

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF STATE**

**REPORT CONCERNING THE EXAMINATION RESULTS OF
DOMINION VOTING SYSTEMS DEMOCRACY SUITE 5.5A WITH
IMAGECAST® X BALLOT MARKING DEVICE (ICX-BMD),
IMAGECAST PRECINCT OPTICAL SCANNER (ICP), IMAGECAST
CENTRAL STATION (ICC), AND DEMOCRACY SUITE EMS (EMS)**



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EXAMINATION RESULTS OF DOMINION VOTING SYSTEMS DEMOCRACY SUITE 5.5A WITH IMAGECAST® X BALLOT MARKING DEVICE (ICX-BMD), IMAGECAST PRECINCT OPTICAL SCANNER (ICP), IMAGECAST CENTRAL STATION (ICC), AND DEMOCRACY SUITE EMS (EMS)

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 Dominion Voting Systems Inc. (Dominion), the Department of State's Bureau of Commissions, Elections and Legislation (Department) scheduled an examination for October 15, 2018 of the Democracy Suite 5.5 voting system. The voting system presented for certification in Pennsylvania included the Democracy Suite Election Management System (EMS) election management software used in conjunction with the following components: 1) ImageCast® X (ICX) Ballot Marking Device (BMD), a ballot marking device with Commercial Off The Shelf (COTS) printer, HP LaserJet Pro Printer M402dn/HP LaserJet Pro Printer M402dne, for printing marked ballots; 2) ImageCast Precinct Scanner (ICP), a precinct optical scan ballot tabulator that scans, validates and tabulates hand-marked paper ballots and ballots produced on the BMD; and 3) ImageCast Central Station (ICC), a ballot scanning and tabulating system that can be configured with high speed COTS scanners Canon Image Formula DR-G1130 /Canon Image Formula DR-M160-II to tabulate ballots in central office.

The Secretary appointed SLI Global Solutions (SLI) and the Center for Civic Design (CCD) as professional consultants to conduct the examination of Democracy Suite 5.5. The examination process included a public demonstration and functional examination (functional examination), accessibility examination and security testing. The functional and accessibility examinations were performed in Room G24A/B of the Commonwealth Capitol

Complex - Finance Building, 613 North Street, Harrisburg, PA 17120. Mike Santos, Senior Test Manager, and Kyle Johnson, Senior Test Engineer (Functional Examiner), of SLI Global Solutions, conducted the functional examination of the Democracy Suite 5.5 pursuant to Section 1105-A(a) of the Election Code, 25 P.S. § 3031.5(a). Whitney Quesenbery, Denis Anson and Michael Weisman (Accessibility Examiner), representing CCD, performed an accessibility examination of the Democracy Suite 5.5 system. The examinations commenced on October 15, 2018, and lasted approximately four days. Jonathan Marks, Commissioner of the Bureau of Commissions, Elections and Legislation; Kathryn Boockvar, Senior Advisor to the Governor on Election Modernization; Jessica Myers, Deputy Director, Office of Policy; Kathleen Kotula, Executive Deputy Chief Counsel, Office of Chief Counsel; and Sindhu Ramachandran, Voting Systems Analyst, represented the Secretary of the Commonwealth. Jessica Bowers, Director of Certification, and Matt Coffey, Systems Specialist, represented Dominion. Additional staff members from the Department also attended the examination. The functional examination was open to the public and was videotaped by Department staff. Security testing of the Democracy Suite 5.5 system was performed at SLI facilities located at 4720 Independence Street, Wheat Ridge, Colorado, prior to the functional examination. Mike Santos, Senior Test Manager, and Jesse Peterson, Security Specialist, at SLI Global Solutions, served as the Security Examiner for the Democracy Suite 5.5 security testing. The Functional Examiner and Accessibility Examiner concluded that the Democracy Suite 5.5 did not comply with Sections 1107-A(10) and (15), 25 P.S. §§ 3031.7(10) & (15), of the Pennsylvania Election Code because the ICX BMD did not allow the voter to remove all candidate selections in a contest after voting straight party and the screen referenced the process of marking and printing the ballot as “casting” the ballot. Additionally, the Security Examiner noted that the system hardening measures documented in the Technical Data Package (TDP) required additional modifications for a secure implementation.

Thereafter, Dominion incorporated corrections for the issues identified during the Democracy Suite 5.5 examination, and re-submitted the new release, Democracy Suite 5.5A, to both the U.S. Election Assistance Commission (EAC) for federal approval and the

Department for state certification. The system components remained the same and the only change in the new release was the software enhancements to remediate the identified anomalies. The Functional Examiner performed a follow-up examination of Democracy Suite 5.5A on December 5-6, 2018, at SLI Global Solutions located at in Wheat Ridge, Colorado. Department staff observed the examination via web conference. The examination was videotaped by SLI and the video is on file at the Department. The Security Examiner validated that the documentation has been updated to reflect accurate system hardening steps for a secure implementation. Since the software changes made to the Democracy Suite 5.5A system were specifically to remediate the identified anomalies in Democracy Suite 5.5, it was determined that the results of the accessibility examination and security testing conducted as part of the Democracy Suite 5.5 examination may be utilized for Democracy Suite 5.5A certification. The Department discussed the software modifications with the Accessibility Examiner, since both the straight party usability issue and usage of the word “cast” were also part of the Accessibility test findings.

II. The Democracy Suite 5.5A Voting System

Democracy Suite 5.5A components considered for use in Pennsylvania¹ provide a paper-based voting system with 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 BMDs as the ADA component. The system components include: the Election Management System (EMS), the ImageCast Central (ICC) - utilizing two Commercial Off the Shelf (COTS) scanners, the ImageCast Precinct (ICP) optical scanner and the ImageCast X (ICX) (Prime and Classic) ballot marking devices.

The following is a description of the Democracy Suite 5.5A components summarized from Section 2.0 (System Overview) of the Test Report for Examination of Democracy Suite 5.5A, prepared by the Functional Examiner and documentation submitted by

¹ The EAC certified system includes a DRE option for the ICX device which is not considered for certification in Pennsylvania.

Dominion as part of the Technical Data Package (TDP).

Election Management System (EMS)

The Dominion Democracy Suite 5.5A EMS supports elections on the ICX Prime, ICX Classic, ICP and ICC systems. The EMS set of applications are responsible for all pre-voting and post-voting groups of activities in the process of defining and managing elections. EMS software platform consists of end-user (client) and back-end (server) applications. The EMS platform consists of the following major components.

EMS Election Event Designer (EED) - Supports pre-voting activities including election definition together with ballot styling capabilities.

EMS Audio Studio (AS) - End-user helper application used to record audio files for a given election project utilized during the pre-voting phase of the election cycle.

EMS Application Server – Server-side application responsible for executing long running processes, such as rendering ballots, generating audio files and election files, etc.

EMS Results Tally and Reporting (RTR) - Integrates election results acquisition, validation, tabulation, reporting, and publishing capabilities and represents a main post-voting phase end-user application.

EMS File System Service (FSS) - Stand-alone service that runs on client machines, enabling access to low level operating system API for partitioning CF cards, reading raw partition on ICP CF card, etc.

EMS Data Center Manager (DCM) - End-user application used to export election data from election project and import election data into election project.

EMS Election Data Translator (EDT) - End-user application used to export election data from election project and import election data into election project.

EMS Adjudication (ADJ) and EMS Adjudication Service - Server and client components responsible for adjudication, including reporting and generation of adjudicated

result files from ImageCast Central tabulators and adjudication of write-in selections from ImageCast Precinct and Image Cast Central tabulators.

ImageCast Voter Activation (ICVA) - Installed on a workstation or laptop at the polling place, that allows the poll workers to program smart cards for voters. The smart cards are used to activate voting sessions on ImageCast X.

ImageCast X (ICX) Ballot Marking Device (BMD)

The ICX ballot marking platform is used for creation of paper cast vote records. These ballots can be scanned, reviewed, cast and tabulated at the polling location on an ICP or later scanned and tabulated by the ICC at a central location. The ICX consists of two models, ICX Prime and ICX Classic.

2.3 ImageCast Precinct (ICP)

The ICP is a hybrid precinct optical scan ballot counter designed to provide ballot scanning, ballot review and tabulation at a polling place.

2.4 ImageCast Central (ICC) Count Scanner

The ICC is a high-speed, central ballot scan tabulator based on Commercial off the Shelf (COTS) hardware, coupled with the custom-made ballot processing application software. It is used for high speed scanning and counting of paper ballots.

Manufacturer Software/Firmware

The **Dominion Democracy Suite 5.5A** voting system consists of the following software and firmware components:

Application	Version
EMS Election Event Designer (EED)	5.5.12.1
EMS Results Tally and Reporting (RTR)	5.5.12.1
EMS Application Server	5.5.12.1
EMS File System Service (FSS)	5.5.12.1
EMS Audio Studio (AS)	5.5.12.1
EMS Data Center Manager (DCM)	5.5.12.1

Application	Version
EMS Election Data Translator (EDT)	5.5.12.1
ImageCast Voter Activation (ICVA)	5.5.12.1
EMS Adjudication	5.5.8.1
EMS Adjudication Service	5.5.8.1
Smart Card Helper Service	5.5.12.1
ImageCast Precinct	5.5.3-0002
ImageCast Central	5.5.3.0002
ImageCast X	5.5.30

COTS Software/Firmware

Additional COTS software and firmware included in the system has been defined as part of the EAC system certification scope that will be added to this report as Attachment A once the final certification is granted for Democracy Suite 5.5A.

III. EXAMINATION APPROACH, PROCEDURES AND RESULTS

A. Examination Approach

To ascertain whether Democracy Suite 5.5A can be safely used by voters at elections in the Commonwealth and meets all the requirements of the Pennsylvania Election Code, the Examiners developed test protocols for the examination. The initial functional examination of Democracy Suite 5.5 held October 15 through 19, 2018, determined that the system did not comply with Sections 1107-A(10) and (15), 25 P.S. §§ 3031.7 (10) & (15). The Examiners observed the following issues:

1. The ICX-BMD did not allow a voter to deselect all choices in a contest after voting straight party when the voter attempted to do so. Instead, a warning message that required no user acknowledgment displayed above the contest indicating that their “implicit” straight party selections would remain in effect. The screen presented to the voter had all the selections deselected and when the voter printed the ballot, the paper ballot indicated votes for the candidates chosen by the straight party option.

The warning message wording did not clearly indicate the intent. Also, the message displayed was not intuitive enough for a voter to notice it and there was no acknowledgment action required of the voter indicating that the message was seen.

2. The ICX-BMD final screen presented to the voter indicated that the voter was about to cast their ballot, even though the voter was only printing the ballot which needs to be further scanned by the ICP or ICC.

Dominion remediated the software issues and the Examiners then performed a follow-up examination of Democracy Suite 5.5A to confirm that the anomalies identified in Democracy Suite 5.5 were corrected and the system complies with all the requirements of the Pennsylvania Election Code. The examination approach followed for Democracy Suite 5.5 and Democracy Suite 5.5A is discussed in the below sections.

Democracy Suite 5.5 Examination Approach

Functional Examination

The test protocols separated the requirements of Article XI-A of the Pennsylvania Election Code, Sections 1101-A to 1122-A, 25 P.S. §§ 3031.1 - 3031.22, into six main areas of test execution: (1) Source Code Review; (2) Documentation Review; (3) System Level Testing; (4) Security/Penetration Testing; (5) Privacy Analysis; and (6) Usability Analysis.

Source Code Review was performed prior to the functional examination to determine if there were any vulnerabilities found that would warrant additional security examination.

Documentation Review was performed to verify that the portions of the Pennsylvania Election Code, which reference documentation detail, are sufficiently met by the Dominion Democracy Suite 5.5 documentation. The Functional Examiner validated compliance of the system to the following sections of the Election Code during the documentation review.

- 1105-A(a), 25 P.S. § 3031.5(a), requiring that an electronic voting system has been examined and approved by a federally recognized ITA;
- 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;

- 1107-A(13), 25 P.S. § 3031.7(13), requiring an electronic voting system to correctly tabulate every vote;
- 1107-A(14), 25 P.S. § 3031.7(14), requiring an electronic voting system to be safely transportable; and
- 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.

System Level Analysis examined the Dominion Democracy Suite 5.5 voting system by conducting an election starting with creating an election definition using EMS and then creating the election media needed to populate the voting devices (the ICX - Classic and Prime with COTS printer HP LaserJet Pro Printer M402dn, ICP, ICC with COTS scanners - Canon DR-G1130 and Canon DR-M160-II). Ballots were marked, manually as well as via both models (Classic and Prime) of the ICX ballot marking device, and tabulated through the ICP and ICC (both COTS scanners). The results reports were validated against the expected results of the voted ballots. All components of the Democracy Suite 5.5 system were exercised to verify that they met all pertinent requirements of the Pennsylvania Election Code. The test cases were designed to ascertain compliance with the following sections of the Election Code:

- 1101-A, 25 P.S. § 3031.1, requiring an electronic voting system to provide for a permanent physical record of all votes cast;
- 1107-A(2), 25 P.S. § 3031.7(2), requiring an electronic voting system to permit voting on both candidates and ballot questions, according to the official ballot;
- 1107-A(3), 25 P.S. § 3031.7(3), requiring an electronic voting system to permit straight party voting, including the "Pennsylvania method" of straight party voting;
- 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;
- 1107-A(5), 25 P.S. § 3031.7(5), requiring an electronic voting system to permit a voter to enter write-in votes;
- 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;

- 1107-A(7), 25 P.S. § 3031.7(7), requiring an electronic voting system to prevent over-votes;
- 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;
- 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; and
- 1107-A(10), 25 P.S. § 3031.7(10), requiring an electronic voting system that registers votes electronically to permit voters to change their votes up until taking the final step to register the vote, and for systems that use paper ballots or ballot cards, permits a voter to get a new ballot in the case of a spoiled ballot, and to mark and cancel the spoiled ballot;
- Parts of 1107-A(16), 25 P.S. § 3031.7(16), requiring an electronic voting system which provides for district-level tabulation to include (i) a public counter to register how many ballots are submitted to be counted; (iv) will not tabulate an over-vote, with an option to notify a voter of an over-vote if used during voting hours; and (v) generates a printed record that counters are set to zero before voting commences; and
- Parts of 1107-A(17), 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 reports.

The Functional Examiner also used the System Level Testing to further evaluate the design and accuracy aspects of the system as required by Sections 1107-A(11) and (13), 25 P.S. §§ 3031.7(11) & (13), through his use at public demonstration, in addition to the requirements being validated in the documentation review phase by reviewing EAC certification reports.

The Security/Penetration Analysis examined the voting system's compliance with the requirements of the Pennsylvania Election Code by analyzing physical security procedures and impoundment of ballots. Precinct tabulation devices were installed for delivery to the precinct, and the Functional Examiner analyzed the pertinent security procedures performed

on each device to ascertain compliance with 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. The Functional Examiner also used the security analysis phase of testing to validate compliance with parts of Sections 1107-A(16) and (17), 25 P.S. §§ 3031.7(16) & (17), that relates to system security.

The Privacy Analysis examined the voting system's compliance with Section 1107-A(1) of the Election Code, 25 P.S. § 3031.7(1), requiring that an electronic voting system provide for absolute secrecy of the vote, by analyzing how the polling place devices met the pertinent privacy requirements.

The Usability Analysis evaluated the compliance of the voting system with Sections 1107-A(14) and (15), 25 P.S. § 3031.7(14) & (15). The results from the tests were used by the Functional Examiner to supplement his conclusions from the documentation review phase.

Accessibility Examination

The accessibility examination 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 determined the test ballot parameters and 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 ballot contained 14 contests: 1 straight party contest, 1 vote for a pair (President/Vice President), 7 vote for one, 2 vote for not more than three, 1 vote for not more than five, 1 referendum contest and 1 retention contest. The facilitator instructed voters on the vote selections to be made, so that results could be compared between each session and different examinations.

Security Testing

The 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 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 conducted tests that covered the following areas of testing - documentation review, design, software security, network capabilities, audit logging, physical security and penetration testing.

Democracy Suite 5.5A Examination Approach

Democracy Suite 5.5A is a release to correct the anomalies noted in Democracy Suite 5.5 system. The examiners evaluated the changes submitted by Dominion and developed test protocols to validate the modifications to Democracy Suite 5.5 to ensure that the fixes

resolved the identified anomalies and that the modified system maintained compliance with all the PA Election Code requirements.

Functional Examination

The Functional Examiner and Department agreed that the test approach must include Documentation Review, Source Code Review, System Level Testing and Usability Analysis. Security/Penetration and Privacy analysis results were leveraged from Democracy Suite 5.5 examination since those aspects of the system remained unaffected by the isolated code changes made to the system.

Documentation review was performed to verify that the portions of the Pennsylvania Election Code, which reference documentation detail, are sufficiently met by the Dominion Democracy Suite 5.5A documentation. Source code review was done to determine if there were any vulnerabilities that warranted additional testing and the review focused on source code modifications for the Democracy Suite 5.5A release. System Level Testing examined Democracy Suite 5.5A by conducting a general election and closed primary election. The election runs were to (a) test and confirm that the anomalies identified during Democracy Suite 5.5 examination were remediated, and (b) to perform regression testing of all components of the system. The election runs allowed the Functional Examiner to ascertain that the compliance with the Election Code requirements determined during the System Level Testing of Democracy Suite 5.5 is maintained in the new release. Usability analysis was performed to verify that the usability concerns identified during the examination of Dominion Democracy Suite 5.5 is remediated in the new release.

Security Testing

The Department of State in consultation with the Security Examiner decided that the test approach must include only validating the documentation updates to ensure secure

implementation of the system components, since the isolated code changes did not affect the security aspects of the system.

Accessibility Examination

The Department of State, in consultation with the Accessibility Examiner, decided that the findings from Democracy Suite 5.5 Accessibility Examination can be used for Democracy Suite 5.5A, since there were no hardware changes and the isolated code changes were for correcting the anomalies identified during Democracy Suite 5.5. The Department discussed the software changes done for the ICX with the Accessibility Examiner, since Accessibility testing also reported the same usability concerns identified during Functional Examination.

B. Examination Process and Procedures

The examination process and procedures followed for the Democracy Suite 5.5 and Democracy Suite 5.5A examinations are listed in the sections below. The final determination in this report is based on the combined analysis of the results and conclusions from both examinations.

Democracy Suite 5.5 Examination

Functional Examination

The public demonstration and functional examination portion commenced on October 15, 2018, at Room G24A/B of the Commonwealth Capitol Complex - Finance Building, 613 North Street, Harrisburg, PA 17120. The test execution tasks took approximately four days. Members of the public were allowed as observers for the examination. The Functional Examiner performed System Level Testing, Security/Penetration Testing and Privacy and Usability Analysis during the examination. Source code and Documentation review were completed prior to the public examination at SLI lab facilities in Wheat Ridge, Colorado.

Dominion supplied all the hardware equipment required for the examination. All

software and firmware necessary to perform the examination was received directly from the Voting System Test Laboratories (VSTL) that tested the voting system for EAC certification. The trusted build of the software and firmware for each device being evaluated were installed using the appropriate media for installation. The hash codes for all system components were captured using the process listed in the manufacturer's Technical Data Package (TDP) by the Functional Examiner with assistance from Dominion representative. 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.

The Functional Examiner created the election definition using EMS – EED and transport media was created to populate the devices under examination with the election. The polling place was set up using ICP and ICX - BMD (Classic and Prime). A primary and general election were then run using polling place devices and central scanners. Ballots were tabulated at the polling place using ICP and ICC using scanners Canon imageFormula DR-G1130 and Canon imageFormula DR-M160II. Results were then tabulated using EMS and validated against expected results.

Accessibility Examination

The accessibility examination portion commenced on October 15, 2018, at Room G24A/B of the Commonwealth Capitol Complex - Finance Building. The examination lasted approximately three days followed by a debrief meeting on October 18, 2018, with DOS and CCD to discuss initial findings. The examination included expert review by the Accessibility Examiner, sessions with four poll worker groups, and sessions with six voters with disabilities using different accessible devices for voting. The voter sessions each took approximately an hour. The poll worker sessions took approximately one hour to 90 minutes each. Dominion 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. This test examined the Dominion Voting ImageCast X (ICX) touch screen ballot marking device with COTS printer HP LaserJet Pro Printer M402dne and the

ImageCast Precinct Optical Scanner (ICP).

The typical accessible voting experience involves the voter making selections on the ICX to mark their ballot, printing their ballot using a separate printer, and then scanning their printed ballot on the ICP to cast the ballot. The Accessibility Examiner identified the accessibility features of each component as listed below:

ICX accessibility features:

- ADA compliant voting booth
- Touch screen, in portrait orientation
- Audio ballot with two voices: a prerendered, tactile keypad instructions voice and a ballot content, text-to-speech voice
- Tactile key pad with different-shaped, braille encoded buttons
- Binary input/Dual switch jack (on tactile key pad)
- Audio output jack
- Dual switch “jelly bean” buttons
- Sip-and-puff device, mountable to the table with adjustable arm
- Voter settings:
 - Language choice
 - Audio volume and tempo changes
 - Text Size (default, “Big”)
 - Screen contrast options: color, white background with black text, and black background with white text
 - Screen blank, while using the audio only

ICP scanner features

The ICP scanner had no notable accessibility features.

The machine features listed above are not exhaustive. For more information about the Dominion Democracy Suite 5.5 system, refer to the vendor provided technical specifications.

The Accessibility Examiner prepared voting scenarios for each voting session to

allow comparison of results between each session. 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.

The Accessibility Examination does not produce a typical voting session, but it provides a structured opportunity to explore how the voting system works in all interaction modes including:

- Visual display mode with default settings and use of enhanced options for text size, brightness, and contrast
- Audio format with options for volume and tempo
- Touch input and navigation on the display screen
- Input and navigation using a tactile keypad
- Input and navigation using a dual switch

Expert Review by Accessibility Examiner

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:

- An opening interview about their previous voting experience and the types of assistive technologies they use in daily life and in voting.
- A very basic orientation to the system with opportunities for voters to ask questions about any assistive technologies available.

- 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.
- Voting a ballot following facilitator-guided voting instructions, and facilitator help only where necessary. 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.
- 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 an hour and a half, depending on the group size and provided the most activity variability. Each session included:

- A brief orientation to the voting systems and the accessibility features, similar to a poll worker training.
- An opportunity for the poll workers to review vendor-provided instructions before trying the system. They marked ballots and experimented with the accessibility features.
- An opportunity for the poll workers to interact with two to three different access-needs scenarios, depending on the size of the group and available time. Each scenario involved an examiner role-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. Note: due to lack of time, the final poll worker group did not participate in the examiner role-plays.

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 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
- Likely to prevent independent voting for voters with some disabilities- problems that will prevent successful independent and private voting for voters with some disabilities, 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.

Security Testing

The Security Testing was done at SLI lab facilities in Wheat Ridge, Colorado. The

Security Examiner received the hardware devices from Dominion and the software and firmware were obtained from 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. The Security Examiner evaluated each component of the Democracy Suite 5.5 system and the system as a whole for interactions between components. These test suites covered areas of documentation review, design, software security, network capabilities, audit logging, physical security of the voting systems.

The requirements associated to each area of testing were applied to the Democracy Suite 5.5 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. The Security Examiner then designed tests that included in depth verification and validation of reports, audit logs and physical and logical access controls for each of the components of the voting system. The physical security examination included security seals, lock/key combinations, measures for collection of voting in the event of an extended power outage, ballot box and system access points. Tests were done to ensure that election results, media used, reports and audit logs were protected from attempts to decrypt, manipulate and corrupt election data. The Security Examiner also created a vulnerability assessment and performed penetration testing of the Democracy Suite 5.5 system.

Dominion Democracy Suite 5.5A examination

Functional Examination

The follow-up examination was conducted on December 5 and 6, 2018, at SLI Global Solutions facility, 4720 Independence Street, Wheat Ridge, Colorado, and was observed by Department staff remotely in a conference room in BCEL, 210 North Office Building, 401 North Street, Harrisburg, Pennsylvania via web conference. Dominion supplied all the

hardware equipment required for the examination. All software and firmware necessary to perform the examination was received directly from the VSTL that tested the voting system for EAC certification. The Functional Examiner installed and/or verified the Trusted Build for each system component. A primary and general election were then run using EMS, ICX-Classic and Prime, ICP and ICC. Results were then tabulated and validated against expected results. The Functional Examiner performed the Source Code and Documentation Review before the witnessed examination.

C. Examination Results

Democracy Suite 5.5 Functional Examination

On November 17, 2018, the Functional Examiner issued his draft report for the testing of Democracy Suite 5.5 with a recommendation that the system was not in compliance with Section 1107-A(10) and (15), 25 P.S. §§ 3031.7(10) & (15), of the Pennsylvania Election Code. The report noted the following concerns:

- 1) The ICX BMD did not allow the user to cast a “no vote” in a contest after voting straight party without exiting the straight party option. The system behavior was not intuitive enough for the user to understand and did not adequately communicate to the voter what they needed to do to accomplish their vote intent.
- 2) The ICX BMD indicated to the voter that they were casting their ballot even though the ballot was only being printed for scanning and tabulation on ICP or ICC.

The Functional Examiner’s report indicated successful completion of tests executed to ascertain compliance to all other requirements mandated by the Pennsylvania Election Code. The Examiner report for Democracy Suite 5.5 (Test Report – PDV-003-FTR-01) included details of the test cases, execution and successful completion. The following section is a summary of the results of the examination as set forth in fuller detail in the Examiner's Report.

1. Source Code Review

Source Code Review for Democracy Suite 5.5 was performed, with a focus on determining whether any vulnerabilities could be found. The Functional Examiner reported that the code review was completed with no malicious software, cryptographic software, process control or password management vulnerabilities being found. The Examiner concluded that no deficiencies were found during source code review.

2. Documentation Review

The Documentation Review testing performed by the Functional Examiner demonstrated that the Democracy Suite 5.5 meets the relevant requirements of the Pennsylvania Election Code. The Examiner reviewed the “Test Report for EAC 2005 VVSG Certification Testing of Dominion Democracy Suite 5.5 Voting System”

The review of the EAC test reports by the Functional Examiner and the EAC certifications submitted by Dominion satisfy the requirements of Section 1105-A(a) of the Election Code, 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), or VSTL as such authorities are now called, as meeting the applicable performance and test standards established by the federal government.

Functional Examiner concluded that the design requirements of Sections 1107-A(11) and (14) of the Pennsylvania Election Code, 25 P.S. § 3031.7(11) & (14), are met by the combination of EAC hardware Non-Operating Environmental Tests, which included bench handling, vibration, low temperature, high temperature, humidity and product safety tests. The system accuracy testing during EAC certification testing provided confirmation of system accuracy as required by Section 1107-A(11) of the Pennsylvania Election Code, 25 P.S. § 3031.7(11).

The Functional Examiner reviewed the system summative usability test report submitted to EAC to ascertain compliance to the usability requirement of Section 1107-A(15) of the Pennsylvania Election Code, 25 P.S. § 3031.7(15). The review determined that

the system documentation provided met EAC criteria for usability².

Accuracy testing performed during EAC certification testing provided confirmation of system accuracy to ascertain compliance to Section 1107-A(13) of the Pennsylvania Election Code, 25 P.S. § 3031.7(13). Additional testing to ensure system accuracy in tabulating PA specific voting scenarios was done during the Primary and General Election runs.

3. System Level Testing

As set forth in the examination approach, System Level Testing was divided into two separate tests, a closed primary election and a general election. The ballots defined had contests with voting variations supported in Pennsylvania.

A closed primary election consisting of two political parties (Republican, Democratic), three precincts Precinct 1, Precinct 2 - split into Precinct 2a and 2b, Precinct 3, was run utilizing EMS, ICX (Classic and Prime), ICP and ICC (two scanners). For the Republican ballot, there were 21 contests: 19 partisan contests and 2 referendums, 10 “Vote for One”, 1 “Vote for no more than Two”, 3 “Vote for no more than Three”, 4 “Vote for no more than Four” and 1 “Vote for no more than Fifteen”. For the Democratic ballot, there were 21 contests: 19 partisan contests and 2 referendums, 11 “Vote for One”, 1 “Vote for no more than Two”, 1 “Vote for no more than Three”, 5 “Vote for no more than Four” and 1 “Vote for no more than Fifteen”. Referendum contests were added to test the generation of non-partisan ballots. The Functional Examiner validated compliance of the system to Sections 1101-A and 1107-A(2), (5)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2), (5)-(11) & (13). All test cases passed without anomalies.

A general election consisting of four political parties (Republican, Democratic, Green and Libertarian), three precincts (Precinct 1, a split precinct 2, consisting of splits 2a and 2b, Precinct 3), and 21 contests (19 partisan contests and 2 retentions, 11 “Vote for

² The Functional Examiner, however, further identified during Usability Analysis that the system did not comply with Section 1107-A(15) of the Pennsylvania Election Code, 25 P.S. § 3031.7(15).

One”, 1 “Vote for no more than Two”, 5 “Vote for no more than Three”, 1 “Vote for no more than Four” and 1 “Vote for no more than Fifteen”) was run utilizing EMS, ICX (Classic and Prime), ICP and ICC (two scanners). The Functional Examiner examined the compliance of the system to Sections 1101-A and 1107-A(2)-(8), (10)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2)-(8), (10)-(11) & (13). All test cases except those validating 25 P.S. § 3031.7(10) passed without anomalies.

Functional Examiner included test cases to validate Sections 1107-A(16) and (17), 25 P.S. § 3031.7(16) & (17), that mandate voting systems to generate zero proof reports and correctly handle over-votes during the election runs. The remainder of the requirements of 25 P.S. § 3031.7(16) and (17) were validated by the Functional Examiner during the Security/Penetration Analysis.

Election definitions for both primary and general elections were created within EMS-EED, and transport media was created to populate ICP, ICX and ICC. Polls were opened and ballots were marked manually, as well as electronically via the ballot marking devices ICX (Prime and Classic). Ballots were tabulated utilizing the ICP and ICC (Canon DR-G1130 and Canon DR-M160-II) scanners.

The Functional Examiner used English and Spanish ballots for the test. Reports were generated after closing polls and results were validated against expected results. Each specific hardware and software component was tested for compliance with the required sections of the Election Code.

The Democracy Suite 5.5 is a paper based system and paper ballots provide a permanent physical record of each vote cast adhering to Section 1101-A(1) of the Election Code, 25 P.S. § 3031.1. Hand-marked paper ballots and ballots marked electronically using ICX are tabulated when voters insert the ballots into the ICP polling place scanner or when the ballots are tabulated at the central location using ICC.

The primary and general election definitions were created using EMS-EED and loaded to polling place devices and central scanners, which provided assurance that the

system can perform ballot creation activities. The Functional Examiner successfully added contests including straight party, parties, choices, precincts, districts, ballot styles, referendum questions and retention contests with appropriate candidates and choices. Media was created to load the election to ICP, ICX (Classic and Prime) and ICC. The ICP and ICX (Classic and Prime) components of the Democracy Suite 5.5 successfully permitted votes for "1 of 1," "N of M," and "Question" contests for a standard and ADA voting session. The test cases also included straight party voting to confirm that all appropriate candidates were selected. The Functional Examiner thus concluded that the system is in compliance with Section 1107-A(2), 25 P.S. § 3031.7(2).

Each of the applicable components of Democracy Suite 5.5 allowed the test voter to cast votes for candidates on the ballot and also a write-in vote, demonstrating compliance with Section 1107-A(5), 25 P.S. § 3031.7(5).

Democracy Suite 5.5 meets the requirements for Section 1107-A(6), 25 P.S. § 3031.7(6), because the test voters cast votes on different ballot styles for candidates and questions and the ICX (Classic and Prime) displayed only contests for which the voter was entitled to vote.

The system's compliance to Section 1107-A(7), 25 P.S. § 3031.7(7), was demonstrated since ICP has the capability to indicate overvotes for any office and the voter has the ability to either spoil the ballot or cast the ballot with overvotes if the voter decides to do so. Ballot marking device ICX (Classic and Prime) did not allow overvotes. The Functional Examiner also noted that the system allowed undervotes, but warned the user about the undervote if configured to do so.

The successful validation of the election results showed that ICC as well as precinct tabulator ICP include the capability to reject all choices recorded on the ballot for an office or question if the number of choices exceeds the number for which the voter is entitled to vote, adhering to Section 1107-A(8), 25 P.S. § 3031.7(8).

The Democracy Suite 5.5 complies with Section 1107-A(9), 25 P.S. § 3031.7(9),

because test voters in the closed primary election were only able to vote for referendum questions and candidates seeking the nomination of their party.

The Functional Examiner validated adherence to Section 1107-A(10), 25 P.S. § 3031.7(10), for both ADA and standard voting sessions. Ballot marking device ICX (Classic and Prime) allowed the voters to review their ballots before printing for tabulation on ICP or ICC. The Functional Examiner attempted to change votes on ICX (Classic and Prime) for candidates within the contest, as well as after leaving the contest and then returning to other contests and while reviewing the summary screen. The tests demonstrated that ICX allowed changing the selections until the voter decides to print the ballot. The Functional Examiner noted that the system did not intuitively allow the voter to deselect all candidates in a contest after voting straight party. The BMD, ICX (Prime and Classic), also showed a message to the voter that they were casting the ballot even though the ballots were being printed to be scanned and tabulated on the ICP or ICC. The ICP, precinct scanner of Democracy Suite 5.5 provides the voter with a caution message when the ballot contains errors, such as overvotes or undervotes. The voter is also presented an error report on the screen when the tabulator detects potential errors. The voter can either decide to affirm their intent by casting the ballot, or spoil the ballot and fill out another ballot.

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

The Functional Examiner validated via test cases during the primary and general election that the tabulating devices ICP and ICC generated zero proof reports only before ballots were cast, the system rejected all votes for the contest in an overvote situation, and produced a results report when appropriately configured, as required under Sections 1107-A(16) and (17), 25 P.S. § 3031.7(16) & (17). The Functional Examiner confirmed that the zero-proof report cannot be generated on demand after a ballot is cast.

Ballots were marked by hand including write-in votes during the general election to

examine the system's ability to properly enact the PA method of straight party voting. The ICP, ICC and ICX (Classic and Prime) demonstrated compliance to Sections 1107-A(3) and (4), 25 P.S. § 3031.7(3) & (4). The ballot marking devices allowed marking ballots following the PA method and the scanners/tabulators appropriately tabulated ballots with PA method test scenarios.

The voting variations used for the examination included write-in votes, to ensure that all components of the system will identify the appropriate write-ins and allow the election official to tabulate all votes including write-in votes.

4. Security/Penetration Analysis

The Functional Examiner adopted a strategy to review each pertinent requirement for this test individually and then created test cases to address it in either a documentation review, a functional test, or both.

Precinct tabulation devices and ballot marking devices were configured for delivery to a polling place from warehouse including all seals and locks recommended by the manufacturer. The central scanners were configured for operation in a county office. The devices were inspected for the ability to be tampered with. The Functional Examiner examined the polling place equipment to confirm the following:

- Adequate seals and locks are present to prevent tampering, and the system provides noticeable evidence if any tamper attempt (successful or failed) occurs (ICP, ICX - Classic and Prime);
- There is no access to the ballots/ballot cards, either via printer, the ICP or ballot card stock, to tamper or substitute any ballots (processed, unprocessed, challenged or provisional) (ICP, ICX – Classic and Prime);
- Devices are not accessible to unauthorized personnel to programmatically tamper with the device that would affect ballot presentation, print, or any other feature/activity (ICX – Classic and Prime);

- Devices not accessible to unauthorized personnel to programmatically tamper with the device that would affect ballot processing, delivery to ballot box, or any other feature/activity (ICX – Classic and Prime and ICP); and
- The Ballot box is tamper proof and/or tamper evident.

The Functional Examiner physically examined the central count equipment ICC for ballot security procedures, and verification of the system adequately preventing the tampering and substitution of ballots.

The Functional Examiner also examined the components of the Democracy Suite 5.5 system for password management of administrative functions and ensured that the system counter could not be reset by unauthorized persons. In addition, the Functional Examiner also reviewed Dominion System Documentation for ballot security procedures at the polling place and central location to ensure that the manufacturer recommended the required steps for configuring the Democracy Suite 5.5 securely for Election. Based on the tests the Functional Examiner concluded that that the system complies to 1107-A(12), 25 P.S. § 3031.7(12).

The Functional Examiner included test cases during the Security/Penetration analysis phase of the testing to evaluate the security requirements mandated by Section 1107-A(16) and (17), 25 P.S. § 3031.7(16) & (17). The Functional Examiner validated that the polling place tabulation device, the ICP, had a visible public counter and the system prevented authorized and unauthorized users access to vote data while polls are open. Tests were completed to verify that USB ports do not allow any data or information to be transferred to the ICP and no maintenance, poll worker or administrator accessible screens allow tampering with the tabulating element. The system did not allow polls to be opened without running a zero-proof report and the content of zero-proof report showed that all candidate positions, each question and the public counter were all set to zero. The functionality of the system to generate the close of polls report was verified and the report contents were analyzed to ensure that it contained the total number of ballots tabulated and total number of votes for each candidate and question on the ballot. Based on the above tests and the test cases executed while running the elections, the Functional Examiner concluded that

Democracy Suite 5.5 complies with all requirements mandated by 25 P.S. §§ 3031.7(16) and (17).

5. Privacy Analysis

The Functional Examiner reviewed and inspected the privacy aspects of the Democracy Suite 5.5 system to determine compliance with Section 1107-A(1) of the Election Code, 25 P.S. § 3031.7(1). The Functional Examiner determined that the components of the system used at the polling place comply with 25 P.S. § 3031.7(1) by review of system documentation and physical inspection. Central scanners were physically examined by the Examiner for adequate visual secrecy. The Functional Examiner also verified that no voter data, including stored ballot images are tied back to any specific voter, in a manner that would compromise voter secrecy.

6. Usability Analysis

The Functional Examiner determined that Democracy Suite 5.5 demonstrated compliance with the usability requirements of Section 1107-A(14) of the Election Code, 25 P.S. § 3031.7(14) , by reviewing appropriate EAC certification reports and vendor documentation. The Examiner determined that the ICX (Classic and Prime) BMD did not comply with the requirements of Section 1107-A(15) of the Election Code, 25 P.S. § 3031.7(15), since the system did not allow the user to cast a “no vote” in a contest after voting straight party without exiting the straight party option. The system behavior was not intuitive enough for the user to understand and did not adequately communicate to the voter what they needed to do to accomplish their vote intent. Additionally, the ICX-BMD informed the voter that they are “casting” their vote even though the ballot was only being printed for scanning and tabulation on ICP or ICC.

Democracy Suite 5.5 Accessibility Examination

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

Examiner Review

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:

- 4 blind from birth
- 1 late onset blindness
- 1 dexterity/limited use of hands

Age Ranges: 35 thru 70. All but one (a 70-year old) were in the 35-60-year-old age range.

Counties: Allegheny, Dauphin, Lebanon, Philadelphia, or York

Voters had a range of voting experiences. The Accessibility Examiner noted that the test population included a limited range of disabilities and the top problems with the ICX and ICP machines largely focused on issues a low or no vision voter would experience.

Poll worker Sessions

Poll workers were invited to come in teams. We had a total of fourteen participants across five sessions, which represented poll workers in Perry and Dauphin counties. The poll worker groups:

- Had between five and twenty-six years of experience.
- Had at least one election judge
- Were experienced with the Danaher ELECTronic 1242 and the ES&S iVotronic systems
- Had mostly limited experience serving voters with disabilities.

Unique facts about the poll worker groups:

- Three poll workers had blind family members
- One poll worker was blind
- One poll worker was a retired user interface designer

The Accessibility Examiner noted that poll workers with a wider range of voting system experience and different sized communities would have provided a better sample size for the test.

The Accessibility Examiner compiled the findings from the examiner review, voter sessions and poll worker sessions into positives, annoyances, problem solving, needs assistance and likely to prevent independent voting for voters with some disabilities. The Accessibility Examiner included recommendations for improving the accessible voting experience with each of the top five accessibility issues identified. The report also included recommendations on how election officials can support voters and poll workers when the new system is fielded. This section presents a summary of the report. Attachment B of this document lists these issues and recommendations in fuller detail and also describes all the observations from the Accessibility Examination.

The Accessibility Examiner noted in the summary section of the report that the

Dominion systems are an advance in independence and privacy for Pennsylvania voters with disabilities, and identified several positive aspects of the system including the following:

- Voters could vote privately and independently.
- 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 all sighted voters and the ability to increase to a larger font, if desired.
- Visual interface is clean and generally intuitive.
- Printed ballots could easily be read by app-based screen readers

The top five accessibility issues identified by Accessibility Examiner and voters are summarized in the following section. The Department further evaluated each of the findings and recommendations from the Accessibility Examiner and included the fielding recommendations as conditions for certification of the system³. The Department also discussed the findings from the Accessibility testing, specifically the ones that were marked as “Likely to prevent independent voting for voters with some disabilities” to ensure that appropriate fielding recommendations would alleviate the concerns for most voters.

Top 5 Accessibility Issues:

Privacy and independence restrictions -

- Poll workers must create a special voter card and initialize the assistive devices for voters. This means voters have to disclose disabilities to poll workers or poll workers have to guess voter’s abilities.
- The large ICX touchscreen and placement inside the voting booth may make it possible for other voters and people in the polling location to see how the

³Examples of conditions for certification can be found in this report at identification numbers B, R, T, U, V, FF and GG which relate to the top five accessibility issues found during the examination findings.

voter is voting, unless the county mitigates this risk when configuring the polling place.

Assistive technologies quality, instructions, and feedback –

- For the ICX audio, one voice provides voting instructions and the other announces ballot content. These appeared to use different technologies. Initially, there was a dramatic volume difference between the two, but the vendor was able to correct this problem. The rate of speech is different for the two voices, and the content voice is difficult to understand at very slow or high speeds because of how the audio playback managed the speed.
- The tactile keypad has duplicated buttons and a help button that is not helpful.
- The voting instructions are persistent and repetitive, with poor phrasing that makes it difficult for voters to understand. Lastly, the content of the instructions is too wordy, confusing, and ultimately unhelpful. Voters found it easier to ignore the instructions.

Write-in process

- The write-in process was difficult for the blind voters, and each required some facilitator aid to successfully finish.
- For voters using the audio assistance, there are no instructions to help a voter edit and verify their write-in.

Silent/Hidden selection and deselection

- The implementation of the straight party option made candidate selection and deselection confusing for some voters.
- When candidates overrode their straight party vote in a longer contest, candidates could be deselected off screen and out of the voter's view, without any system alert.
- Overvote protections on the system greys out the remaining options once the maximum number of selections are reached. This may cause the voter using the audio ballot to not hear all of the options in a contest.

Paper ballot handling

- The scanner bed is very shallow and cannot support the entire ballot, and if the ballot is not inserted properly, the scanner will return it to the voter. Since the scanner bed is not full size, the ballot may fall on the floor.
- There are no audible cues to assist blind voters, and the scanner screen is not easy to see.
- Contest alerts used on the paper ballots are not used or worded differently on the touchscreen device.
- The Accessibility Examiner noted that paper ballot is printed on cardstock and can be read by personal assistive devices. It was noted that the system uses a COTS printer for printing the ballots and the voters need not handle blank ballots before making the choices. The implementation reduces the verifiability for voters using assistive devices, since the ballot cannot be reinserted to be “read back”. Three out of the five blind voters were able to use app-based print readers to read the ballot back to them.
- There are no audible cues on the ICP to assist blind voters, and the scanner screen is not easy to see.

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.

Democracy Suite 5.5 Security Examination

As mentioned in the Examination Approach section of this document, the Security Examiner defined the Security Testing to be 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. The examiner analyzed the test results

and summarized any identified deficiencies into 4 major categories: documentation, source code, hardware, and functional. The Security Examiner then evaluated the physical and logical security, software hardening and control measures in place and identified items that required remediation before the system is certified for use in Pennsylvania.

The security testing identified the need to modify the hardening procedures for EMS and the ICX BMD printer for a more secure installation. The examiner also provided recommendations on secure implementation and deployment.

Democracy Suite 5.5A Examination Results

Democracy Suite 5.5A Functional Examination

As identified in the test approach section of this document the follow-up examination of Democracy Suite 5.5A included Documentation Review, Source Code Review and System Level Testing and Usability Analysis.

1. Documentation Review

The Examiner reviewed the draft “Test Report for EAC 2005 VVSG Certification Testing Dominion Voting Solutions Democracy Suite 5.5A voting system”. The review confirmed that the Dominion Democracy Suite 5.5A has been evaluated to federal standards by a VSTL. Democracy Suite 5.5A was provided the initial certification decision by EAC on December 20, 2018, which serves as an acknowledgement by EAC that the system has successfully completed conformance testing to VVSG 1.0, and hence complies with Section 1105-A(a) of the Election Code, 25 P.S. § 3031.5(a), which requires that a voting system must be examined and approved by a federally recognized independent testing authority (ITA), or VSTL as such authorities are now called.

2. Source Code Review

A Source Code Review for the code modifications for Democracy Suite 5.5A was performed, with a focus on determining whether any vulnerabilities could be found that would warrant additional testing. The Functional Examiner concluded that no vulnerabilities

were found during source code review that would warrant additional testing.

3. System Level Testing

The System Level Testing was divided into two tests, a primary election and general election. The Functional Examiner included test cases to specifically test the PA method anomalies identified during Democracy Suite 5.5 testing as part of the general election.

A closed primary election consisting of two political parties (Republican, Democratic), three precincts (Precinct 1, Precinct 2 - split into Precinct 2a and 2b, Precinct 3 was run utilizing EMS, ICX (Classic and Prime), ICP and ICC (two scanners - Canon DR-G1130 & Canon DR-M160-11). For the Republican ballot, there were 21 contests: 19 partisan contests and 2 referendums, 10 “Vote for One”, 1 “Vote for no more than Two”, 3 “Vote for no more than Three”, 4 “Vote for no more than Four” and 1 “Vote for no more than Fifteen”. For the Democratic ballot, there were 21 contests: 19 partisan contests and 2 referendums, 11 “Vote for One”, 1 “Vote for no more than Two”, 1 “Vote for no more than Three”, 5 “Vote for no more than Four” and 1 “Vote for no more than Fifteen”. Referendum contests were added to test the generation of non-partisan ballots. The Functional Examiner validated compliance of the system to Sections 1101-A and 1107-A(2), (5)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2), (5)-(11) & (13). No issues or anomalies were experienced during these tests, and the objective criteria established in the test protocols were met.

A general election consisting of four political parties (Republican, Democratic, Green and Libertarian), three precincts one of which was a split precinct (Precinct 1, split precinct 2, consisting of splits 2a and 2b, Precinct 3) , and 21 contests (19 partisan contests, and 2 retentions, 11 “Vote for One”, 1 “Vote for no more than Two”, 5 “Vote for no more than Three”, 1 “Vote for no more than Four” and 1 “Vote for no more than Fifteen”) was run utilizing EMS, ICP, ICX and ICC. The Functional Examiner examined the compliance

of the system to Sections 1101-A and 1107-A(2)-(8), (10)-(11) and (13), 25 P.S. §§ 3031.1, 3031.7(2)-(8), (10)-(11) & (13).

The Functional Examiner created election definitions and executed appropriate test cases on all components of Democracy Suite 5.5A to ensure that the modified system satisfies all requirements of the Election Code. The Functional Examiner used English and Spanish ballots for the test. Reports were generated after closing polls and results were validated against expected results. Each specific hardware and software component was tested for compliance with the required sections of the Election Code.

The Functional Examiner confirmed with appropriate test cases and voting patterns that Democracy Suite 5.5A maintains compliance to Sections 1101-A and 1107-A(2), (4)-(11) and (16)-(17), 25 P.S. §§ 3031.1, 3031.7(2), (4)-(11), (16) & (17), via tests cases in a similar manner as done during the Democracy Suite 5.5 examination. The Functional Examiner validated that the issues identified during the examination of Democracy Suite 5.5 are resolved and demonstrated compliance to Section 1107-A(10), 25 P.S. § 3031.7(10).

4. Usability Analysis

The Functional Examiner validated that the usability issues on the ICX BMD noted during the Dominion Democracy Suite 5.5A were resolved. The ICX-BMD did not have any references to the word “cast” during the printing process. The ICX-BMD displayed a pop up message requiring user acknowledgement indicating that the voter has to exit out of the straight party option to cast a “no vote” in a contest. The Functional Examiner hence concluded that the system demonstrated compliance to Section 1107-A(15), 25 P.S. § 3031.7(15).

Additional Security/Penetration and Privacy analysis were not conducted during the Democracy Suite 5.5A examination since the test cases validated during these tests were not affected by the isolated modification done to the ICX-BMD to resolve the anomalies noted during the Democracy Suite 5.5 examination.

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

- 25 P.S. § 3031.2;
- 25 P.S. § 3031.3;
- 25 P.S. § 3031.4;
- 25 P.S. § 3031.6;
- 25 P.S. § 3031.8;
- 25 P.S. § 3031.9;
- 25 P.S. § 3031.10;
- 25 P.S. § 3031.11;
- 25 P.S. § 3031.12;
- 25 P.S. § 3031.13;
- 25 P.S. § 3031.14;
- 25 P.S. § 3031.15;
- 25 P.S. § 3031.16;
- 25 P.S. § 3031.18;
- 25 P.S. § 3031.19;
- 25 P.S. § 3031.20;
- 25 P.S. § 3031.21; and
- 25 P.S. § 3031.22.

After all the testing activities, the examiners and Department concluded that the Democracy Suite 5.5A 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. The conclusion was drawn based on the examination of Democracy Suite 5.5A in conjunction with the Democracy Suite 5.5 examination.

Democracy Suite 5.5A Security Examination

The Security Examiner evaluated the documentation changes made to the system hardening procedures and confirmed that if the system is implemented following the hardening procedures, it provides a secure implementation.

D. Observations

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

1. The system presented for examination had undervote warnings turned on for straight party contest on ICX (Classic and Prime). This may make the voter believe that there is a need to make a selection in that contest.
2. Observations/Findings from the Accessibility Examination are listed on pages 32 thru 34 and as Attachment B of this document.
3. Dominion Democracy Suite 5.5A does not support cumulative voting.
4. The configuration of the system complying with the Pennsylvania Election Code requirements including the PA method of straight party voting will require the use of appropriate selections of configurable parameters.
5. The ADA compliant ballot marking device ICX (Classic and Prime) presented as part of the Democracy Suite 5.5A 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 devices.
6. The system allows configuration of button labels, warning/alert messages, voter instructions etc. There are some configuration elements that can be configured via the EMS Graphical User Interface (GUI) while there are some elements like button labels that cannot be configured via Graphical User Interface and will need to be done by editing a configuration (JSON) file on the EMS server.
7. The use of voter access cards for activation will create a lot of components to

manage and track on Election Day. Creating a large number of voter activation cards prior to Election Day would make it difficult to keep track of the card inventory. If jurisdictions choose to create cards on demand that would necessitate the need for an additional system at the polling place.

8. The ICX (Classic and Prime) BMDs use a COTS printer for printing marked ballots. The printer settings need to be appropriately adjusted for the printed ballots to be read by ICP or ICC.

IV. Conditions for Certification

Given the results of the examination that occurred in October and December 2018 and the findings of the Examiners as set forth in their reports, the Secretary of the Commonwealth certifies the Democracy Suite 5.5A subject to the following conditions:

A. This certification for Democracy Suite 5.5A is based on the EAC initial certification decision dated December 20, 2018, and will be appended with the final EAC certification documentation after the final EAC certification is issued.⁴ Any jurisdictions purchasing and implementing the system before the final EAC certification must perform a trusted build validation after the final EAC certification to ensure that the certified system components are installed. This validation must happen even if the jurisdiction has done a trusted build validation during the system acceptance.

B. Pennsylvania counties using the Democracy Suite 5.5A 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 June 9, 2011, 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 ICX in the

⁴ This certification is being issued due to the unique circumstances of the federal government shutdown after the successful initial certification decision was issued by the EAC and notice was given that no further testing is necessary. Consequently, only ministerial documentation remains, which will be appended once issued.

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 ICX (Classic and Prime) 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.

C. No components of the Democracy Suite 5.5A 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 Democracy Suite 5.5A, 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 Democracy Suite 5.5A is a paper-based system, counties using the Democracy Suite 5.5A 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 June 9, 2011 and any future revisions or directives that may apply to audits of electronic voting systems.

E. All jurisdictions implementing the Democracy Suite 5.5A 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. Counties must ensure that the L&A test cases include all applicable scenarios of the PA straight party method identified in Attachment C to the Directive for electronic voting systems published by BCEL on September 11, 2017.

F. Democracy Suite 5.5A 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 ICX as an ADA compliant device in configuring a precinct polling place. Jurisdictions must also take into consideration the ICP 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 Democracy Suite 5.5A 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, September 2016.

H. Jurisdictions implementing the Democracy Suite 5.5A 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 the Democracy Suite 5.5A 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. All jurisdictions implementing Democracy Suite 5.5A must configure the polling place components of the voting system to notify voter on overvotes.

K. All jurisdictions implementing Democracy Suite 5.5A must work with Dominion 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.

L. Dominion must work with the jurisdictions implementing Democracy Suite 5.5A 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.

M. 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.

N. Jurisdictions implementing Democracy Suite 5.5A must work with Dominion 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.

O. Jurisdictions using the services of Dominion or a third-party vendor for election preparation activities must work with Dominion 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.

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

Q. Jurisdictions must not use individual voter access cards for activating the ICX Ballot Marking device. This is to avoid lost, stolen or misplaced cards with the activator chip, which would be a potential vulnerability. Jurisdictions using poll worker cards for ICX activation must ensure that poll workers are trained to maintain strict chain of custody of the activation card.

R. Dominion must ensure that any implementations in Pennsylvania counties must appropriately indicate that the ICX BMD is printing the ballot and the final messaging on the ICX 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 Dominion support personnel and verified by county election officials.

S. Jurisdictions must have appropriate instructions on the ICX BMD to ensure that the voter reviews the entire ballot before printing the ballot. This is to avoid voters

missing selections in contests, especially after voting straight party.

T. Jurisdictions must work with Dominion 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. This is specifically important for Dominion Democracy Suite 5.5A. Jurisdictions must note that the general instructions and ballot instructions are configured separately and could have different volume setting and audio rates. This was noted during the Accessibility Examination and made the audio ballot almost unusable before adjusting the volume settings. Specific attention must be given to ensure that the audio ballots are tested by multiple personnel to evaluate the voice quality and the instruction accuracy.

U. Jurisdictions must work with Dominion during the ballot definition to ensure that voters using assistive devices have clear instructions for the write-in process. The on-screen 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.

V. Jurisdictions must work with Dominion 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.

W. Jurisdictions must make voters aware that voting straight party is optional via clear instructions on paper, on screen and audio ballots. This is to ensure that the voter

doesn't assume that he/she must make a selection for the straight party contest. The ballot instructions must be approved by the Department and follow any directives and/or guidance issued by the Department. Jurisdictions must also ensure during the election definition process that the straight party contest is excluded from undervote warnings. This is to ensure that the voter doesn't assume that he/she must make a selection for the straight party contest.

X. Dominion must ensure that the COTS printer used for ICX BMD (HP LaserJet Pro Printer M402dn /HP LaserJet Pro Printer M402dne) must be configured to ensure that the printer settings cannot be changed by the voter at the polling place. The configuration must ensure that the printer settings can only be modified by authorized personnel.

Y. 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.

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

AA. 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 Dominion 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.

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

CC. 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.

DD. Jurisdictions implementing Democracy Suite 5.5A 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.

EE. Jurisdictions implementing Democracy Suite 5.5A must work with Dominion 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.

FF. Jurisdictions implementing Democracy Suite 5.5A 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.

GG. Jurisdictions implementing Democracy Suite 5.5A 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 ICX and the ICP 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.

- The cords for tactile keypads, headphones and BMD printer need to be placed so that they don't interfere with the printed ballot and the voter's ability to find and take the ballot.

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

HH. Jurisdictions implementing Democracy Suite 5.5A must ensure that the iButton used for activating administrative access on ICP is managed with strict chain of custody. The iButton pass codes must be modified at a minimum for every election. If an iButton pass code requires change after the initial assignment, appropriate EMS options must be selected to ensure that only the latest assigned iButton pass code is active.

II. Dominion 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.

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

JJ. Dominion must adhere to the following reporting requirements and submit the following to the Secretary:

- Equipment Reporting. Reported field issues or anomalies that occur in Pennsylvania or elsewhere with any piece of equipment deployed in the Commonwealth of Pennsylvania within 3 days of the occurrence;
- 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;
- Ownership, Financing, Employees, Hosting Location. Any changes of information on the Supplier's employees and affiliates, locations, company size and ability to provide technical support simultaneously to several counties in the Commonwealth of Pennsylvania and other jurisdictions that use its Voting System. Additionally, Dominion 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;
- Security Measures and any updated security testing or risk/vulnerability assessments conducted by the Supplier or a third-party; and
- SOC 2 Reporting – Dominion shall provide the Secretary with its annual American Institute of Certified Public Accountants (AICPA) Attestation Standard (AT) Sec. 101 Service Organization Control (“SOC”) 2, Type 2 certification (AT Sec. 101 SOC 2, Type 2), or an equivalent certification approved by the Commonwealth. Equivalent certifications include, but are not limited to: International Organization of Standards (ISO) 2700x certification; certification under the Federal Information Security Management Act

(FISMA); and AT Sec. 101 SOC 3 (SysTrust/WebTrust) certification.

KK. Dominion must adhere to the “Source Code and Escrow Items Obligations” specified in Attachment E of this document. In addition, Dominion must provide a copy of the source code on a password protected CD to the Secretary.

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

MM. Jurisdictions implementing the Democracy Suite 5.5A and Dominion 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. § 3031.5(a)-(b). Dominion must ensure that future releases of the voting system with enhanced security and accessibility features are presented for approval to the Secretary.

NN. Dominion 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. In addition, pursuant to the Directive on Electronic Voting Systems issued by the Secretary of the Commonwealth on August 8, 2006, the Directive Concerning the Use, Implementation and Operation of Electronic Voting Systems by the County Boards of Elections issued on June 9, 2011 and section 1105-A(d) of the Pennsylvania Election Code, 25 P.S. § 3031.5(d), this certification and approval is valid only for Democracy Suite 5.5A. If the vendor or a County Board of Elections makes any changes to the Democracy Suite 5.5A 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 Democracy Suite 5.5A Voting System in the Commonwealth of Pennsylvania.

V. Recommendations

A. All jurisdictions implementing Democracy Suite 5.5A Voting System should ensure that the system is correctly set up pursuant to all the recommendations of 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 June 9, 2011 and Guidance on Electronic Voting System Preparation and Security, September 2016.

B. All jurisdictions implementing Democracy Suite 5.5A should take appropriate steps to ensure that voter education is part of the implementation plan.

C. All jurisdictions implementing the Democracy Suite 5.5A should ensure that precinct election officials and poll workers receive appropriate training and are comfortable using the system.

D. All jurisdictions considering purchase of the Democracy Suite 5.5A should review the System Limits as mentioned in the EAC certification scope.

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

F. 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.

G. Secretary recommends configuring the election with only one contest being displayed on each screen presented to the voter on ICX. This is to ensure that all screens presented to the voter are similar and voters don't need to adapt to the situation that there may be multiple contests displayed on a screen.

VI. 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 the Democracy Suite 5.5A 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 Democracy Suite 5.5A for use in this Commonwealth.

The ICX can accommodate 4 to 5 voters using assistive devices per hour or around 19 voters per hour when used as the primary voting system depending on the size of the ballot. The ICP precinct scanner can serve 30 voters per hour depending on the length of the ballot.

Attachment A – EAC Certification Scope

To be added when final certification is granted by EAC.

Attachment B – Accessibility Examination Findings and Recommendations

A) Top problems and Recommendations as listed in the accessibility examiner’s report



Top problems -
Dominion.pdf

B) All observations from Accessibility Examination



All
observations.pdf

C) Other Recommendations for Deployment from Accessibility Examiner report



Other issues and
recommendations fc

D) Top positives



Top positives -
Dominion.pdf

Top problems

The following discusses the problems that surfaced during the expert examinations and voter/poll worker observations with the Dominion Voting ICX ballot marking system.

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

1. Privacy and Independence

What Happened?

The ICX voting system, as it was configured during certification testing, presents two impediments to voters with disabilities voting privately and independently.

- **Machine set up.** The ICX has a 27-inch, portrait oriented diagonal display, which is very large and produces very clear print. Also, as with most modern displays, the screen can be viewed at wide angles without distortion. Also, the machine and printer take up a sizable operating footprint. Which means in most voting booths, the screen will sit near the front of the booth in order to fit.
- **Voter check-in and disclosure.** With the ICX system, voters receive a voter “smart card” from the check-in table that contains all the information the machine needs to pull up the correct ballot. There are many ways a county could implement this system, but it was clear that a card would need to be created for each voter in advance or on demand. There were two types of voter cards: standard and accessibility devices enabled. The second type of card must be inserted by a poll worker to activate the accessibility device options screen, where the preferred device, such as the tactile keypad, switch input, or audible output is chosen. Then, the preferred device is given to the voter.
- **Accommodation screen.** The accommodation selection screen is available only once in the voting process, so it is not possible to try

different accommodations to see which would work best. And, once the voter has begun voting, they cannot change the type of accommodation without canceling the ballot and starting again.

- **Really only two options.** The accommodation screen presents four choices: Audio-Tactile Interface (ATI), Paddles, Sip and Puff, or Audio/Visual mode. While this suggests that there are four modes of interaction, there are, in fact, only two. The ATI, Paddles, and Sip and Puff selections produce identical behavior. The Paddles and Sip and Puff choices, from the point of view of the voting machine, are identical, as would be any user-provided switch input. In all three methods, the machines “listens” for input from the switches and provides auditory feedback. In the fourth choice, Audio/Visual mode, the system provides auditory navigation and feedback, but does not listen for switch input.
- **Active touchscreen, all the time.** In all four modes, the touch-screen remains active. When the voter touches a control for the first time, its purpose and content is announced, but not selected. A second touch selects the control and activates it (if a button). On second touch, the content of the choice is repeated aloud, which allows a voter with low-vision to explore the screen by touching various controls and hearing their function without accidentally making choices.

This behavior for various switch and audio modes is not well implemented. A person who elects to use the switch input will not touch the screen for control, as that is beyond their capability (hence the use of the switch interface). However, if a switch user needs assistance from another person, the double-touch function means the poll worker or aide must touch each choice twice. In these cases, the two-step selection is an unnecessary burden. Since the switch user (blind or sighted) would be using a personal listening device such as the provided headphones or personal headset, the selected choice being read prior to the selection would not be apparent to the

person helping, and learning the two-step selection could be difficult.

Why is this a problem?

The poll worker setup and required voter disclosure are problems for three reasons.

- **Bright and clear.** Anyone within 10 feet of a booth, including in nearby booths, can observe the selections of any voter.
- **Voters cannot independently choose and initiate their preferred voting method.** For a voter to have access to the assistive devices they must declare their need at sign-in, and receive a different activation card than that provided to non-disabled voters. In some cases, such as blindness or mobility impairment, the disability is overt, and there is no loss of confidentiality. When such a voter enters the polling place, their need for accommodation is readily apparent, and there is no additional exposure from requesting an accommodations card (and generally the assistance of a poll worker in setting up the machine).

Because a poll worker must initiate the accommodations, and then walk away, there's no method where the voter could do this by themselves and then test the different devices.

- **Social stigma and privacy.** There are other types of disability that are not readily apparent, and those living with these limitations would also benefit from the available accommodations. For example, voters with low literacy or cognitive impairment would benefit from the audio/visual assistive option, but might not understand that the accessibility options can help them vote more effectively, or they may not wish to reveal their status to the poll workers and the community. The ICX voting machine requires this disclosure to activate the accommodations.

Recommendations

The recommendation for the physical privacy concern is relatively straightforward. Counties will need to think about how a polling location is set up. Keeping the open side of the voting booth close to a wall and ensuring adequate clearance around the voting machine can help. Also, exploring different voting booth manufacturers and types. One that is deeper and allowed the machine to be pushed back into the booth could provide enough side-to-side privacy.

A county choosing this machine will have to do at least two things *before* Election Day to ensure poll workers and voters are successful.

- **Poll Worker accessibility training.** Counties can create a poll worker accessibility training component that gives poll workers tools to effectively help voters with disabilities. Counties that already have this type of program can evaluate it against this machine's requirements. Such training programs could include ways to identify voters who may need assistance, how to appropriately ask a voter if they need assistance, and how to assist a voter once identified.
- **Voter education and demonstrations.** Officials can create voters with disabilities education and demonstration events around the county. Here, voters can learn how to use the new machine, and the county can demonstrate all the machine's accessibility features. While demonstrating them, officials can give examples of who could benefit from using each assistive device, and especially include examples of voters most would not immediately identify as having a disability. For example, an older voter with sight problems might benefit from the additional audio instructions. Or a diabetic with neuropathy in their hands may prefer to use the dual-switch paddles. Both examples of voters may not have known the options and devices were available before.

A strong two-pronged training and education program will help poll workers be more comfortable with assisting voters with disabilities. Having who know all of the accessibility options and well-trained poll workers will make voters feel more comfortable asking for assistance on Election Day.

2. Audio Quality, Instructions, and Feedback

The ICX voting machine had a number of problems with the audio quality, instructions, and feedback.

What happened?

The ICX machine uses two distinct voices for its audio interface.

- **Instructions.** One voice, used for instructions, appears to be prerecorded synthesized voice that will remain constant across elections. This voice is well articulated and clear, but was considered “harsh,” “not good,” and “rinky-dink” by voters who were more experienced with the state-of-the-art voices provided on their personal devices. The pacing and phrasing of this voice meant it was difficult to know when a sentence started and ended. For a brief announcement, this voice would be acceptable, but the long-term use was a problem (see below).
- **Ballot content.** The second voice uses text-to-speech and reads the content of the ballot. Unlike the pre-recorded voice, this voice is “live,” somewhat “fuzzier,” and less harsh than the instructional voice.

As delivered, these two voices had five problems, one of which was corrected before the voters arrived.

- **Volume difference.** The first, correctable, issue was that the voices started at quite different volumes. When the instructional voice was set to a comfortable level, the content voice was nearly inaudible. This problem was fixed by an adjustment by the manufacturer, but should have been tested before delivery.
- **Rate of speech and voice quality.** The system allowed voters to change the rate of speech, which is common for audio assistive devices. The range of speech rates was very different between the two voices. The instructional voice could be slowed by as much as 50%, and accelerated by approximately 200%. The content voice, by contrast, could be sped up by about 600%. An increase in the rate of the instructional voice from 100 words per minute to 110 words per

minute might result in a change of the content voice from 100 wpm to 200 words per minute. After the initial orientation to the machine, voters were more interested in the information provided by the content voice. These two voices need to respond similarly to the settings.

- **Audio and tactile keypad.** At the top of the keypad, there are controls to adjust the rate and volume of the auditory feedback. These buttons are convex on top to indicate increasing, or concave to indicate decreasing the assigned function. Below this are five buttons: a right-left pair, the select button, and an up-down pair. At the bottom of the keypad is a “Help” button that reaches from side to side.

On the lower edge of the keypad are ports for headphones or access switches. These ports are physically identical (3.5mm phono jacks), and have nearly invisible raised labels (black on black). There is no Braille marking on the ports.

The tactile keypad’s navigation buttons do not have a unique function in this voting system.

- The yellow, left and right buttons and the blue, up and down buttons do exactly the same thing. During the ATI instructions, this was not stated. The instructions described the yellow-and blue-buttons as having different functions. At each step, the buttons were described by color, shape, and function: “the yellow, left-arrow button to move left,” or “the blue up-arrow button to move up.”
- The single exception to this was the select button. In the Help instructions, this was identified as the “red, x-shaped select button.” However, throughout the audio narration on the machine, this was only described as the “red select button.” Several blind voters commented, “Why do I care what color it is?” When it was explained that a person with low vision might use this interface, and might be able to use the color as an aid, they were accepting, but the select button, being used so

often, should have been identified, using this logic, as x-shaped rather than simply “red.”

- **Persistence and repetition.** The phrasing of audio commands should place the most important information first. This allows the voter to attend when the narration of interest, and think about other things when it is not.
 - The same instructions played every time a voter pressed a button in the same contest area. The instructions only changed when they moved to a new contest area or page. Also, if the voter paused to think about the next action, the instructions would immediately start to play again. Voters stopped thinking about voting to listen to the voice to ensure no new information was available. After voters figured out the pattern, they stopped listening to the instructions altogether.
- **Instructions content.** The content instructions are also long, confusing, or unhelpful.
 - The audio instructions for the Dominion system repeatedly said “Use the yellow, right-arrow button or the blue down arrow button to move to the next item.” This long text was confusing. More efficient wording might simply ignore one set of buttons, for example, “To move to the next item, use the blue down-arrow button.”
 - The introduction to the write-in screen says that you can write-in a candidate of your choice, but does not provide guidance on how to do that. This disturbed even the sighted voters, but every blind voter had to be cued to move beyond the box announced as “Write-in candidate, blank” to find the keyboard.

Sometimes the voting instructions on the screen are poorly worded.

- The screen to select a straight party vote, the instructions say “You may select the party of your choice by selecting the party of your choice.”

Why is this a problem?

To some extent, the audio instructions and content feature of the Dominion system may suffer from an “uncanny valley” where it is close enough to good to be annoying, though it is actually better than the feedback from some of the other machines we have evaluated.

Blind users typically want their text-to-speech voices to speak at rates above 400 words per minute, so that they can listen at the same rate sighted people can read. Many blind individuals read at speeds in excess of 600 words per minute, and up to 1000 words per minute (the limit of current technology). People with cognitive limitations such as auditory processing disorders may need the voice to speak more slowly, to give them time to understand it.

Voices designed for screen reading do not necessarily sound like human voices, but remain understandable over a wide range of speeds. To accomplish this, the components of voice that carry information are identified, and the filler sounds between those components are stretched or shortened to change the overall speech rate without loss of intelligibility. People who routinely listen to synthetic voices expect this.

The voices used in the Dominion voting machine are not this sophisticated. To increase speech rate, it appears that they simply slice sections from the sound stream. To slow the voice down, they insert silence at intervals in the sound stream. This approach is “effective” for compressions and stretches of 10 to 20%, as the human brain can fill in the blanks fairly effectively. However, the Dominion system attempts to use this technique with slowing to as little as 50% of the speech rate, and increasing rate by several hundred percent.

The use of two audio voices for instructions and ballot content in and of itself is not a problem (in fact, it meets the VSG requirement that they be different). But Dominion’s implementation of the voices is a problem for at least two reasons.

- **Election Day Ready.** The ICX seems to have a lot of configuration points, which could be a good thing for counties. However, when many of the settings, like the disparate volumes between instructions and content speech, are not usable out-of-the-box, some counties

may not know that they need to make those changes for an option to be usable.

- **Cognitive overhead.** Voters had to concentrate excessively to understand what was being said. At the lower three speed settings, the instructional voice was noticeably broken up, and at the highest two settings the gaps made it impossible to process what was being said.

When voters have to interpret poorly written instructions, it means they are not thinking about voting. This is made harder for voters using the audio when the quality, rate, and phrasing mean they are spending more time figuring out how to use the machine than they are on which candidate is best for the contest.

Recommendations

Counties choosing this machine can ensure that they:

- Test the audio rates and volumes before deployment to make sure they are usable for both blind voters and others who might use the audio.
- Train poll workers well on the potential issues and questions voters might have about using the audio while voting.
- Provide community demonstrations so voters can practice with the machine. Voting on Election Day may be smoother if they know what to expect.

Also, if the audio style and content is configurable, counties should ask the vendor to do the following:

- **Use better voices.** Many of the blind voters demonstrated the voices they use on their personal assistive devices, and explained why they were better. Much better voices than those on the tested system are available for purchase or license. The vendor could provide a synthetic voice that is designed for high compression levels such as those used in commercial screen readers or cell phones.

- **Include verbosity control and contextual help.** The blind voters all indicated that they would prefer some verbosity control on the audio instructions, or changing the level and wordiness of the help as needed. In the initial orientation, the full names could be used. Once the voter is oriented, though, this could be contracted to “Use the arrows to move forward or back.” If the voter got confused, the Help button on the ATI could be configured to provide more detailed instructions about the current screen.

3. The Write-In Process

The write-in screen and process presented two problems for voters using the audio assistance.

What happened?

When visually choosing to write in a candidate on the ICX, the voter enters the write-in screen and is presented with a text box, where the write-in name will appear, editing buttons (“Clear all” and “Delete”). Below this is an on-screen keyboard in alphabetical order to enter the name of the chosen candidate. At the bottom of the screen is a button to confirm the write-in and return to the ballot. This all makes sense for a sighted voter because the layout is clear.

- **No instructions.** There were very few instructions for sighted voters, but the layout of the screen made use self-explanatory for everyone in this test. The audio had no additional instructions beyond “Please enter your write in candidate.” Then when the voter navigated to the next option, they only heard the voice say the text box was empty. Voters became caught in this area for a long time. The “Help” button on the tactile keypad only gave voters instructions on how to use the tactile keypad.

All of the blind voters needed facilitator assistance to successfully write in a candidate. Each voter had trouble moving beyond the write-in name box. But once they advanced to, and heard, “A,” they rapidly and generally accurately typed the name of the write-in candidate. At intervals, the users *could* navigate to the write-in name box to hear

their entry spelled back to them, then return to typing. None of our blind voters discovered this capability.

- **Editing Problems.** The Dominion ICX had implementation problems with editing a name once it had been entered and using the audio assistance.
 - **Deleting.** The only option for editing an error in name entry is to delete letters or the entire name and start from scratch. For sighted voters, this makes sense visually. They can see the letters disappearing and can easily see what letters remain. For blind voters using the audio, each letter is announced when typed, but when deleted, the key announces only “Delete,” and not what has been deleted.
 - **Repeating too soon.** If the voter stops to consider what they are doing while editing a name, the ICX repeats the last audio instruction given. While this is not ordinarily more than an annoyance, in text entry it can be challenging. If the name being written in has a double letter, and the user pauses to think about the spelling of the name, the system will repeat the last instruction, “You selected ‘M’.” If this occurs as the user presses the select key to double the “M,” it is not clear whether a second “M” has been typed, or if the audio has just repeated the previous letter. The user must navigate to the name box to hear the name spelled out to find out how many letter “Ms” have been typed. (This process is not described in the audio instructions, and must be discovered by the voter.)
 - **Does not voice the “Space.”** The “space” character between names is not voiced. A blind voter may have forgotten to enter a space, but would not know.
 - **No reentry.** True for all voters: If a voter has entered a write-in name, returns to the ballot, and then realizes that the name was misspelled, touching the write-in option again clears the text in the box.

Why is this a problem?

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

- An entry the voter thought was cast correctly because there were no audible mistakes might still be voided because of inaudible errors.
- Limited instructions combined with editing problems can lead to voter confusion. Even if they can figure out a method to get the system to voice what is actually in the text box, it takes an inordinate amount of mental resources. Resources that some voters cannot spare and should be reserved to deciding who to vote for.

Recommendation

We recommend the following changes to the write-in system:

- Adjust the on-screen instructions so that the audio reads it.
- Include audio instructions how to navigate to find the keyboard.
- Rework how the system voices deleted characters and the frequency it repeats them.
- Include any and all spaces and special characters in the text box when reading the entry to the voter.

4. Silent/Hidden selection and deselection

What happened?

There were three elements of silent and/or hidden selection and de-selection on the ICX 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 confirming the vote for that candidate, instead of deselecting that candidate, as the voters stated they had expected. The voters were, in this case where the changes were evident, able to correct the error and vote as instructed. (Please see more about candidate selection in the next section)

- **When the contest was long, candidates were often de-selected on a different screen, with no notification from the system.** For sighted voters, this automatic change resulted in candidates who had been selected not being voted for as intended by the voter. For audio users, no deselection is voiced at any time.
- **Overvoting protections do not protect audio users.** Once a voter selects the maximum number of candidates in a contest, the system greys out the remaining options. This is a strong protective feature and intuitive for a sighted voter. The sighted voter is able to scan through the remaining candidates and find others who s/he might prefer, and change selections. However, when using the audio assistance, this way of handling overvote protection removes the ability for the system to read the remaining candidates, so a voter may not hear all of the options.

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 audio feedback messages and confirmation processes 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.

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. The implementation of the printing and paper-handling of these paper ballots had some issues that limited the ability of voters to use them effectively.

Reading the paper ballot

For the Dominion ICX ballot marking system, the ballot is printed using a separate, off-the-shelf printer on 8.5 x 11-inch cardstock. The cardstock is stored inside the printer next to the tablet. 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. Three of our five blind voters were able to use app-based print readers on their phone to take a picture of the ballot and read it back to them. This is only an option for voters with this technology. There is no built-in option for all voters.

The paper ballot included alerts and language that was not used on the touchscreen. For example, undervoted contests are called out with “UNDER_VOTE_BY_N” where N is the number of positions still available. The ballot review screen does not do this, which means it is not announced to visually impaired voters using the audio assistance.

Interacting with the ICP ballot scanner

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

Only one feature stood out and could be considered a positive 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. Each asked how to insert it.

The most serious problems are:

- The scanner bed is very shallow so the entire ballot does not fit on it. Only the top third of the page can be rested on the scanner. Voters with no/low use of their hands would rely on assistance for feeding the ballot into the scanner. And the supplied privacy sleeve was of little help because it was not designed for use with these ballots. Some of the test participants commented on these issues.
- There are no audible cues. The scanner did not include robust features to alert voters that their ballot has been cast successfully.
- If the ballot is not perfectly aligned as the scanner begins to grab it, the scanner will spit it back out. If the voter is not ready for this, the ballot will fall to the floor. This is a problem for all voters but potentially very embarrassing and frustrating for those with disabilities.
- There are subtle visual cues from a small screen 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. Also, the quality of the screen is poor. If the voter or poll worker is not directly over the screen, it is difficult or impossible to read.

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

Recommendations

For the printed ballot layout

- Make the alerts and language on the ballot and touch screen consistent.

For the scanner

- Increase the length of the scanner bed so that the full ballot can sit on it before inserting it into the machine. This will help low mobility and dexterity voters and will catch the ballot if it is inserted incorrectly.
- Make the cues more obvious that the ballot is cast. Large print words or simple images to indicate the scanning steps on the screen, and a stronger visual cue can show that the ballot scanned successfully. Adding a subtle 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 for poll workers to use to guide a voter in casting their own ballot, or narrating the poll worker's actions so that the voter understands what the poll worker is doing.

Other issues for deployment

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

Alerts

Both the poll workers and the voters were uncomfortable with the language of the on-screen warnings.

In general, they felt that warnings were appropriate for conditions that might invalidate a ballot, where “alerts” would be appropriate for acceptable conditions that could be changed.

- **“If left blank, this contest will have implicit choice selections for party [straight party choice].”** One of the most egregious involves any contest that is left blank, but the voter selected a straight party. In this case, the system provides an alert that says “If left blank, this contest will have implicit choice selections for party [straight party choice].” The system does not have an immediate way to straight party vote *and* abstain from a contest, which is a problem in and of itself. But the high-level language in the alert confused most voters and poll workers. And all said that the message needed to change.
- **“Your ballot is valid, but there are warnings.”** If a voter does not select a straight party, the review screen first indicates that “Your ballot is valid, but there are warnings.” Then, the straight party contest alert indicates that “This contest is blank.” The wording of this alert suggests that the straight party selection is a ballot contest rather than a convenience, and that selection is mandatory. In either case, the language is unnecessarily harsh and coercive.
- **“This contest is undervoted!”** If a voter does not select all of the available candidates in a contest, they receive a warning that the contest is undervoted. “Undervoted” is not a clear language term, and is potentially confusing to voters. The warning also suggests that full voting is required.

The language of on-screen or audio “warnings” should be informative, not coercive, and should be in plain language. Where possible, counties should work with the vendor to reconfigure or rewrite these warnings.

Poll Worker Concerns

Poll workers were very excited about the ability of the scanner to tabulate absentee ballots. However, they had some concerns about the touchscreen and general process.

- **Power needs and cords.** Several poll workers commented that the machine included the ballot marking tablet and a separate printer. They were concerned about the power requirements this would present in some of their polling places. Combined with the wires for the headphones and access switches, they felt that the number of cables would be a burden to manage in the polling site.
- **Lots of pieces.** The poll workers were concerned about managing the “parts” of the process. This machine uses activation cards to select the appropriate primary ballot by party, and uses different cards for “normal” versus “accommodated” voting. In polling places that serve more than one precinct, each might have a different ballot. This suggests the need for many types of cards, or new system entirely to manage at the voter check-in area. The scanner also has compact flash cards and security keys. They did not like the idea of complicating the voting process with additional things.
- **Casting the ballot and traffic management.** Poll workers were also worried that the voter must carry the ballot from the voting machine to the scanner and ensuring they actually fed the ballot into the scanner. This has been a common concern from poll workers who do not currently use paper ballots. However, this concern was justified in this instance because of the language on the print ballot screen.
 - When you press the “Print” button at the end of voting, the machine produces a new window with an alert. It has a message “Some warning detected on your ballot. You cannot make any more changes after casting the ballot.” Then there are two buttons labeled: “Cast your ballot” and “Review your

choices.” To make it worse, the final screen says “Thank you for voting! Your ballot is successfully cast.” This language choice is misleading and incorrect. The touchscreen device just creates the ballot and printer prints it. The ballot is not “cast” until it has been scanned by the tabulator.

- Poll workers became worried that voters may misinterpret these screens and just walk away. Since many voters desire a receipt for voting (to validate time off from work or credit for school), they might think that they had indeed cast their ballot (because the machine said they had), and the printed copy is their receipt.
- The poll workers were anxious about traffic management to assure that the ballots and cards all came to the scanner. They suggested that a message on screen when the ballot was printed would help. It could instruct voters to take their ballot and activation card to the scanner to cast their ballot.
- The poll workers were uneasy about the comfort level of the older voters with change in the process. They all agreed that having the machines available in public spaces (libraries) prior to the election to allow voters to try them would be important.
- There was some apprehension about the use of compact flash cards to record tallies. These are small, and may be difficult to manage from some workers with limited dexterity.

Candidate Selection

The Dominion software uses two levels of candidate selection, which interact in two different ways from the point of view of the voter.

- **Soft Selection vs Hard Selection.** The first level of selection might be called “soft-selection.” When a voter selects a straight party ballot, the candidates from that party are soft-selected and pre-marked throughout the ballot. This will count as a vote unless modified by action of the voter, as discussed in the “implicit” alert area above.

If a voter touches the screen to select a candidate without a straight party choice, this direct action creates a “hard selection.” If a soft-selected candidate is touched by the voter, this converts the soft-selection to a hard selection.

- **Cannot leave a straight party contest blank.** Once a voter selects a straight party, the machine will not allow a voter to abstain from any contest. As mentioned in the “Alerts” section, the machine informs the voter that a blank contest will be marked as straight party—even if the voter leaves the names unselected. As one voter discovered on her own, she could effectively abstain from the contest by submitting a blank write-in entry. This is not an appropriate work around.

To the voter, soft-selected and hard-selected votes look the same. This is logically sound, but has unexpected repercussions.

- **Destructive behavior.** If a voter decides that they want to remove a straight party selected candidate in a “Vote for N” contest, they will try to deselect that candidate by touching or selecting that candidate. Instead of deselecting the soft-selected candidate, it converts it to a hard selection. This was not what the voter intended, so naturally the voter touches the selection again. This results in deselecting the candidate, and also deselecting all of the other straight party votes in that contest. This unexpected destructive behavior confused sighted voters.
- **Soft-selection cue.** All of our blind voters, when instructed to vote for an in-party candidate, reselected that candidate, making the selection a hard selection. This suggests that the cue that the candidate had already been soft-selected was not adequate to alert the voter, and might result in unintended cancellation of other in-party candidates.

There were additional candidate selection issues that confused voters.

- **Number of available candidates vs number of selected candidates.** In contests where the voter is allowed to select multiple candidates from the presented roster, there is no indication of the number of candidates available. Nor, after selecting one or more

candidates, is there indication of how many candidates have been selected.

When the roster of candidates is longer than a single screen, or for all blind voters, it is not clear how many candidates are available. This could be remedied by messages that say "Vote for 5 of the 23 candidates" and "You have voted for three of the allowed five votes." When the voter has selected fewer than the allowed number of candidates, they are presented with a warning that they have "undervoted" the contest. It was not clear to our voters what "undervoted" meant, and the language of the warning suggested that this was not a valid vote, and that all five candidates must be selected to be appropriate.

Not all of the issues in this section have clear workarounds or immediate vendor-provided solutions. Counties should have extensive poll worker trainings and many opportunities for voter education to ensure all poll workers and voters know how to successfully cast each vote at the polls.

Reviewing and verifying the ballot

Voters with disabilities will also need voter education on how the ballot review and verification process works for the combination of presentation and interaction mode they are using. This is particularly important because of the use of straight party voting in Pennsylvania

In this voting system, it is possible for a voter to select a straight party option, go directly to the review screen, and then directly to print without any notification from the ballot marking device that they have undervoted any nonpartisan contests or ballot questions.

A blind or low-vision voter who cannot easily verify the printed ballot might never learn that they skipped contests, especially if the precinct ballot scanners are not programmed to report undervotes.

One solution to this would be for the audio at the beginning of the review to announce if there are undervoted contests (and perhaps how many there are).

Recommendations for deployment

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

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

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

Advanced training and hands-on practice

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

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

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

- Instructions or a practice system in the polling place, especially in districts with many older people.

Training for poll workers to support voters with disabilities

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

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

- A “what if” troubleshooting guide could include specific questions to ask and prompts that poll workers can use to help a voter with problem solving without looking at the screen.
- Give poll workers guidance on where to stand while supporting voters. For example, standing behind the ICX 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 ICX, the setting and preferences buttons are at the top of the screen at all times. The poll worker can review these with the voter (reading the instructions to be sure they are consistent and accurate).

Poll worker procedures

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

- Tell voters how to insert their ballot: identify that the ballot must be placed in the center of the scan bed, and tell them the ballot is inserted directly into the machine, not just slid forward.

- Remind voters to check both the review screen and their paper ballot before casting.
- Tell voters that if they make a mistake, they can get a new ballot.
- Instruct voters that their ballot can be inserted into the scanner in any orientation. Using the privacy sleeve is the most secure. However, inserting the ballot upside down, with the print toward the floor, is sufficient.

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

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

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

- Help voters get positioned at the voting system so they can reach all controls. The ICX screen can be adjusted to change its angle for a closer approach, adapting to standing or sitting postures, and avoiding glare.
- Provide help 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 ICX, the tactile keypad includes two 3.5mm jacks that seems appropriate to insert a headset. One is marked in very small letters that it is for audio. However, the other jack is where the dual switch connects. Counties should ensure poll workers explain the two jacks to voters, at a bare minimum.
- Make sure voters are oriented and know where all parts of the voting system are, including the privacy shields. The ICX includes options to blank the screen during the audio ballot, but then poll workers could bring back the visual mode if the voter has a question.
- Remind voters how to cast their ballot and how to know when they are finished.

Polling place setup

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

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

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

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

Voting booth setup for this system

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

- **Cable management for assistive devices.** The tactile keypad is normally stored behind the screen, connected on a semi-permanent cord. The headphone is plugged in on the right-side front of the tactile keypad. The printer could be set up to the right or left.
Recommendation: The cords need to be placed so that they don't interfere with the printed ballot or the voter's ability to find and take it.
- **Privacy.** The screen for this system 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 manual or motorized wheel chair to get to the voting booth easily (see above).

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	Blind voter/poll worker - "Once I understand the system, I can whiz!"	ICX	Positive
Display and Navigation	Large, clear, easy to read screen. The screen angle can be changed to three angles: flat, slight incline, and almost vertical.	ICX	Positive
	Default font large enough for most sighted voters.	ICX	Positive
	The system prevents overvotes by greying out the remaining options once the voter has selected the maximum number of candidates in a contest.	ICX	Positive
	Alerts are generally well formatted and in appropriate places. The wording in the alerts is not good, however. (See Problems section below)	ICX	Positive
	The ballot review button is always visible and functional. Voters don't have to review the entire contest or ballot to navigate to the review screen. Likewise, the print ballot button is always available from the review screen.	ICX	Positive
	Large "scroll down/up" buttons at the top and bottom that span the width of the screen.	ICX	Positive
	Straight party vote indicator that allows you to turn on and off straight party votes at any point.	ICX	Positive

Function	Observation	System	Severity
Display and Navigation	Ballot review screen is generally well formatted. Alerts are present in each contest where necessary. In blank or undervoted contests, a "No selection made" label is present for each potential vote for number.	ICX	Positive
Assistive Technology (AT)	Voter - "The disability functions are the best features."	ICX	Positive
	AT includes an audio mode that leaves the screen enabled. The first screen touch reads the selection, and then the same item touched a second time selects it.	ICX	Positive
	If the voter chooses the assistive technology, the touch screen is still active for those who may want to use both. Poll worker commented that these machines would help counties find accessible locations for the machines.		
Write-In Screen	Once a blind voter found the on-screen keyboard, they were able to enter the candidate name quickly.	ICX	Positive
	After completing the write-in, one blind voter said, "That was easy."	ICX	Positive
Printed Ballot & Scanner	While sighted voters (and poll workers) generally did not want to check the printed ballot, blind voters generally did. The use of card stock made the ballot easy to handle. The card reader at the base of the screen created a make-shift easel. Voters could rest the ballot against the machine and use personal AT devices to verify their ballot. Seeing AI and other personal AT were able to read the printed ballot to the voters successfully who attempted it.	ICX/ICP	Positive

Function	Observation	System	Severity
Printed Ballot & Scanner	After the ballot printed, one voter responded "Neat!"	ICX	Positive

Problems

Function	Observation	System	Severity
Setup for Voters	Concern about the power requirements (marker and printer use separate power cords) and confused cables for tactile keypad, speaker, switches, and headphones with power cords. Counties will need to ensure polling locations have enough outlets available, and they will need to think of strategies to contain the cords.	ICX/ICP	Annoyance
	This machine has a lot of additional parts: memory cards, voter cards, access keys.	ICX/ICP	Annoyance
	“Seems like a lot of parts to the process. Our voters will get confused.”	ICX/ICP	Annoyance
	Poll workers were concerned if their county did not switch to an electronic poll book, then they would have to have another system to create voter cards on demand.	ICX/ICP	Annoyance
	Poll workers felt that early hands-on exposure to the machines should be provided several weeks before the election, so that voters could become familiar with the process.	ICX/ICP	General comment
Privacy	Because of the large screen size and clear print, some voters were concerned about privacy. It was easy to read the display from several feet away.	ICX/ICP	Annoyance
	When privacy cover is used on ballot, the ballot cannot be inserted to the bottom of the sleeve. The top of the ballot must be outside the sleeve for the scanner to pick it up.	ICX/ICP	Annoyance
Orientation and Navigation	For one contest on the sample ballot, (County Commissioner), the down-contest candidates are not visible on the initial screen. If it were indicated that there were “X Candidates” in total, the voter would be cued to scroll down to find them.	ICX	Problem solving

Function	Observation	System	Severity
Orientation and Navigation	If a voter wants to quickly vote straight party, the system allows selecting straight party, then review, then print. In this process, however, the voter is never presented with the ballot questions. If they do not review their ballot entirely, they receive no warning that any non-partisan contests are blank.	ICX	Problem solving
	As part of the overvote protection, the additional candidates or options are greyed out once the maximum number of selections has been reached. However, this means that the audio does not announce the additional candidate names. This could lead to a voter missing a desired candidate.	ICX	Likely to prevent independent voting for voters with some disabilities
	When using the audio, the straight party button is present in all contests. Every blind voter got stuck on this button and the instructions are unclear as to what the button is or how to navigate away from it.	ICX	Needs Assistance
	No blind voter was able to do the write-in process without some assistance. Most navigated to the box where the name appears, and stopped. No instructions describing the process are available. Once the voter pressed the down or right arrow buttons enough times, they discovered the keyboard, and oriented themselves within the layout.	ICX	Needs Assistance
	It is not obvious that to change your vote, you have to deselect the chosen candidate to bring back the check boxes on the other candidates.	ICX	Problem Solving
Orientation and Navigation	In ballot contests, the keypad navigation wraps from bottom to top, but not from top to bottom. In dialogs, the navigation wraps both ways. This inconsistent behavior can be confusing, and results in inefficient operation.	ICX	Problem Solving

Function	Observation	System	Severity
	<p>On contests that have a number of votes allowed, there must be the same number of write-in opportunities. When navigating by audio, each of these is announced as "Write-in" with no variation in speech. For those depending on this feedback, it is not clear that they are moving through different selections on the ballot. A voter recommended that it say "Write in #1, Write-in #2..." to clarify this.</p>	ICX	Problem Solving
	<p>One voter accidentally selected the ballot "Review" button rather than "Next," after making the first selection in a contest.</p>	ICX	Problem Solving
	<p>There are four ways to insert the card, only one of which works. For a blind voter, the activation card does not have an indication of the correct orientation. (Only the visual display provides instructions). Although all of our blind voters were able to feel the integrated circuit on the card, some instruction is needed on how to insert the card. One voter suggested a small Braille dot on the card as a cue.</p>	ICX	Problem Solving
	<p>At the top of the display at all times there are controls for text size, contrast, and language. For AT users to navigate to these controls, they must press "Select" while the contest title is active, then they can scan through the settings. Used in this way, the select button is inconsistent between selecting choices and navigation, which will be an issue for those with cognitive disabilities. Some blind voters were tripped up by this.</p>	ICX	Problem Solving
Orientation and Navigation	<p>Sighted voter felt that the instruction for the number of available votes (Vote for N) should be larger, and spaced down from the contest title.</p>	ICX	Annoyances
	<p>A sighted poll worker was surprised when the "Next" button changed to "Review." Suggested "End of Ballot" message.</p>	ICX	Annoyances

Function	Observation	System	Severity
	While reviewing the ballot, the voter can jump back to individual contests and make changes. The review ballot button, to return to the review process always returns to the top of the ballot. On long ballots, with voters who make multiple changes, this is an unnecessary burden.	ICX	Annoyances
	If the voter is looking at the second contest on a single screen, making the text larger can cause that contest "disappear." It actually moves to the next page, but that isn't obvious.	ICX	Annoyances
	Poll worker (retired user interface designer) indicated that there should be more space between "Scroll down" and "Print" buttons on the review screen. He accidentally pressed it a few times.	ICX	Annoyances
	The Up/Down and Left/Right buttons on the tactile keypad perform the same navigation. Once voters discovered it, they used only one set of buttons.	ICX	Annoyances
	Several voters and candidates attempted to navigate by swiping, it is not enabled on this system.	ICX	Annoyances
	For voters using the dual switch input, on contests with many candidates, the "Next" button requires many, many button presses. It can cause voters to overshoot their target, and have to do it again.	ICX	Annoyances
	When text is enlarged, text size stays the same in alert messages in a different window.	ICX	Annoyances
Audio Instructions	Ballot header instructions are centered. When instructions are longer than a few words, the justification can chop up sentences strangely.	ICX	Annoyances
	Blind poll worker said "Oh!" In response to the content voice. Then said, "Oh, that's terrible!"	ICX	Problem Solving

Function	Observation	System	Severity
	The voice used for the audio feedback was described by voters as “crappy” and “rinky-dink.” Truncates words at high speeds. The word “write-in” was rendered as “ret.”	ICX	Problem Solving
	The rate range of the content voice (difference between slowest and fastest rate) was much higher than the instruction voice. When adjusting, the voter can only hear the instruction voice, so may require several tries to get the voice to a desired rate.	ICX	Problem Solving
	The audio instructions are repeated too quickly after pausing on a selection, and they are repeated too often after each navigation.	ICX	Problem Solving
	"The audio instructions are needlessly complicated."	ICX	Problem Solving
	"The [audio] instructions are kind of confusing."	ICX	Problem Solving
	Blind voters indicated that they wanted a verbosity control for the audio instructions. "Give me detailed instructions the first time, then shorter after that, but let me get full instructions again if I need them."	ICX	Problem Solving
	Several voters indicated that they wanted contextual help, not a repeat of the instructions for the tactile keypad when pressing "Help"	ICX	Annoyance
	After going through the instructions for the keypad, the voter asked, “How do I get out of here.” It wasn’t clear that pressing the “Select” button ended the instructions and moved back into the ballot.	ICX	Problem Solving
Audio Instructions	At the ballot header screen, the audio instructions do not say what to do to enter the contests. Voters repeatedly got stuck.	ICX	Problem Solving

Function	Observation	System	Severity
	The straight party button at the beginning of every contest confused all of the voters. The audio announces it as "Selected straight party candidate republican" and then immediately beings to give instructions on how to select the button.	ICX	Problem Solving
	The straight party button audio instructions are confusing to voters. The visual version is confusing as well. (See more in Alerts section below.)	ICX	Problem Solving
	When you override a straight party vote, the audio still announces the straight party button as "selected straight party" even though none are selected.	ICX	Problem Solving
	One blind voter was confused by the audio instructions. When the machine instructed her to press the "right" button, she interpreted this as the right-hand button, not the right arrow under her left hand.	ICX	Problem Solving
	When the blind voter hit the wrong button on the "Review Screen" button, and moved to the top of the contest, "I doesn't tell me that I didn't go to the review. It takes me back to the top."	ICX	Problem Solving
	All blind users reselect candidates selected by straight party choice. This could suggest that the cue that they are selected is not strong enough.	ICX	Problem Solving
	In the testing process, the voter was instructed to vote for the candidate that was endorsed by both parties. On first pass, this was missed because the pause between "Republican" and "Slash" made it sound as if only one party was involved.	ICX	Needs Assistance
	There are no audio or on-screen instructions for any of the other assistive devices (buttons, sip-and puff).	ICX	Needs Assistance

Function	Observation	System	Severity
Straight Party Voting	Once a voter chooses a straight party option, the system will not let them abstain from a partisan contest. It gives the voter an alert that says that even though the contest is blank, the candidates that match the straight party will be selected. (See more in the Alerts section below.)	ICX	Likely to prevent independent voting for voters with some disabilities
	Overriding a straight party vote deselects the straight party selections. In contests where the Vote for N number is greater than the straight party candidates, voters tried to select additional candidates, but had to reselect straight party candidates.	ICX	Problem Solving
	If you have overridden your straight party vote in any contest, the system will not allow you to cancel your straight party choice without de-selecting the out-of-party votes. All voters who tried to cancel their straight party had to ask how to do it.	ICX	Needs Assistance
	Voters complained that the system seemed to require a straight party vote. They thought it should have instructions indicating that if they do not want to vote straight party, they should select "Next."	ICX	Problem Solving
	Some voters thought that the straight party option selected the party's ballot, as in the primary. Poll workers independently reported the same concern, even they knew the function. Both groups said the instructions were unclear.	ICX	Annoyances
Alerts	The wording of the alerts is not good. Some language was too high level. One message uses the word "implicit."	ICX	Problem Solving

Function	Observation	System	Severity
Alerts	Alert: If left blank, this contest will have implicit choice selections for party [straight party choice] appeared in any contest where a voter made no candidate selection. Most voters and poll workers had no idea what this meant.	ICX	Problem Solving
	One poll worker said "This will get us sued. Voters will say that 'You changed my vote!'" in response to the "implicit" alert in a blank straight party contest.	ICX	Problem Solving
	Most alerts begin with "Warning" which voters and poll workers found too overbearing.	ICX	Problem Solving
	One blind vote indicated "I don't like 'warnings.' I would like to have information about how to proceed or correct an error."	ICX	Problem Solving
	The poll workers did not like "warnings." They preferred information about options to fix them.	ICX	Problem Solving
	When no selection is made in the straight party contest, the system generates a message "Warning, this contest is left blank!" Voters thought they had to make a selection.	ICX	Problem Solving
	The straight party cancel alert language and button labels are overly confusing. This is especially true in the audio instructions.	ICX	Problem Solving
	The straight party audio instructions are too wordy and complicated. It asks the voter to "select 'Confirm' to cancel or 'Cancel' to cancel."	ICX	Problem Solving
	Many voters thought that the undervoted contests warning implied that they were required to vote for the maximum number of candidates.	ICX	Problem Solving

Function	Observation	System	Severity
	On the review screen, a poll worker questioned the location of the message that "Your ballot is valid, but you have warnings." Rather than being located at the top of the screen, she suggested that it be placed between Scroll Down and Print. She said she almost missed it.	ICX	Problem Solving
	On the review screen, a poll worker thought it would be better if the alert icons could be touched for more information and options.	ICX	Problem Solving
Printing/Ballot Verification	After you press "Print" at the bottom of the screen, the alert window warns you that you are about to "Cast" your ballot. This action does not cast your ballot.	ICX	Likely to prevent independent voting for voters with some disabilities
	After you print your ballot, the machine displays a message "Thank you for voting! Your ballot is successfully cast." This action does not cast your ballot.	ICX	Likely to prevent independent voting for voters with some disabilities
	Poll workers reported that the "your ballot is cast" language will be a problem because voters might leave without putting their ballot in the scanner thinking it is their receipt.	ICX	Needs assistance
	Poll workers thought that the final screen should instruct voters to take their ballot and their voter card to the scanner.	ICX	Likely to prevent independent voting for voters with some disabilities
	The printed ballot reports undervoted contests as "UNDER_VOTE_BY_N" where N is the number of positions still available. The ballot review screen does not do this, which means it is not announced to visually impaired voters using the audio assistance	ICX	Likely to prevent independent voting for voters with some disabilities
	Printed ballot displays no straight party selection as being "Blank contest."	ICX	Problem Solving
	Alerts on printed ballot not informative and confusing. Poll workers thought that voters might think something is wrong since the ballot review screen said something different.	ICX	Problem Solving

Function	Observation	System	Severity
	One voter suggested printing arrows at the top of the ballot to match those on the scanner, indicating the correct alignment. Even when the scanner accepts the ballot in all orientations, this provides a hint that will reduce confusion.	ICX	Annoyances
	One poll worker suggested that the printed ballot should look more like the historical paper ballots.	ICX	Annoyances
Write-In Screen	Using the audio, when a typo is being corrected, the letter just deleted is not announced. This makes it difficult to impossible to know where you are in the process.	ICX	Problem solving
	Using the audio, when deleting characters to correct a misspelling, the audio feedback is "Delete" but does not announce the letter being deleted.	ICX	Likely to prevent independent voting for voters with some disabilities
	When the voter leaves the Write in screen, the audio instructions say "You have written in " and spells the name entered. However, it does not voice the space, so the voter may think that they failed to enter it. "It didn't tell me I had a space. I know I put one in." when writing in a candidate using the audio assistance.	ICX	Likely to prevent independent voting for voters with some disabilities
	No blind voter was able to complete the write-in process without some coaching to continue moving down the write-in page until they found the alphabet. Once they found the alphabet, they were able to proceed quickly.	ICX	Needs Assistance

Function	Observation	System	Severity
	When writing in a candidate using the audio, each letter typed is spoken. If the user pauses, the last audio information is repeated. If the letter is entered again, (for names with double letters), the spoken feedback sounds exactly the same as the repeated feedback from the last entry. There is a high risk of inadvertent doubles or single letters. Repeated feedback and new feedback should sound different.	ICX	Likely to prevent independent voting for voters with some disabilities
	No blind voter was able to complete the write-in process without some coaching to continue moving down the write-in page until they found the alphabet. Once they found the alphabet, they were able to proceed quickly.	ICX	Needs Assistance
Write-In Screen	In standard mode, once you have entered a write-in, you cannot correct it because touching it deselects it. Then when you go back into the write-in screen, it has removed the entry.	ICX	Problem Solving
	The page for write-in candidates doesn't actually provide instructions on how to do the write-in. This is true for standard mode and audio instructions. Audio voters must continue to press down or right to get beyond the text box and editing buttons to find the keyboard.	ICX	Problem Solving
	While using the audio, one blind voter suggested that she might use Help to figure out how to use the Write-In Screen. Help only repeats the instructions for the keypad, and does not provide contextual help as expected.	ICX	Problem Solving
	"It doesn't tell you how to do a write-in, does it? You would never know to press down again."	ICX	Problem Solving
	"OK, I guess I have to go all the way to the end," said one voter when trying to find the write-in screen keyboard in audio mode.	ICX	Problem Solving

Function	Observation	System	Severity
	When navigating the keyboard, the “period” key is announced as “dot.” While this makes sense in some applications, names include periods, not dots.	ICX	Annoyances
	Poll Workers: Expected QWERTY layout for on-screen keyboard, but when saw that switch access scanned in order, saw the logic of the layout.	ICX	Annoyances
Assistive Devices	Poll workers felt that the keypad has too many buttons.	ICX	Annoyances
	The “Left/Right” and “Up/Down” buttons do exactly the same thing. Why are they both included?	ICX	Annoyances
Assistive Devices	There is no dedicated button on the tactile keypad to move to the next contest.	ICX	Annoyances
	The help button of the tactile keypad repeats the instructions for how to use the keypad. Blind voters suggested context help on the contests, indicating how to write in a candidate, how to select candidates, etc.	ICX	Annoyances
	The headphone and switch ports on the tactile keypad have no Braille markings, and are very difficult to see for sighted voters.	ICX	Annoyances
	If a voter chooses any assistive device, the touchscreen remains active, but each selection must be touched twice.	ICX	Annoyances
	When used for long ballots, the buttons tend to slide. A person who needs to use the paddle switches may not be able to effectively reposition them. They should be provided with small non-slip pads to hold them in place more strongly.	ICX	Annoyances
	The colors of the button switches (red and blue) were taken to indicate party affiliation. The buttons are provided with green and yellow caps as well, and non-partisan colors should be used.	ICX	Annoyances

Function	Observation	System	Severity
Scanner	The scanner provides no audio feedback to the blind voter.	ICP	Annoyances
	Scanner screen very hard to read at all, impossible from seated position	ICP	Annoyances
	Entry tray for ballots is very small – not long enough to support the entire ballot	ICP	Annoyances
Scanner	Memory cards for poll workers are very small – hard to handle – dexterity problems handling them. But at least not the teeny tiny ones (Compact Flash cards rather than SD cards)	ICP	Annoyances
	“All that [absentee] paperwork after the election [is gone]. Whoopee!” One poll worker said after realizing they could scan absentees instead of tallying them by hand.	ICP	Annoyances

Top positives

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

Independent voting

Generally, voters were able to complete their ballot on the ICX and ICP 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 participants 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 relatively easily. Most of the voters use similar assistive devices daily or when they vote.

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 with minimal help – a reasonable outcome for an initial introduction to the system.

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

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.

Visual interface clean and intuitive

The examiners observed that the visual interface had aspects that would be intuitive to voters. Some voters echoed this as they experienced the machines, and others demonstrated the good design through use.

- **Selection behaviors.** As voters make selects, the screens behaved as expected for a modern touch interface.
 - **Candidate selection.** Selecting options within each contest was intuitive for voters. Touching the option once put a mark in the box for that candidate. Touching again removed the mark. Straight party votes were cleanly marked in each contest.
 - **Overvoting.** When voters have selected the maximum number of available candidates in a contest, the remaining candidates grey out. In this state, they are visible to the voter, but the voters are unable to select them. This behavior is not mirrored in the audio, though, and is a major problem for audio users. More discussion on this issue can be found in the problems section.
 - **Undervotes.** If voters have not selected the maximum number of allowed candidates in a contest, the candidates remain highlighted and available for selection. Visually, this becomes a noticeable pattern and voters quickly learn in which contests they could select additional candidates.
 - **Straight party.** If the voter selected a straight party option at the beginning of the ballot, the system placed a button just below the contest header and instructions in each partisan contest. This was an intuitive reminder to the voters that they had voted straight party.
- Furthermore, If the voter had selected a straight party option, the system did not grey out the remaining candidate names, but the matching straight party candidates had a check next to them. Voters who understood the straight party method seemed to understand

that they could make changes if necessary, but did not need to make additional selections.

- **Alerts structure.** While marking the ballot, if the voter left a contest blank or undervoted in a contest, for example, the system would alert the voter. The alerts were generally well placed and formatted in a way that makes sense to the voter. Also, if the voter wanted to change a straight party selection, the system alerted the voter in a new differently formatted tile. The same is true right before they printed the ballot.

All this said, the text in the alerts is small and the wording used in the alerts *was not* good and will be discussed in the problems section below.

- **Review screen.** The review screen was formatted well and generally intuitive. For any contest that was blank or undervoted, the system provided an alert and the label “No selection made” for each of the available candidate spots. This made it easy for voters to recognize how many selections they could make.

Printed ballots verifiable and accessible

The ICX prints the ballot selections on an 8.5 x 11-inch piece of heavy weighted paper. The text is small but could be read by all the sighted voters. They all agreed that this satisfied verification for them.

Voters with low-vision, however would not be able to read the printed ballot without a magnifier or other assistive technology. The print on the ballot was much smaller than the on-screen text.

Three of the blind voters were able to use a phone-based app that took a picture of the ballot and then read its contents back to them. Each of the voters who used this option were satisfied with this as the verification step.

Attachment C – Implementation Attestation



Implementation
attestation Dominio



Voting System Implementation Attestation

System Name: _____

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 <small>(Please specify the implementation details, single device / (desktop/laptop), Client/server/ as applicable)</small>
EMS Election Event Designer (EED)	5.5.12.1			
EMS Results Tally and Reporting (RTR)	5.5.12.1			
EMS Application Server	5.5.12.1			
EMS File System Service (FSS)	5.5.12.1			
EMS Audio Studio (AS)	5.5.12.1			
EMS Data Center Manager (DCM)	5.5.12.1			
EMS Election Data Translator (EDT)	5.5.12.1			
ImageCast Voter Activation (ICVA)	5.5.12.1			
EMS Adjudication	5.5.8.1			

EMS Adjudication Service	5.5.8.1			
Smart Card Helper Service	5.5.12.1			
ImageCast Precinct	5.5.3-0002			
ImageCast Central	5.5.3.0002			
ImageCast X	5.5.30			

Further to the key hardware/software components listed above, any of the COTS software and

ancillary components like switches, ballot boxes, charging carts sold on this contract are EAC certified components of the Dominion Democracy Suite 5.5A electronic voting system. (Attach a list of items sold on this contract.)

Dominion has validated that the systems have been installed and hardened following the EAC certified system hardening instructions and no software other than the voting system software has been installed on any of the components.

Vendor Representative Signature: _____

Vendor Representative Name: _____ **Title:** _____

Telephone: _____ **Email:** _____

County Representative Signature: _____

County Representative Name: _____ **Title:** _____

Attachment D – Minimum Training Requirements

Dominion 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 the Supplier'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:
 - i. programming of all voting units and ancillary devices;
 - ii. tabulating results during the unofficial and official canvass;
 - iii. ensuring accuracy and integrity of results;
 - iv. preparing polling places and setting up the system for election day operation;
 - v. Training on accessibility options of the voting system
 - vi. Election day operating procedures;
 - vii. auditing procedures;
 - viii. conducting a recount;
 - ix. preserving records;
 - x. printing, designing, and formatting election reports;
 - xi. troubleshooting common issues;
 - xii. safeguarding and preventing tampering and unauthorized access to all parts of the Voting System; and

xiii. 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 Supplier's assistance and support.

e) Training materials for a purchasing county 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.

Attachment E – Source Code Escrow Obligations for Dominion

The Supplier 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 subsection (d). The Supplier must pay all costs associated with 1) placing the codes in escrow and 2) verifying that the Supplier 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 Members, the Supplier 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 the Supplier, Supplier 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 Supplier.
- 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.
- d. Obtaining source code. Supplier agrees that upon the occurrence of any event or circumstance which demonstrates with reasonable certainty the inability or unwillingness of Supplier 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 Supplier Property placed in escrow from the escrow agent.