early Voting requirements. The OVI-VC enables voters during early voting to cast regional ballots and voters with special needs to prepare their ballots independently and privately on Election Day. The OVI-VC unit features a 15-inch full-color touch-screen display. The OVI-VC will present each contest on the correct ballot to the voter in visual and (optionally) audio formats. The voter with limited vision navigates through the ballot using the audio ballot and the ADA keypad or touchscreen input to make their selections. The voter validates his or her selections by listening to the audio summary, printing the ballot, and inserting it into the OVO or FVS.

The OVI-VC facilitates special needs voters through a variety of methods including wheelchair access, sip & puff, zoom-in ballot function, and audio assistance for the visually impaired. The OVI-VC provides for write-in candidates when authorized by the jurisdiction. Voters input candidates' names via the ADA keypad, touchscreen or sip & puff device. Each OVI-VC can support multiple languages for both visual and audio ballots, allowing the voter to choose their preferred language.

OpenElect Voting Central Scanner (OVCS)

The OVCS resides at election headquarters designated to read absentee, provisional, or recount ballots in large jurisdictions, or read the entire election's ballots at a central count location in smaller jurisdictions. The OVCS also captures write-in data images and produces a write-in image report for manual processing upon request. The OVCS system consists of the following components: OVCS Workstation and either a Canon DR-X10C Scanner, Canon DR-G2140 or a Canon M-160II Scanner.

FreedomVote Tablet (FVT)
The FVT is a tablet ballot marking device that enables voters make their vote selections and to print their voted ballot. The FVT can be used on Election Day or during an early voting period. Like the OVI-VC, the FVT is ADA compliant. It assists voters, with varying levels of ability, through the voting process, ballot review, and printing functions. The FVT presents each contest on the ballot style to the voter in visual and/or audio formats. It facilitates special needs voters through a variety of methods including wheelchair access, sip and puff, zoom-in ballot function and audio assistance for the visually impaired. The voter with limited vision can navigate through the ballot using an audio ballot and the ADA keypad or touchscreen to input their selections. Once the ballot is printed, it is taken to the OVO or FVS to be cast. Each FVT can support multiple languages for both visual and audio ballots, allowing the voter to choose their preferred language.

FreedomVote Battery (FVT-B)
The FVT-B is a FreedomVote Tablet with a battery backup unit installed that provides two hours of continuous power to the system in the event of a power outage. The FVT and FVT-B's look and function the same.

FreedomVote Scanner (FVS)
The FVS is a full-page dual-sided optical scan precinct scanner that scans and validates voter ballot pages and provides a summary of all ballot pages cast. The election is loaded from an Election TM. On Election Day, an FVS at each poll location scans and validates voters' ballots and provides precinct tabulation and reporting. The FVS runs Logic Tests and Training Elections in addition to General and Primary Elections. The FVS unit can also be paired with FVT and/or OVI-VC units for early voting to scan and tabulate early voting ballots and election support at voting centers. Additionally, FVS units can be used at election headquarters to read absentee, provisional, or recount ballots in smaller jurisdictions.

Certified System before Modification
OpenElect 2.2

Changes Addressed by Modification
The submitted modifications include the following changes from OVS version 2.2 to 2.2.3:

- **FreedomVote Tablet (FVT)**
  Additional tablet added to COTS hardware list to replace previous tablet which has reached its end-of-life.
  Make the Close with Barcode process on FVT match the Close with Button process, so that they have the same end point.

- **FreedomVote Tablet - Battery Backup (FVT-B)**

Upgraded processor and RAM for the FVT tablet.
The Diagnostic Printer Test was updated to prevent printing interruption in the event of an electromagnetic pulse (EMP).

- **Tabulator Reports**
  When determining the number of ballots cast in an election with multiple page ballots base the number of ballots cast on the first page. This modification also creates a Desktop Shortcut to Reports directory when new "Run" is created.

- **Tabulator**
  When determining the number of ballots cast in an election with multiple page ballots base the number of ballots cast on the first page.

Mark Definition

The Unisyn OpenElect system will consistently recognize a 60% fill of the target area. Marks must be made with a marking device with sufficiently low reflectance in the visible red band and is of sufficient density/color such that the scanner registers it as black. Most blue, black and green ballpoint pens and markers also meet necessary reflectance requirements and may be used.

Tested Marking Devices

- BIC Grip Roller
- EF Felt Tip Pen

Language Capability

System supports Hindi, Chinese, English, Japanese, Korean, Navajo, Spanish, and Thai as well as bilingual (English and one other language on a single ballot page).

Components Included

This section provides information describing the components and revision level of the primary components included in this Certification.

Proprietary Software Components

Proprietary Software	Version
[OCS] Adjudicator Application	2.2
[OCS] Ballot Layout Manager Application	2.2
[OCS] Cast Vote Record Utility	2.2
[OCS] Election Manager	2.2
[OCS] OVCS Application	2.2
[OCS] Tabulator Client	2.2
[OCS] Tabulator Monitor	2.2.3
[OCS] Tabulator Reports	2.2.3
[OCS] Write-In Extractor Utility	2.2

[OCS] Write-In Manager Utility	2.2
[OCS] Common Files	2.2.3
[OCS] OCS Installer Application	2.2.3
OVI	2.2
FVS	2.2
FVT	2.2.3
OVO	2.2.2

COTS Software Components

FVT, FVS, OVO, and OVI-VC Device Software	Version
CentOS Linux (OVO1 and OVI-VC1)	5.0
CentOS Linux (OVO2 and OVI-VC2)	6.3
CentOS Linux (FVS)	8.0
Java JRE + Unlimited Cryptographic Extension (OVO and OVI-VC)	1.6.0_02
Java JRE + Unlimited Cryptographic Extension (FVS)	1.6.0_45
Android OS (FVT)	4.4.4

OCS and OVCS Device Software	Version
CentOS Linux	6.5, 6.8, 7.6 and 7.9
Java JRE + Unlimited Cryptographic Extension	1.6.0_02
Apache-Tomcat Application Server	6.0.13
MySQL Database (BLM. EM, A, and Tab only)	5.0.45-7 5.7 (on CentOS 7.6 and 7.9)
JasperReports	2.0.5
OpenVPN	2.4.4
OpenSSL	1.0.1f-fips

COTS Hardware Components

Hardware	Make	Model
OVO		
Duplex Ballot Scanner	PDI Scan	Pagescan III
Scanner Power Adapter	eUrasia Power	uA36-1024
58mm Thermal Printer	Citizen Printer	CT-5281
Printer Power Adapter	Citizen Printer	28AD4
Chassis	Morex	Morex 2699
DC/DC converter	Morex	MX-0608F
Chassis Fans	Young Lin Tech	DFB404012M
Motherboard	Jetway	JNF9D-2550
Memory	SuperTalent – Onboard RAM	W1333SA2GV
Hard Drive	Western Digital	WD5000AZLX
AC Adapter	EDAC	EA 10951C-120

Hardware	Make	Model
1Gb USB	Innodisk	DEUA1-01G172AC1SB-B88
1 Gb USB	Delkin	UY0GTFLSY-XN000-D
7” LCD Touchscreen Display	Xenarc Technologies	700TSV
AC Power In Module	Delta	Emi 10BEEG3G
FVS		
CPU w/ Fan	Intel	G5400-LGA1151
Motherboard	Jetway	JNC8H-IH310
Memory	Crucial	CT4G48F8824A
SSD 250GB	Crucial	CT250MX500SSD1
80mm Thermal Printer	SNBC	BTS-S80
Duplex Ballot Scanner	PDI Scan	Pagescan V
Battery	RRC Power Solutions Inc.	RRC2040-2
Power Management Module	RRC Power Solutions Inc.	RRC-PMM240
Power Supply 15VDC AC/DC	Meanwell	UHD-200-15
Power Supply 12/12VDC	Meanwell	RSD-60G-12
Power Supply 12/24VDC	Meanwell	RSD-60G-24
AC Inlet Module	Schurter	4303.5013
Fuse Drawer 1P	Schurter	4303.2406
Switch On/Off DPDT	Switchcraft	EHRRSLBPKG
1 Gb USB	Innodisk	DEUA1-01GI72AC1SB-B88
1 Gb USB	Delkin	UY0GTFLSY-XN000-D
OVI-VC		
Sip and Puff (optional)	Origin Instruments	AirVoter
Headphone (optional)	Koss On-Ear Headphones	KPH7
15” LCD Touchscreen Display	GVision	P15BX-OB-4690
82.5mm Thermal Printer	Star	TSP743IID-24, serial interface
Printer Power Adapter	Star	PS60A-24B 1
Power Adapter Kit	Morex	MX-0608F, DC-DC Converter
Motherboard	Jetway	JNF9D-2550
Hard Drive	Western Digital	WD5000AZLX
AC Adapter	EDAC	EA 10951C-120
Chassis Fans	Young Lin Tech	DFB404012M
Motherboard	Jetway	JNF9D-2550
Memory	SuperTalent - Onboard RAM	W1333SA2GV
1 Gb USB	Innodisk	DEUA1-01GI72AC1SB-B88
1 Gb USB	Delkin	UY0GTFLSY-XN000-D
AC Power In Module	Delta	Emi 10BEEG3G
FVT		
Tablet Battery Charger	Sager Power System	GC30B-4P1J
13.3” Touchscreen Tablet - A	Android Tablet	GVision-T13
13.3” Touchscreen Tablet - B	Android Tablet	ENVUW

Hardware	Make	Model
Barcode Reader 1D, 2D series	Newland	FM420, FM430
USB Hub	D-Link	DUB-H4 W/+5V Power Supply and USB cable
Hub Adapter	Meanwell	PSD-15A-05
1Gb USB	Innodisk	DEUA1-01G172AC1SB-B88
1 Gb USB	Delkin	UY0GTFLSY-XN000-D
Micro SD	San Disk	4 GB Edge
Sip and Puff (optional)	Origin Instruments	AirVoter
Headphone (optional)	Koss On-Ear Headphones	KPH7
USB to Ethernet RJ45 Adapter	D-Link	DUB-E100
AC Power In Module	Delta	Emi 10BEEG3G
FVT-B (includes items above)		
Battery	RRC Power Solutions Inc.	RRC2040-2
Power Management Module	RRC Power Solutions Inc.	RRC-PMM240
Power Supply 15VDC AC/DC	Meanwell	UHD-200-15
Power Supply 12/12VDC	Meanwell	RSD-60G-12
Power Supply 12/24VDC	Meanwell	RSD-60G-24
UPS		
UPS, Minuteman Power Technologies	Para Systems, Inc.	Entrepid Series EP1500 LCD
Surgecube – Surge Protector	Belkin	F9H100-CW
OVCS		
Desktop for non-redundant solutions	Dell	OptiPlex 360, 755, 7010, D075/XE2
Desktop for redundant solutions	Dell	Precision T3500, T3600, T5810, T5820, 3420
Laptop	Dell	Dell Latitude E5500, E5540, E5570, E5590, E5500 v2, E5520, Dell XPS m1530, HP 2000
Large Volume Scanner	Canon	DR-X10C DR-G2140
Desktop Scanner	Canon	DR-M160II

System Limitations

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

Characteristic	Limiting Component	Limit	Comment
Maximum Elections	BLM	8	
Maximum Precincts	BLM	2000	
Maximum Splits per Precinct	BLM	9	
Maximum Districts	BLM	400	

Characteristic	Limiting Component	Limit	Comment
Maximum Contests per District	BLM	20	
Maximum Parties	BLM	24	
Maximum Parties in primary	BLM	12	
Maximum Parties w/ Straight Ticket	BLM	12	
Maximum District types	BLM	25	
Maximum Languages	BLM	10	
Maximum Ballot styles per Election	BLM	400	
Maximum Contests per Election	BLM	150	
Maximum Measures per Election	BLM	30	
Maximum Instruction Blocks per Election	BLM	5	
Maximum Headers per Election	BLM	50	
Maximum Candidates per Election	BLM	3000	
Maximum Candidates per Contest	BLM	120	
Maximum Ballot Pages	BLM	3	
Maximum Votes for N of M	BLM	25	
Maximum Ranks in RCV	BLM	3	
Maximum Ballot sheets per OVO	BLM	5000	
Maximum Ballot Pages per batch (OVCS)	OVCS	500	
Maximum Ballot Pages per session	OVCS	5000	
Maximum expected scanning speed (ballot pages per hour)	OVCS	2100	
Maximum Units simultaneously loading	BLM	20	
Maximum Precincts initialized per OVO on Election Day	BLM	30	
Maximum Precincts initialized per OVI-VC/FVT on Election Day	BLM	2000	
Maximum Precincts initialized per OVO/FVS /OVI-VC/FVT in early voting	BLM	2000	
Maximum 11” Ballot positions	BLM	228 (without Rank Choice Voting) 456 (with Rank Choice Voting)	Limit (Double Sided)

Characteristic	Limiting Component	Limit	Comment
Maximum 14” Ballot positions	BLM	300 (without Rank Choice Voting) 600 (with Rank Choice Voting)	Limit (Double Sided)
Maximum 17” Ballot positions	BLM	372 (without Rank Choice Voting) 744 (with Rank Choice Voting	Limit (Double Sided)
Maximum 19” Ballot positions	BLM	420 (without Rank Choice Voting) 840 (with Rank Choice Voting)	Limit (Double Sided)

Functionality

VVSG 1.0 Supported Functionality Declaration

Feature/Characteristic	Yes/No	Comment
Voter Verified Paper Audit Trails		
VVPAT	No	Not applicable
Accessibility		
Forward Approach	No	
Parallel (Side) Approach	No	
Closed Primary		
Primary: Closed	Yes	
Open Primary		
Primary: Open Standard	Yes	A registered voter may vote in any *party primary* regardless of his own party affiliation
Primary: Open Blanket	No	
Partisan & Non-Partisan:		
Partisan & Non-Partisan: Vote for 1 of N race	Yes	
Partisan & Non-Partisan: Multi-member (“vote for N of M”) board races	Yes	

Feature/Characteristic	Yes/No	Comment
Partisan & Non-Partisan: “vote for 1” race with a single candidate and write-in voting	Yes	
Partisan & Non-Partisan “vote for 1” race with no declared candidates and write-in voting	Yes	
Write-In Voting:		
Write-in Voting: System default is a voting position identified for write-ins.	Yes	
Write-in Voting: Without selecting a write in position.	No	
Write-in: With No Declared Candidates	Yes	
Write-in: Identification of write-ins for resolution at central count	Yes	
Primary Presidential Delegation Nominations & Slates:		
Primary Presidential Delegation Nominations: Displayed delegate slates for each presidential party	Yes	
Slate & Group Voting: one selection votes the slate.	No	
Ballot Rotation:		
Rotation of Names within an Office; define all supported rotation methods for location on the ballot and vote tabulation/reporting	Yes	Top to Bottom by Precinct grouping
Straight Party Voting:		
Straight Party: A single selection for partisan races in a general election	Yes	
Straight Party: Vote for each candidate individually	Yes	
Straight Party: Modify straight party selections with crossover votes	Yes	
Straight Party: A race without a candidate for one party	Yes	
Straight Party: “N of M race (where “N”>1)	Yes	
Straight Party: Excludes a partisan contest from the straight party selection	Yes	
Cross-Party Endorsement:		
Cross party endorsements, multiple parties endorse one candidate.	Yes	
Split Precincts:		
Split Precincts: Multiple ballot styles	Yes	
Split Precincts: P & M system support splits with correct contests and ballot identification of each split	Yes	
Split Precincts: DRE matches voter to all applicable races.	No	
Split Precincts: Reporting of voter counts (# of voters) to the precinct split level; Reporting of vote totals is to the precinct level	Yes	
Vote N of M:		
Vote for N of M: Counts each selected candidate if the maximum is not exceeded.	Yes	
Vote for N of M: Invalidates all candidates in an overvote (paper)	Yes	
Recall Issues, with options:		

Feature/Characteristic	Yes/No	Comment
Recall Issues with Options: Simple Yes/No with separate race/election. (Vote Yes or No Question)	Yes	
Recall Issues with Options: Retain is the first option, Replacement candidate for the second or more options (Vote 1 of M)	Yes	
Recall Issues with Options: Two contests with access to a second contest conditional upon a specific vote in contest one. (Must vote Yes to vote in 2nd contest.)	No	
Recall Issues with Options: Two contests with access to a second contest conditional upon any vote in contest one. (Must vote Yes to vote in 2nd contest.)	No	
Cumulative Voting		
Cumulative Voting: Voters are permitted to cast, as many votes as there are seats to be filled for one or more candidates. Voters are not limited to giving only one vote to a candidate. Instead, they can put multiple votes on one or more candidate.	No	
Ranked Order Voting		
Ranked Order Voting: Voters can write in a ranked vote.	Yes	
Ranked Order Voting: A ballot stops being counting when all ranked choices have been eliminated	Yes	
Ranked Order Voting: A ballot with a skipped rank counts the vote for the next rank.	Yes	
Ranked Order Voting: Voters rank candidates in a contest in order of choice. A candidate receiving a majority of the first choice votes wins. If no candidate receives a majority of first choice votes, the last place candidate is deleted, each ballot cast for the deleted candidate counts for the second choice candidate listed on the ballot. The process of eliminating the last place candidate and recounting the ballots continues until one candidate receives a majority of the vote	Yes	
Ranked Order Voting: A ballot with two choices ranked the same, stops being counted at the point of two similarly ranked choices.	Yes	
Ranked Order Voting: The total number of votes for two or more candidates with the least votes is less than the votes of the candidate with the next highest number of votes, the candidates with the least votes are eliminated simultaneously and their votes transferred to the next-ranked continuing candidate.	Yes	
Provisional or Challenged Ballots		
Provisional/Challenged Ballots: A voted provisional ballot is identified but not included in the tabulation but can be added in the central count.	Yes	

Feature/Characteristic	Yes/No	Comment
Provisional/Challenged Ballots: A voted provisional ballot is included in the tabulation, but is identified and can be subtracted in the central count	Yes	
Provisional/Challenged Ballots: Provisional ballots maintain the secrecy of the ballot.	Yes	
Overvotes (must support for specific type of voting system)		
Overvotes: P & M: Overvote invalidates the vote. Define how overvotes are counted.	Yes	Supported. Overvotes are tabulated for each office as an Over / Under Vote report in Vote Tabulation
Overvotes: DRE: Prevented from or requires correction of overvoting.	No	
Overvotes: If a system does not prevent overvotes, it must count them. Define how overvotes are counted.	Yes	
Overvotes: DRE systems that provide a method to data enter absentee votes must account for overvotes.	No	
Undervotes		
Undervotes: System counts undervotes cast for accounting purposes	Yes	Supported. Undervotes are tabulated for each office as an Over / Under Vote report in Vote Tabulation
Blank Ballots		
Totally Blank Ballots: Any blank ballot alert is tested.	Yes	
Totally Blank Ballots: If blank ballots are not immediately processed, there must be a provision to recognize and accept them	Yes	
Totally Blank Ballots: If operators can access a blank ballot, there must be a provision for resolution.	Yes	
Demonstrates the voting system capability to handle the designated language groups		
Default language (English)	Yes	
Secondary language using a Western European font	Yes	
Ideographic language (such as Chinese or Korean),	Yes	
Non-written languages requiring audio support	Yes	

XI. Attachment B- Recommendations from Accessibility Examiner

Attachment B - OpenElect 2.0 Acces

Top problems

The following discusses the problems that surfaced during the expert examinations and voter/poll worker observations with the Unisyn FVT, OVI, and OVO machines.

Testing identified four accessibility problems that could reduce the ability of people with disabilities to vote independently and privately on the FVT or OVI voting machines.

Each of these problems are limitations of the machines regardless of the voter. The issues could act as a "canary in the coal mine," they are likely to affect all voters, even if to lesser degree. Likewise, they will all detract from the ability of the voter to concentrate on the process of deliberate voting.

All of these problems increased the difficulty of using the system for voters with disabilities, especially when using some of the accessibility features. They all include:

- **Complex navigation.** Large text means that more contests require multiple pages—even for races with fewer candidates. This adds complexity to navigation through the ballot and makes it harder for voters to easily check their selections on a contest. This problem is made worse by the required behavior for over-riding straight party voting selections under the PA Method.
- **Inconsistent behavior.** Some buttons change their function without a clear explanation. The button in the lower right-hand corner of the screen changes from "More candidates" to "Next Contest." This caused confusion for almost all of the voters using the visual display.

1. Silent/Hidden selection and deselection

What happened?

There were three elements of silent and/or hidden selection and de-selection on both the FVT and OVI that voters found confusing. In most cases, voters were able to mark their ballot as instructed through trial and error, but in others, they did not notice changes made by the system and might vote in a way that does not match their intent.

- **Destructive candidate deselection when changing a straight party contest**
  After making a straight party choice, if voters wanted to vote for additional candidates from another party or "scratch" and change party for that contest, the system automatically deselects all of the other pre-marked candidates. In a contest with a short list of candidates, this behavior, dictated by the PA Method, caused confusion, but with persistence voters were able to select the candidates specified in the instructions. When the voters were asked to vote for just one of the three automatically selected candidates, they universally attempted to deselect an unwanted candidate by pressing on that candidate's name. Because of the interpretation of the PA Method, this resulted in deselecting the other preselected candidates and selecting the candidate whom the voter had just attempted to deselect. The voters were, in this case where the changes were evident, able to correct the error and vote as instructed.
- **When the contest was long, candidates were often de-selected on a different screen, with no notification from the system**. Voters using the audio format had an advantage in this situation, because the audio announced the deselected candidates. For sighted voters, this automatic change resulted in candidates who had been selected not being voted for as intended by the voter.
- **Confusing behavior when trying to deselect a candidate in a straight party slate**
  Voters also expected to be able to deselect a candidate in the same method they would deselect other choices (toggle on and off). However, when trying to deselect a candidate in a straight party slate, the result is that *only* that candidate was left selected. Voters reported that they expected the mark for that candidate to be removed, instead of what happened.
- **Destructive and confusing behavior for overvotes**
  When voters attempted to make more selections in a race than allowed (or overvoting), the system deselected all other marks, leaving the most recent candidate selected. For example, in a "Vote for 5" race, the sixth vote would deselect the first five marks and leave only the sixth vote marked. There were no alerts on the screen to warn the voter that they had made too many selections in that race, nor did the system warn the voter that their other candidates would be deselected. In longer ballot measures, the candidates

being deselected might be on a different screen than the voter is currently seeing, so that these candidates would not be voted for as intended.

There were two positive system behaviors to note:

- Once a voter made a change to a straight party contest it followed the regular selection rules, including allowing no selection to be made at all in the contest.
- The audio ballot announces all selections and deselections, both on entry to the contest (if the voter waits long enough to hear it) and as any change is made, including deselections made when changing a straight party selection. However, in the case where a blind voter wants to vote for only the first of three straight party candidates, the audio first announces that each of the three candidates has been deselected, then announces that the first candidate has been selected. Since the first thing the voter hears is the opposite of his/her intent, this causes concern.

Why is this a problem?

The system relies on voters perceiving the change in selections and understanding why those changes have happened. This is a problem because:

- All voters should have control of all selections.
- Off-screen actions force all voters into problem solving. This is worse for voters using the audio format or a dual switch because navigation is more difficult.
- Voters with cognitive disabilities may be unable to understand what has happened when the interface is unpredictable and/or inconsistent.
- If a voter has to ask for assistance in the middle of the ballot, their privacy and independence are compromised.
- Ultimately, voters may vote in a way they had not intended.

Recommendations

While the machines must comply with the "Pennsylvania Method" of straight party voting, there are ways to fully inform the voter of selection and deselection changes. For example:

- Create meaningful feedback messages and confirmation screens to tell voters what is happening—including the number and names of the candidates being deselected. No selection or deselection should ever take place without

explicit action or confirmation from the voter. Language should be included like: “If you do X, these voters will be deselected” or “Are you sure you want to….”

- Be consistent and toggle all selections on and off when touched or selected with the tactile keypad, including selections made when the straight party option is active. This is consistent with how selection and deselection works in general and is not destructive.

2. Confusing navigation and highlighting

What happened?

Voters found two navigation problems while moving through the FVT's different screens.

- **Confusing buttons.** The FVT's main navigation buttons change functions without warning and this confused voters. The buttons are located at the bottom of the touchscreen. They include a circle-shaped navigation button in the lower left and right corners and a larger oval button labeled done in the middle. Also, the navigation using the dual switch did not meet some expected behavior.
    - **Circle-shaped navigation buttons.** When the system loads a contest with more candidates than it can display on one screen, the circles function as scroll buttons to move up and down the candidate list. The buttons turn red when there is more to view. Once all candidates have been viewed, the circles change to contest navigation buttons, allowing voters to move backward or forward to another race. These changes are not well described to the voter.
    - **Oval-shaped action buttons.** For initial contest and candidate selection, the oval button sits at the bottom of the screen with a light grey color and the word "Done." Its function is not enabled until the voter reached the last contest. Then, it changes to a dark grey button, with the word "Print" on it. When a voter returns to a contest screen to make a change it changes back to a "Done" button, but this time it is dark grey and active. When pressed, it returns to the ballot summary screen. Several voters tried to advance to the next contest with the "Done" button, since it seemed to indicate that the voter was done with a specific contest. The button should be hidden completely.
    - **Inconsistent dual switch navigation.** In most navigation of the system, when moving between contests, the switch scanning starts at the top of the screen. By the time the voter reaches the review screen, this is a strong expectation. However, when returning to a ballot measure for review, the scanning begins on the scroll button. The automatic behavior of pressing the switch to move in to the contest selections instead moves the voter to the control icons at the top of the screen

- **Highlighting.** When using the tactile keypad or the dual switch input devices, voters reported difficulty seeing which button or section of the screen was highlighted. This problem was worse on the write-in onscreen keyboard:
  - The highlighted letter button was only slightly different than the surrounding buttons.
  - On the FVT, the on-screen keyboard used a QWERTY layout, but using the tactile keypad or dual switch input devices, the system cycled through the letters in alphabetical order. Voters using both the screen and keypad found this confusing since they could see the keyboard was in QWERTY order. For such voters, it is common to look at how many letters lie between the current highlight and the next target, then rapidly advance to near the target, slowing only for final selection. It is not possible to visually make this estimation when the user sees a different order than the highlight advances.

The OVI had two additional problems not seen on the FVT.

- **Confusing "Continue" prompt.** On the OVI, voters tried to touch the prompt that there are more candidates than fit on a screen, not realizing it is not an active button. This screen also included an arrow icon that seemed to indicate that it would advance, though it was not an active control.
- **More than one contest on the screen.** For most of the ballot, the OVI presented one contest on the screen at a time. In the middle of the test ballot, however, the last candidate from one contest and two additional short contests were displayed on a single screen. At least one participant did not understand that there were multiple contests displayed at once and could not tell which office the candidates were running for.

Why is this a problem?

These navigation issues are problems for voters with disabilities, specifically those who are blind, have low vision, or low literacy for four reasons.

- When navigation is inconsistent, it becomes a problem for everyone, but the problem is amplified for people with limited resources to solve them.

Example: Inactive buttons

When the "Done" button is visible at the bottom of the screen, but is not functional, it confuses users. Voters thought when they finished making

selections in each race the should touch or select the "Done" button. However, pressing this button did not do anything, confusing voters

Example: Buttons that change function
The button in the bottom right corner of the screen is used to both display more candidates in a contest *and* to move from one contest to another. In long contests, voters sometimes pressed the button too many times, and skipped a contest. Using large text makes this problem worse, as contests are more likely to span multiple screens.

- People who use assistive technologies on a regular basis have expectations about basic navigation. Whenever possible, those expectations should be supported.

Example: Write-in keyboard
Using the tactile keypad or dual switch input device to enter text is a slow process requiring voters to scan through the alphabet one letter at a time to spell a name. The highlighting on letter buttons was difficult to see, but more importantly, it was hard to predict how the other buttons on the screen – including space, backspace, and completing the entry, were placed in the selection sequence.

Recommendations

Many of these problems were relatively easy to find during the expert review and confirmed through observing voters. Two changes would make the interactions clearer:

- **Hide buttons that are not available rather than simply disabling them**. Voters could not tell that the buttons were disabled and were forced to problem solve to figure out what to do.
- **Increase the visual difference for highlighted buttons.** Better contrast between selected and unselected items, or between items have focus and those that do not would make it easier for voters to understand the current status.

3. Reviewing undervoted contests

What happened?

Once a voter has completed their ballot, they move on to a ballot summary screen to review all the choices they have made. Expert review and voter observation identified three problems with the ballot summary/review screen on the VFT and OVI.

- **Red background with black text for undervoted contests.** In any race where voters have not voted for the maximum number of candidates, the system displays the entire contest block in black text with a dark red background.
- **Undervotes are not communicated clearly or consistently.** If no candidate or option has been selected, the system reports "No selection made (for vote-for-1). If fewer than the maximum selections in a vote-for-N contest, the system reports a single "Undervote" under the list of candidates selected, no matter how many voting options remain. Test voters did not see this message clearly, in part because it is displayed in the same font and size as the candidate names.
- **Red means compulsory.** Voters immediately noticed the red shaded areas. Some voters said that it made them think they were required to correct the "error". The audio message says that "You have not voted for all of the *required* number of candidates, reinforcing this perception

Why is this a problem?

- Voters could not figure out why races were highlighted red and had trouble understanding why the system had drawn their attention to it.

Example: Undervotes in a vote-for-N contest

Two voters and one poll worker all voted the County Commissioner "Vote for 5" race in such a way that they chose four candidates. When they finished the rest of the ballot and made it to the ballot summary, they noticed this race was highlighted with the red background. Two individuals took a significant amount of time, along with assists from the moderator, to figure out why the race was highlighted. One voter was unable to solve this question.

Their confusion stemmed from the formatting. The system displayed the four candidate names chosen by the voter, but also included the word "undervote" directly beneath the final name, The word "undervote" looked like another name in the fifth spot. Voters who saw this message in other races were able to make sense of it more quickly because the number of items did not match the maximum "Vote for" number.

- Red backgrounds are hard to read, in general, but a serious problem for voters with red-green color blindness, who perceive the background as dark greyish brown which means the black text and the dark background are indistinguishable from one another.
- Using this shade of red with black text does not meet the Voluntary Voter System Guidelines (VVSG) 1.1 contrast requirements.
- "Undervote" is election jargon and may not make sense to all voters.
- The bright red color suggested to some voters that this is an error and that they were required to make a change or vote for additional candidates.
- Ultimately, voters may vote in a way they had not intended because they cannot read and understand the review function.

Recommendations

Using a color that does not meet the VVSG 1.1 requirements of a 10:1 contrast ratio for candidate information is a serious problem that must be fixed.

It is also possible to make the undervote messages on the review screen clearer and more consistent, for example:

- Using easily understand language that is meaningful to all voters. "No selection made" is clearer than "Undervote"
- Make the message informative by explaining the actions voters can take, both on the review and contest screens. For example, saying "Selected 2 of 5 candidates" or "You may select 3 more candidates" makes both the problem and action to fix it clear.
- Design the message to clear and visually noticeable without making the selection of additional candidates appear compulsory.

4. Compulsory behavior

What happened?

Voters reported and the expert team discovered that the FVT requires voters to:

- Scroll through all candidates before leaving a contest.
- Page through all contests before moving to the review screen.
- View all pages of the review screen before printing the ballot.

Why is this a problem?

This compulsory behavior is a problem for two reasons.

- Voters who voted straight party and/or do not wish to make any more selections in a race or on the ballot must page through all of it in order to print their ballot.
- As the expert team, we ask if this level of review is necessary or appropriate? There are a number of legitimate reasons why a voter may not need to or want to page through the entire ballot before printing. In years with many contests and many candidates, this requirement can slow down voters.

Recommendations

As long as legal requirements have been met and there are sufficient safe guards in place to alert voters of undervotes/no selections at the review screen, there is no need for system-imposed obstacles to completing the ballot.

5. 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. However, paper ballots intrinsically add accessibility issues. The implementation of the printing and paper-handling of these paper ballots had several limitations that limited the ability of voters to use them effectively.

The layout of the printed ballot

- The font used on the printed ballot is too small. It may be smaller than the VVSG requirement of 3.0mm. The tight spacing of the letters and lines of text, so that the print was compressed into a very tight block further reduce the legibility. In the heading of the ballot, there were no spaces between the words of the ballot title.
- The number preceding each candidate name confused some of the voters, especially when listening to the ballot being read by an OCR reader. Among the guesses for the meaning of the numbers was "it might be the number of votes that this candidate has gotten so far…" The actual purpose of the number was to indicate the field at the bottom of the ballot where the bar-coding was printed.

Reading the paper ballot

In both the OVI and FVT ballot marking systems, the ballot is printed on a roll of paper stored inside the machine. This means that voters do not have to handle a blank ballot before making choices.

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. The single blind voter participant raised this issue as a common feature that makes it possible for voters with visual disabilities to verify the paper ballot.

She tried using a personal OCR application on her phone to read the ballot. Because she was holding the ballot in her lap with limited stability and because of

some of the design elements of the printed ballot (run-together words and the numbers in front of the candidate names) she was only partially successful,

Interacting with the OVO ballot scanner

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

Four features stood out and could be considered positives for voters with disabilities.

- Voters may insert the ballot in any orientation. This provides another layer of privacy and limits the potential failures. However, this was not clear to any of the voters or poll workers
- The scanner bed includes engraved chevrons/arrowheads that point toward the ballot insertion area. A blind or low vision voter feel the indentations allowing them to independently cast their printed ballot. While our volunteer voters were able to use the scanner independently, some had difficult aligning the ballot for insertion.
- Unisyn provided an optional ballot privacy sleeve that also serves to position the ballot correctly to be scanned. Using the sleeve, a poll worker may assist a voter without seeing their ballot. Our voters with limited dexterity had some difficulty aligning the ballot against the fold/guide, though they managed this task independently.
- There are subtle visual cues from a small screen and LED that notify voters that the scanner is ready, reading a ballot, and finished scanning. These were not available for voters with low or no vision.

The most serious problems are

- There are no audible instructions. The scanner did not include robust features to alert voters that their ballot has been cast successfully.
- Despite the guides voters struggled to align the narrow ballot to insert it straight enough that the system would grab it into the scanning path.
- It is also important to mention that voters with no/low use of their hands would rely on assistance for this part of voting. Some of the test participants commented on this issue.

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.

- **Blind or low vision voters** would have difficulty scanning their ballot without instruction or assistance. Voters must insert the smaller ballots in the center of the scanner bed, aligned perfectly with the path of travel. Blind or low vision voters can feel the engraved arrows to orient the ballot but would need to know that this feature exists.
- **Voters have limited cues that ballots are cast successfully**. There is a small screen and an LED that changes colors for different steps of the ballot scanning process, but these cues are do not work for voters who cannot see them.
- **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. Privacy sleeves are available to jurisdictions as a purchase option, which also allow someone to assist a voter without seeing the ballot.

Recommendations

For the printed ballot layout

- The text on the printed ballot could be larger, with additional line spacing to make it easier to read.
- The numbers can be moved after the names or placed on the right margin so that they are separated from the candidate name.

For reading back the ballot

- At the polling place, having a small table with a mobile phone stand (a common and inexpensive tool) would provide blind voters with appropriate personal technology to read and verify their ballot with a personal OCR application.
- Alternatively a station with full magnification and OCR tools could be deployed in every polling place to complete the voting system and allow blind and low vision voters to verify their ballot.

For the scanner

- Use physical guides on the ballot scanner that minimize the chance for error. Because voters have to insert the ballot in the middle of a scanner that also accepts full size sheets of paper, it makes it more difficult to position the ballot correctly

- Make the cues that the ballot is cast more obvious. Large print words or simple images to indicate the scanning steps, and a stronger visual cue can show that the ballot scanned successfully. Adding an audio cue that the ballot scanned properly would help blind or low vision voters confirm their ballot was cast.
- Train poll worker to assist voters in ways that do not compromise the voter's privacy. This might include having standard instructions that can 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.

Other issues for deployment

A few other issues produced consistent enough observations to call them out in some detail.

Reading the activation code

The FVT voting machine has a useful feature that uses a printed, one-time-use QR code which to select the ballot style and accessibility features (font-size, contrast, audio rate, volume, and other settings) of the machine. (We did not test using personal preference in the QR code because this feature depends on the capabilities of a separate electronic poll book not included with the system being tested)

Several voters had difficulty scanning the QR code.

- There is no guide or audio instructions for blind or low-vision voters.
- It is easy to cover the code with a finger while trying to position the paper under the scanner.
- Deaf voters cannot hear the (quiet) beep indicating the scan was successful and the visual cue was not sufficient to draw attention.

Recommendation for deployment. A simple guide for where to place the activation code would increase the accessibility of this feature. If not included with the voting system, election officials might create one, for example by taping a tactile ridge in position as a guide.

Audio quality for instructions

For a voter who cannot see the screen, voice quality is just as important as print quality is to a sighted voter and can affect their understanding of the ballot contents, navigation options, or both.

Voice quality is critical to understanding candidate names, especially because there is no option to spell out a name when it is not clear.

The voice used for testing was created using MP3 files, pieced together to create the messages. The resulting voice was very difficult to understand, and the flow of the instructions was very poor. One blind voter immediately said, “Oh, that’s nasty!”

- The letters in the write-in alphabet are not pronounced clearly.

- The words “Done” and “Down” were indistinguishable making it hard to understand the action of these navigation buttons.
- The narration had pauses and changes in tone that made the semantics of the sentences hard to understand.

The system has a second style of audio that uses text-to-speech (TTS) technology. This voice (based on Google’s speech synthesis) was clear and smooth, and vastly superior in understandability.

Recommendation for deployment: Election officials should use the TTS option over the voice constructed from recorded snippets. We understand that this is an option available as part of the standard system.

Screen freezing

We had one other problem that may have simply been a technical issuer or a misunderstanding about how the system works: plugging in the speaker we were using so a group could hear the audio froze the system. This may have been because the poll workers first plugged the speaker into the switch jack. We managed to freeze the system twice with the powered speaker.

We later were told about a “screen reader mode” in which the system only activates buttons through the tactile keypad and the screen responds only to limited gestures. It is possible that the system was in this mode when we believed the screen had frozen.

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	Voter liked that the voting machine height works for power wheelchair users. “It’s on my voter's level.”	OVI	Positive
	Voters liked having a review screen: "You get to go back twice to check your vote."	OVI	Positive
	"This is a lot easier" than the currently used voting machine.	OVI	Positive
Display and Navigation	When the system returns to the review screen, it lands on the item that was just reviewed rather than the top of the ballot.	FVT	Positive
	Despite some initial confusing, voters said it was easy to move around the ballot once you figure it out.	FVT	Positive
	The ability to scroll the screen with a swipe was useful, but not obvious.	FVT	Positive
	Some voters liked that the system forced viewing all candidates."	FVT	Positive
Setup for voters	Poll workers felt that setting the accessibility features for voters was easy.	FVT	Positive
	"Very self-explanatory"	FVT	Positive
	Changing your vote is simple.	FVT	Positive
	Changing settings seems straight forward	FVT	Positive

Function	Observation	System	Severity
	Accessibility settings can be included in the QR setup code, but polling place would have to use an electronic voter register to print them as needed.	FVT	Positive
Write-Ins	Voters were able to write in a candidate without difficulty.	Both	Positive
	Voter started the session by saying that they had a problem with write-ins because they're too short to reach the place where you do the write in on the Danaher (it's at the top of the machine).	OVI	Positive
	Voter liked the write-in process. "That was better for me"	OVI	Positive
	Voter thought the write-in was easy. Voter OK with the ABC keyboard	OVI	Positive
	Voter uses the keyboard OK, but asks why not QWERTY	OVI	Positive

Problems

Function	Observation	System	Severity
Setup for voters	"People will play with the settings, slowing down voting."	FVT	Annoyance
	Machine had difficulty picking up QR Code	FVT	Annoyance
	The machine needs to be in speaker mode before vote is initiated with QR code, or resets to beginning.	FVT	Annoyance
	Voters had difficulty getting QR code aligned for camera. A tray or tactile guide would help this.	FVT	Annoyance
	Cable management might be an issue on this device. When the voter was trying to take the ballot, she had to reach around the headphone and tactile keypad cables.	FVT	Annoyance
Privacy	The privacy barriers on the voting tables do not fully mask the screen. The displays are crisp enough to be easily read from the side.	FVT	Annoyance
	The ballot is longer than the privacy sleeve. This is intentional to allow feeding the ballot into the scanner, but to a blind voter has the appearance of a security issue.	FVT	Problem solving
Audio/Voice Quality	In reference to the voice quality: "Ooh, that's nasty!"	FVT	Annoyance
	Some of the letters in the write-in keyboard were pronounced in ways that was hard to understand.	FVT	Annoyance
	The voice quality was not good. Pronunciation was not always clear.	FVT	Problem Solving
	"You have deselected ... " caused confusion. The pronunciation of "deselected" was unclear at both ends of the word.	FVT	Problem Solving

Function	Observation	System	Severity
	In the spoken instructions, "DONE" sounds very much like "DOWN." The voter tried to use the Down arrow to move on, but this was not successful. She did this three times before trying to use the "Select"	FVT	Problem Solving
	The pause between saying the name of the candidate and "Selected" caused the voter to lose the connection between the name and cue. This was especially true on straight party selections where the voter had not directly selected the candidate.	FVT	Problem Solving
Audio Instructions	There should be an indication on the screen that the audio voice is active. Poll workers consistently tried to provide assistance to a blind (simulated) voter who was listening to the narration, making concentration more difficult.	FVT	Annoyance
	When a multi-vote item is presented, the cues say that "you have not selected the [three] 'required' for this election." This makes it seem that voting for the full allowed slate is mandatory.	FVT	Problem Solving
	On screen to select straight party, the audio instructions indicate to use the arrow keys to select a candidate. A voter pointed this out as inaccurate and possibly confusing. The same thing occurs on ballot questions.	FVT	Problem Solving
	There is no command to have words or candidate names spelled. Because of the voice quality this may make it impossible to differentiate names that are near homophones.	FVT	Needs assistance
	The feedback on multi-vote contests is that you have not voted for the "required" 5 candidates. This implies that you must vote for all five, not fewer. This was interpreted as "Must" by this voter, and could be an issue for voters with cognitive issues.	Both	Show Stopper

Function	Observation	System	Severity
Touch Screen	The screen does not respond well to attempts to operate it with a knuckle rather than a fingertip. This is a strategy commonly used by those with limited hand function. We were able to improve this by making the font larger, which increases the target size for the knuckle	FVT	Show Stopper
Keypad	Arrangement of the arrow keys was unexpected and difficult to remember. Voters expected the select button to be in the middle of the direction arrows, rather than to the right of the right arrow.	FVT	Annoyance
	The Braille notation PS on the tactile keypad is intended to mean "Pause." The Braille on the "Tempo" key is "RT" (presumably for Rate). Neither of these labels was clear to the blind voter, who also noted that only 10% of people who are blind can read Braille, so visual labels are important	FVT	Problem Solving
Screen gestures	Tried to scroll screen with finger, inadvertently selected two candidates.	OVI	Annoyance
Printed Ballot	One voter interpreted the numbers next to each candidate as showing how many votes that candidate had received.	Both	Needs assistance
	The font on the printed ballot is small and hard to read. It is, however, 3.0mm, meeting VVSG requirements	Both	Needs assistance
	Leading and kerning is also minimal, making reading even harder.	Both	Needs assistance
	The title “STRAIGHTPARTYSELECTION” is printed as a single word	Both	Needs assistance
Verification and handling the ballot	There is no way for a blind or low vision voter to verify the paper ballot using only the voting system. A voter asked "If I can OCR on my own phone, why can't there be a device as part of the system to do it?"	FVT	Show stopper

Function	Observation	System	Severity
	Using a personal OCR system, it is possible to read the ballot, though with some difficulty. Without a way to lay the paper flat, phone-based OCR readers do not work well. Because of the length of the ballot, it must be read as "short text" not as a document. This includes being able to move the phone across the ballot in a smooth and level motion.		Show stopper
Printing the ballot	When done with the voting process, it was not clear to the voter what to do next to cast the ballot. Eventually selected the "Print" button which was the correct thing to do.	FVT	Problem Solving
	For a blind voter, finding the printed ballot was not easy. She knew the general direction of the printer by its sound, but was confused by the wires to the tactile keypad and the headset which passed in front of the ballot.	FVT	Problem Solving
	Voters reported that the print on the ballot is too small.	Both	Needs Assistance
Navigation	Requirement to view all candidates before moving on prompted voter to say "That's stupid. I know who I wanted to vote for. This is especially annoying when the candidates to be viewed are all "write in" entries that are not candidates.	Both	Annoyance
	Voters felt it would be helpful if the machine provided how many more candidates were available, and how many selected on multi-vote competitions. (“You have selected 2 of the available 5 candidates”)	FVT	Problem Solving
	The pagination of the ballot included going to a screen which had just one write-in box, confusing voters.	OVI	Problem Solving
	Voters were always aware of when the contest is continued - the header doesn't change appearance as a cue.	OVI	Problem Solving

Function	Observation	System	Severity
	Voter had trouble finding names near the end of a contest because the paging model confused them.	OVI	Problem Solving
	Voters were confused when one screen included the end of one contest and two additional contests	OVI	Problem Solving
	In review process, the voter was confused initially about how to get back to the review screen after making a change. It was not clear that the right arrow key, which is used to advance to the next ballot measure now returns to the review screen.	FVT	Problem Solving
	On overvote, suggested "I think it guesses, blanking to a clean slate."	FVT	Problem Solving
	If the voter attempts to over-vote, the system silently deselects the previously selected candidates, and selects the over-vote. There is no verbal cue that it is doing this. The voter indicated that there should be a message that says "You have already voted for the full number of candidates. You must deselect one before making this selection."	Both	Show Stopper
Buttons – Display and naming	The highlight of the buttons is not strong enough of a cue to allow the user to identify the change. This makes switch navigation difficult.	FVT	Annoyance
	The “Next” button is modal, either advancing to a new contest or scrolling the screen, confusing voters.	Both	Annoyance
	Red button to see more candidates was confusing as it looked like an error alert. Voters reported it made them think something is wrong.	Both	Problem Solving
	The “Continue” message confused voters who thought it was an active button	OVI	Problem Solving

Function	Observation	System	Severity
	"Screens have both 'Done' and 'Next', confusing voters about which to use. Voters often tried both - "Do I hit '"Done" ' (grayed) or the arrow?"	FVT	Problem Solving
	The "?" Symbol isn't as clear as "HELP" would be on the button for the help screen.	FVT	Problem Solving
	In one case, the system displayed a button to scroll the screen even when most of the final write-in block was already displayed	OVI	Problem Solving
	Grayed candidates were confusing when a voter encountered a contest with a full slate selected through straight party, but with no selections visible on the first page.	FVT	Problem Solving
	On multi-candidate elections, "If I didn't notice the '3', I would assume that I could only vote for one."	OVI	Problem Solving
	On the last contest - says "Uh oh. No next button" Tries to use the right arrow then finds the DONE button at the top	OVI	Problem Solving
	Tries to use DONE to complete the selection on a contest.	OVI	Problem Solving
	In the review screen, tries settings and then help to make a change, finally finds Change	OVI	Problem Solving
	After going to a contest to correct a vote, uses the arrows to move forward, and doesn't realize that he's seeing the same contests he saw before.	OVI	Problem Solving
	The selection targets on the right side of the contest area were so close the buttons on right side that a voter accidentally pressed the button by mistake. Had to be told that he could press any space on the name or blank.	OVI	Needs assistance
Straight Party	The poll workers did not comment on the machine erasing straight party candidates when out-of-party was selected.	FVT	Annoyance
	"Straight party screen makes it feel like you have to select one."	OVI	Problem solving

Function	Observation	System	Severity
	There is no confirmation of what happens as a result of selecting a party – for example, a simple message that candidates (and perhaps how many) have been pre-selected	OVI	Problem solving
	Voter tried to deselect "straight party" selection as part of making a new selection. This has the effect of "selecting the same candidate. Need to select out of party candidate first, then deselect.	Both	Problem Solving
	Voter (who is an advocate) indicated that the PA Method behavior would be "very confusing for someone with an intellectual disability. They would leave."	FVT	Needs Assistance
	Instructions and warnings for undervote seemed to make full voting compulsory.	FVT	Show Stopper
Write-ins	Voters asked why write-ins were on their own screen on so many contests	Both	Problem Solving
	Write-in candidate that would cause an overvote cancels selections even if it is canceled rather than entered on the ballot.	FVT	Show Stopper
Entering Write-Ins	The write-in process with tactile keypad requires scanning through the alphabet, which is very inefficient. Voter commented that, when scanning through the alphabet, when moving from "S" to "I", for example, there is a mental process of deciding whether to move forward or backward will be shorter. The insertion of a half dozen non-letter buttons complicates this process.	FVT	Annoyance
	A two-switch user doing a write-in can only move forward through the alphabet. In many situations, such a user will look at the visual distance from the current location to the target, and quickly press the switch a few less than that to approach the target, then finish in a more measured way. When scanning a QWERTY keyboard alphabetically, this is not possible.	FVT	Annoyance

Function	Observation	System	Severity
	Was looking for normal keyboard layout rather than alphabetical.	OVI	Annoyance
	On-screen keyboard is alphabetical, slower than QWERTY (for experienced typists), and unexpected	OVI	Annoyance
	Navigating the write-in screen: It was not clear to the voter how to enter the write-in name	FVT	Problem Solving
	Voter looked for a stylus to write in the name, decides to use her finger. When she touches the area, the keyboard pops up and no problem from there.	OVI	Problem Solving
Review Screen: Overvotes	If the undervote were a color other than red, or if it had white text rather than black, it would be more readily seen, and less like an error.	FVT	Problem Solving
	Commented that the red highlight for undervote suggests that this is an error, and full voting is required.	Both	Problem Solving
	The red color could make the text of a contest with undervote unreadable. At least one advocate commented on this asking “what if I can’t see red?”	FVT	Show Stopper
	Makes the voter think that you have to fully vote each competition. Undervotes are cued as errors.	Both	Show Stopper

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 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 FVT 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 VFT, there is a help button and a setting "cog" that the poll worker can review 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. The FVT help screen could be the basis for these instructions, though the language should be simpler (3rd or 4th grade reading level).
- 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 FVT screen can be adjusted to change its angle for a closer approach, adapting to standing or sitting postures, and avoiding glare.
- Provide assistance plugging in personal headsets or switches with verbal instructions or by doing it for the voter.
- A voter with a disability is likely to know how to plug in their personal headset or switch, but they will not know the location of the jacks on the machine. On the FVT, the tactile keypad that is used by a blind voter includes a 3.5mm jack that seems appropriate to insert a headset. However, this is where the dual switch connects rather than the headphone, which plugs directly into the screen component.
- Make sure voters are oriented and know where all parts of the voting system are, including the privacy shields. The FVT includes options to blank the screen during the audio ballot.
- 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 permanent cord. The headphone is plugged in on the right side of the screen. The printer and location where the paper ballot appears is also on the right.
  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 it.
- **Privacy.** The screen for both systems sits close to the front 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 pushed or motorized wheel chair to get to the voting booth easily (see above).

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 FVT and OVI independently, once the facilitator/poll worker provided them with the appropriate accessibility features. No one found the system so difficult or frustrating that they were unable to vote, although several identified features that they felt would frustrate less competent voters.

Access features easily learned and helpful

As voters explored the access features, they seemed to learn them easily. Some voters use similar assistive devices daily or when they vote. Others use an assistant or do not have the options on their current voting machines. One voter who had never used the sip and puff dual switch before picked it up quickly and was able to successfully complete a ballot. She wished it was an option in Philadelphia County.

After a very brief overview of each machine, the facilitator asked poll workers to demonstrate that they understood the function of each access feature by offering the appropriate option to the roll-play voter. Poll workers set up the machines successfully without a great deal of help.

Two of the three groups of poll workers reported that the access features would help voters that 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.

Default text size

The default text size was large enough for most of the participants. Once the voters discovered the settings button and options, they could easily change the font size. Only one voter required a larger font size to read the screen more easily.

Accessible voting booth

The FVT and OVI sat on top of a vendor provided, collapsible voting booth that placed the machines at an accessible level and had wide legs to accommodate wheelchairs. The voting booth height was not adjustable, but worked for all participants. One power wheelchair voter even exclaimed the voting machine is “at my level.”

One negative about these booths relates to the position of the screen in the booth. The booths were clearly designed for voting systems that place the screen toward the back of the booth, so that the side shields provide some privacy. With the two machines in this test, the touch-screen is positioned at the front of the booth, and is very close to the leading edge of the side walls, so it provides only minimal privacy protection. Voters used to voting inside curtains were particularly sensitive to this issue.

Summary-screen/review process

The ballot summary and review process seemed to be intuitive to both voters and poll workers. Voters were able to make changes to the ballot and then return to the summary screen without more than minimal confusion about the navigation.

This worked best on the FVT. On the OVI, the button to return to the review screen was in the upper-right. Participants often used the button in the lower right to move to the next contest rather than returning directly to the review screen. In a least one case, the voter did not realize he was seeing the same contests he had already marked.

Voters using the FVT were pleased that they were returned to the same contest on the review screen, rather than having so start over from the top. This was particularly important to people using the audio format or dual-switch access.

Gestures

Those voters who discovered the screen gestures of the FVT (scroll up and down, swipe left to right) had no confusion about the function and adjusted quickly. They reported liking that it was an option.

Other issues for deployment

A few other issues produced consistent enough observations to call them out in some detail.

Reading the activation code

The FVT voting machine has a useful feature that uses a printed, one-time-use QR code which to select the ballot style and accessibility features (font-size, contrast, audio rate, volume, and other settings) of the machine. (We did not test using personal preference in the QR code because this feature depends on the capabilities of a separate electronic poll book not included with the system being tested)

Several voters had difficulty scanning the QR code.

- There is no guide or audio instructions for blind or low-vision voters.
- It is easy to cover the code with a finger while trying to position the paper under the scanner.
- Deaf voters cannot hear the (quiet) beep indicating the scan was successful and the visual cue was not sufficient to draw attention.

Recommendation for deployment. A simple guide for where to place the activation code would increase the accessibility of this feature. If not included with the voting system, election officials might create one, for example by taping a tactile ridge in position as a guide.

Audio quality for instructions

For a voter who cannot see the screen, voice quality is just as important as print quality is to a sighted voter and can affect their understanding of the ballot contents, navigation options, or both.

Voice quality is critical to understanding candidate names, especially because there is no option to spell out a name when it is not clear.

The voice used for testing was created using MP3 files, pieced together to create the messages. The resulting voice was very difficult to understand, and the flow of the instructions was very poor. One blind voter immediately said, “Oh, that’s nasty!”

- The letters in the write-in alphabet are not pronounced clearly.

- The words “Done” and “Down” were indistinguishable making it hard to understand the action of these navigation buttons.
- The narration had pauses and changes in tone that made the semantics of the sentences hard to understand.

The system has a second style of audio that uses text-to-speech (TTS) technology. This voice (based on Google’s speech synthesis) was clear and smooth, and vastly superior in understandability.

Recommendation for deployment: Election officials should use the TTS option over the voice constructed from recorded snippets. We understand that this is an option available as part of the standard system.

Screen freezing

We had one other problem that may have simply been a technical issuer or a misunderstanding about how the system works: plugging in the speaker we were using so a group could hear the audio froze the system. This may have been because the poll workers first plugged the speaker into the switch jack. We managed to freeze the system twice with the powered speaker.

We later were told about a “screen reader mode” in which the system only activates buttons through the tactile keypad and the screen responds only to limited gestures. It is possible that the system was in this mode when we believed the screen had frozen.

XII. Attachment C- Acceptance Testing Attestation

Attachment C - Implementation Atte

Voting System Implementation Attestation

System Name: OpenElect 2.2.3

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
OpenElect Central Suite				(Please specify the implementation, single device (desktop/laptop), Client/server)
[OCS] Ballot Layout Manger Application				
[OCS] Cast Vote Record Utility				
[OCS] Election Manager				
[OCS] OVCS Application				
[OCS] Tabulator Client				
[OCS] Tabulator Monitor				
[OCS] Tabulator Reports				
[OCS] Write-in Extractor Utility				

[OCS] Write-in Manager Utility				
[OCS] Common Files				
[OCS] Installer Application				
FreedomVote Scan				
FreedomVote Tablet				
OpenElect Voting Optical				
OpenElect Votign Central Scan				

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 OpenElect 2.2.3 system. Any ancillary components sold under this contract, such as switches, ballot boxes, and charging carts, are EAC-certified components of the OpenElect 2.2.3 voting system. (Attach a list of all ancillary components sold under this contract.)

Unisyn 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.

Unisyn 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

Unisyn 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 Unisyn'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 the Unisyn'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

Unisyn 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). Unisyn must pay all costs associated with 1) placing the codes in escrow and 2) verifying that Unisyn 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, Unisyn 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 Unisyn, Unisyn 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 Unisyn.
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. Unisyn 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. Unisyn agrees that upon the occurrence of any event or circumstance which demonstrates with reasonable certainty the inability or unwillingness of Unisyn 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 Unisyn Property placed in escrow from the escrow agent.