# Voting Systems Evaluation

# Committee Report

# August 19, 2019

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## I. Committee Membership

At its March 5, 2019 meeting, the Board of Elections authorized the formation of a new voting equipment search committee consisting of the following members:

Frank Alessio, Chief Purchasing Officer – Purchasing Division

Jason Ditzenberger, Deputy CIO – Computer Services Division

Robin Gigliotti, Business Analyst – Computer Services Division

Adam Lentz, Capital Budget Manager – Budget and Finance Department

John O'Brien, Manager of the Voting Machine Division – Elections Division

Allan Opsitnick, Assistant County Solicitor – Law Department

Stephen Pilarski, Deputy County Manager – County Manager's Office

Caylin Snyder, ADA Coordinator –Human Resources Department

Jerry Tyskiewicz, Director - Administrative Services Department

David Voye, Division Manager – Elections Division

To assist them in their efforts, the committee also included two additional members for input and expertise:

Brett Creasy, Security Consultant – bit x bit, LLC

Mark Wolosik, (deceased) Elections Division Manager Emeritus – Consultant

## II.  Statement of Objectives

All Pennsylvania counties, including Allegheny County, have been directed by the Commonwealth to procure certified voting systems in time for use at the April 28, 2020 primary.

The voting equipment search committee's objective was to analyze all Commonwealth-certified voting systems using the following set of criteria:

o   Facilitating the selection of mandated voting equipment by the county Board of Elections[1];

o   Fully researching, inspecting, and considering the various types of voting equipment that have been certified as compliant for use by the Commonwealth of Pennsylvania[2];

o   Maximizing the convenience and confidence of the voting public;

o   Maximizing security in voting, transmission of unofficial results, and tabulation of results, including write in votes;

o   Considering initial procurement cost as well as subsequent and ancillary costs, with the understanding that this selection process is not cost driven;

o   Maximizing effective in-person voting for voters with disabilities;

o   Maximizing public input and transparency in the review and recommendation process; and,

o   Forwarding findings on voting systems to the county Board of Elections.

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[1] A comprehensive Request for Proposal (RFP) was prepared and publicly disseminated; proposals were received and reviewed by the full committee. The RFP can be found at:
https://www.alleghenycounty.us/uploadedFiles/Allegheny_Home/Dept-Content/Elections/Docs/RFP-8211%20Voting%20Equipment%20Software%20and%20Services.pdf.

[2] A full list of voting systems certified by the Commonwealth, which also includes federal Elections Assistance Commission (EAC)  certification information, can be found at:
https://www.dos.pa.gov/VotingElections/OtherServicesEvents/Pages/Voting-Systems.aspx

### III. Methodology

The committee's methodology was to obtain as much relevant information as possible and, utilizing the skill set of each committee member, to make findings consistent with the committee's objective. More specifically, the committee's activities included:

o Regular meetings;

o Drafting of the county's RFP and review of its proposals and supplementary materials from potential vendors;

o Participation in half-day presentations by all four proposing vendors;

o Attendance at public demonstrations conducted by proposing vendors[3];

o Review of public comments, communications and feedback from public demonstration attendees, and review of input and comments from the general public received by committee members, the Elections Division, and the Board of Elections[4];

o Consideration of testimony, public comments and communications presented at the June 7, 2019 Board of Elections meeting[5];

o Meeting with Dr. David A. Eckhardt, Teaching Professor in the Computer Science Department, Carnegie Mellon University School of Computer Science, and Ron Bandes, President of Vote Allegheny;

o Review of The Blue Ribbon Commission on Pennsylvania's Election Security, including source material[6];

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[3] The schedule of public demonstrations by the Elections Division was announced to the public on May 29, 2019 via press release, social media and the Allegheny Alerts system: https://www.alleghenycounty.us/News/2019/6442467741.aspx. On June 21, 2019, an additional demonstration specifically focused on the systems' Americans with Disabilities (ADA) accommodations was announced via press release, social media and the Allegheny Alerts system: https://www.alleghenycounty.us/News/2019/6442468029.aspx.

[4] Appendix C contains summary information of public input from the demonstrations. Additionally, the public is and has been encouraged to access the county's "New Voting Machines Process" tiles on the Elections Division webpage and provide input. All feedback provided as of the date of this writing was reviewed and considered.

[5] The June 7, 2019 Board of Elections meeting was announced to the public on June 4, 2019 via press release, social media, and the Allegheny Alerts system: https://www.alleghenycounty.us/News/2019/6442467806.aspx.

[6] https://www.cyber.pitt.edu/commission

- o Communication with, and reviewed communications from, the Pennsylvania Department of State, other Pennsylvania counties, and membership organizations including the County Commissioners Association of Pennsylvania; this communication included but was not limited to review of proposals and contracts made to and by various counties[7]; and,

- o Review of feedback and response to Elections Division communications with jurisdictions currently using proposed voting systems.

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[7] Appendix D contains a summary of voting machine selections made by counties within Pennsylvania.

### IV.    Allegheny County Requirements

All counties in the state operate under the Pennsylvania Election Code. Allegheny County; however, has some unique requirements to run an election due to its 130 municipalities and 43 school districts that add significant challenges to election preparation and tabulation.

A ballot style is a unique combination of contests and candidates that appears on a voter's ballot.  In Allegheny County, there could be up to 4,000 separate ballot styles during a municipal primary election. As a result, the selected system in Allegheny County must be capable of supporting an election of up to 10,000 candidate positions and 7,000 contests.

Additionally, Allegheny County has some items that are highly desirable to allow the running of an efficient election and return unofficial results in a timely and accurate fashion:

o    Allegheny County has 1,322 separate polling places; each with balloting materials.  At the close of polls, the balloting material needs to be returned for tabulation.  Having 1,322 judges of elections report to a single location causes logistical issues (parking, traffic, staffing).  Therefore, Allegheny County utilizes seven (7) regional centers for turning in balloting material.  It is highly desirable to be able to tabulate unofficial results from these regional sites, as is the current practice.

o    Allegheny County is heavily invested in its election night reporting software provided by Sctyl which makes unofficial results available to the public. It is highly desirable for the selected system to be able to fully integrate with this system.

o    Allegheny County desires to be compliant with recommendations contained in The Blue Ribbon Commission on Pennsylvania's Election Security[8]. Specifically, it is desirable to have risk limiting audits conducted by a third party.

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[8] https://www.cyber.pitt.edu/report

**V.     Review of proposed Voting Systems**

Currently, there are five (5) vendors certified by the state. One firm, Unisyn Voting Solutions, did not respond to the county's RFP.

Proposals were received from the following vendors:

1.   Clear Ballot;
2.   Dominion Voting;
3.   Election Systems & Software (ES&S); and,
4.   Hart InterCivic.

Contained within the proposals were several systems and equipment configurations resulting in nine different options being presented for consideration. Each presented option was reviewed by the individual committee members who then provided pros and cons that were aggregated into the notes contained in this document.

**Clear Ballot**

The Clear Ballot voting system proposes use of a hand-marked paper ballot that is completed by the voter who would, when satisfied with their vote(s), feed the ballot into a scanner for the vote(s) to be tabulated. Also included in the system for Americans with Disabilities Act (ADA) use is a ballot marking device (BMD) which utilizes a touch screen interface to mark the ballot. Once marked and the voter is satisfied with their vote(s), the ballot is fed into a scanner for the vote to be tabulated.

A.	**Findings Related to Administration of Elections (Pros):**

1. Export files are compatible with Scytl results tabulation software; however, the voter by contest feature may not be supported.
2. System has strong auditing capabilities because the company started as an audit company. It is capable of auditing elections run on other systems and audit capabilities include the visual inspection of the actual marks made by the voter, held within a proprietary and searchable database; risk limiting audits, and other audits to ensure accuracy of results.
3. The hardware for the system is available commercially off the shelf (COTS) and is non-proprietary. Battery is easily replaceable.
4. Ballot collection box is easy to set-up and transport.
5. Ballot paper can be purchased from various sources allowing for competitive bid.
6. The system utilizes an "anywhere ballot," an open-source online template that meets current web standards, to create a ballot that is universally-usable.
7. Scanners and related software have greater tolerances for ballots, making scanning and tabulation easier.

B.	**Findings Related to Administration of Elections (Cons):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 3,200 contests, candidates and ballot styles for each election. During a four-year election cycle, Allegheny County will exceed this number three out of four times.
2. There is no current system, certified or otherwise, for software that can accommodate the county's election night regional reporting tabulation. While the committee was told that such software is to be developed, nothing has been proposed or certified as of the date of this writing. Vendor advised that potential solution would be to photograph precinct results tape or call in results for election night tabulation.
3. Candidates nominated by more than one political party must be listed twice on the ballot and vote totals must be manually added together.
4. Company formed in 2009, making this vendor the newest of those which responded. To date, the vendor has not implemented any jurisdictions of similar size to that of Allegheny County.

5. Vendor relies on partner organizations for the "boots on the ground" setup, support and running of the elections/systems. The subcontractor relationship raises concerns regarding the security of all the partner organizations.
6. Pre-Election logic and accuracy testing could take up to four weeks. The process on the current system takes two days for the testing of all machines.

C. **Findings Related to Security and Technology (Pros):**

1. No barcodes are used, including on the BMD-produced ballots. Voters' choices are read by optical scan of a hand-marked paper ballot or a ballot marking device.
2. Manufactured in the United States.
3. The hardware for wireless connections is removed from the devices.
4. The system uses encrypted and digitally-signed USB devices for data transport between the election systems devices.
5. The system runs Linux Ubuntu 18.04 on ClearCast, ClearCount and ClearDesign.

D. **Findings Related to Security and Technology (Cons):**

1. Documentation suggests strong security controls in certain areas but lacks specificity.
2. Details regarding the SLI Global Solutions (security) tests for Pennsylvania are unknown.
3. Foreign vendors/manufacturers are indirectly involved in the process of building the system due to the use of COTS devices.
4. While Linux is generally considered more secure than Windows, it cannot be considered secure just by virtue of not being Windows. Documentation mentions "hardening" to prevent attacks "by ensuring that only known software can be run on these computers" which would imply whitelisting. No details on hardening of the underlying operating system (Linux) has been found/provided although their documentation states they do perform hardening.

E. **Findings Related to Americans with Disabilities Act (ADA) Considerations (Pros):**

1. BMD ballot not easily discernable from voter marked ballots.
2. Adjustable screen to accommodate voters who are standing vs sitting.
3. The system utilizes an "anywhere ballot" which addresses usability issues including font, size, shape, placement, colors, text, etc.
4. ADA keypad is easy to use.

F. **Findings Related to Americans with Disabilities Act (ADA) Considerations (Cons):**

1. Braille overlay label is separate from the ADA keypad.

2. ADA keypad is heavy.
3. No front access panel to audio jack and sip+puff. Instead, it is on the side of the touchscreen and not clearly visible.
4. System uses proprietary assistive technology; the use of personal assistive technology would not be possible.

**Dominion Voting ICX-BMD Touchscreen**

Dominion proposed two different configurations using the same equipment. The ICX-BMD Touchscreen proposal contemplates use of ballot marking devices (BMD) with touch screen interface for all voters. Once marked and the voter is satisfied with their vote(s), the ballot is fed into a scanner for the vote to be tabulated.

A. **Findings Related to Administration of Elections (Pros):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 10,000 candidate positions for each election.
2. Regional tabulation solution with electronic transmission of unofficial results is tested and certified by the EAC and is also currently in use in other locations.
3. Export files are compatible with the county's Scytl results tabulation software; however, the voter by contest feature may not be supported.
4. Risk limiting audits and other audits are supported to ensure accuracy of results. The system employs a patented ballot-level audit trail, "AuditMark," which creates a digital image of every ballot and records what the voter intent was that was interpreted by the system.
5. System used in numerous large jurisdictions.
6. With the exception of the ballot scanner, the hardware for the system is available commercially off the shelf and is non-proprietary. Battery is easily replaceable.
7. Ballot paper can be purchased from various sources allowing for competitive bid.
8. Ballot display options, e.g. font size, color, contrast are selectable by voter.
9. Variety of carts and ballot boxes available.

B. **Findings Related to Administration of Elections (Cons):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 1,000 precincts, 3,000 ballot styles and 1,000 contests. The vendor self-reported that they "stress-tested" to 4,000 precincts. The vendor did not address ballot styles and contests.
2. Not fully compatible with all features of the county's election night results reporting system (Scytl); specifically, the voter by contest feature may not be supported.
3. Foreign-owned (Canadian) company.
4. Election morning setup most complicated of all systems. The vendor suggested delivering equipment in place on covered transfer cart to address concern. This solution raises other concerns related to damage of pieces in transport that could not be easily addressed on election morning.
5. Scanner is the largest of the four vendors (2' x 3'). As the lid detaches fully from unit and has no hinges, there are concerns with storage and transport. The system is also heavy, limiting who may able to set-up and/or move it.

6. BMD is a large tablet with printer and external battery, all available commercially off the shelf (COTS).
7. BMD produces barcoded ballot.
8. Pre-Election logic and accuracy testing could last up to six weeks. The process on the current system takes two days for the testing of all machines.
9. Like with all other non-hand-marked ballot systems, there is a Department of State directive requiring the printing of a set percentage of emergency ballots for each election.

C. **Findings Related to Security and Technology (Pros):**

1. Redundancy built in using two USB drives and ballot itself.
2. Uses Windows 10 operating system and Windows Server 2016.
3. Testing includes source code and system level using Nessus for system level vulnerabilities.
4. Follow NIST[9] and FIPS[10] validate procedures for data integrity.
5. Follows DISA STIG[11] guidelines for the hardening of the COTS based hardware/software.
6. Implement MFA (multi-factor authentication) on all scanner and back office functions.
7. Wireless connections are physically removed from the devices.
8. Member of and participates in various election security industry groups (EI-ISAC[12], among others).

D. **Findings Related to Security and Technology (Cons):**

1. Use of barcodes to tabulate voters' choices.
2. Foreign vendors/manufacturers could be indirectly involved in the process of building the system due to the use of COTS devices.
3. Use of COTS software (Windows server 2016, MS-SQL, etc.) provides a greater baseline attack surface than alternative software choices.
4. Details regarding the SLI (security) tests for Pennsylvania are unknown at this writing.

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[9] National Institute of Standards and Technology is a research laboratory that works with industry and other government agencies to develop information technology standards through voluntary consensus.

[10] Federal Information Processing Standards are standards developed by the United States federal government for non-military agencies for purposes such as computer security.

[11] Defense Information Systems Agency Security Technical Implementation Guides are the published U.S. Department of Defense configuration standards for information systems.

[12] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

5. Use of standard antivirus (Windows Defender and AVAST) on the computer systems is average malware protection.


**E. Findings Related to Americans with Disabilities Act (ADA) Considerations (Pros):**

1. Americans with Disabilities (ADA) Act system is contained in all-in-one cart which is adaptable for wheelchair users with printer below.
2. ADA ballots are indistinguishable from non-ADA ballots.
3. System has an adjustable screen.


**F. Findings Related to Americans with Disabilities Act (ADA) Considerations (Cons):**

1. Vendors appeared to have technical difficulties when demonstrating ADA machine at the public demonstrations, raising concerns for poll workers to be able to utilize it for ADA-voters.
2. ADA keypad has too many components making navigation difficult.
3. If an ADA voter chooses to change the type of accommodation during their voting, a poll worker must reset the system and the voter will need to start over.
4. ADA voter must disclose their specific disability in order for the appropriate accommodation to be made, providing less independence in the voting process.

**Dominion Voting ICP-All Paper**

Dominion proposed two different configurations using the same equipment. The ICP-All Paper option contemplates use of a hand-marked paper ballot that is completed by the voter who would, when satisfied with their vote(s), feed the ballot into a scanner for the vote(s) to be tabulated. It would include one Americans with Disabilities (ADA) Act ballot marking device (BMD).

A. **Findings Related to Administration of Elections (Pros):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 10,000 candidates for each election.
2. Regional tabulation solution with electronic transmission of unofficial results is tested and certified by the EAC and is also currently in use in other locations.
3. Export files are compatible with the county's Scytl results tabulation software; however, the voter by contest feature may not be supported.
4. Risk limiting audits and other audits are supported to ensure accuracy of results. The system employs a patented ballot-level audit trail, "AuditMark," which creates a digital image of every ballot and records what the voter intent was that was interpreted by the system.
5. System used in numerous large jurisdictions.
6. With the exception of the ballot scanner, the hardware for the system is available commercially off the shelf (COTS) and is non-proprietary. Battery easily replaceable.
7. Ballot paper can be purchased from various sources allowing for competitive bid.
8. Ballot display options, e.g. font size, color, contrast are selectable by voter.
9. Variety of carts and ballot boxes available.

B. **Findings Related to Administration of Elections (Cons):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 1,000 precincts, 3,000 ballot styles and 1,000 contests. The vendor self-reported that they "stress-tested" to 4,000 precincts. The vendor did not address ballot styles and contests.
2. Not fully compatible with all features of the county's election night results reporting system (Scytl); specifically, the voter by contest feature may not be supported.
3. Foreign-owned (Canadian) company.
4. Election morning setup most complicated of all systems. The vendor suggested delivering equipment in place on covered transfer cart to address concern. This solution raises other concerns related to damage of pieces in transport that could not be easily addressed on election morning.
5. Scanner is the largest of the four vendors (2' x 3'). As the lid detaches fully from unit and has no hinges, there are concerns with storage and transport.
6. Ballot marking device (BMD) is a large tablet with printer and external battery, all COTS.
7. BMD produces barcoded ballot.

8. Pre-Election logic and accuracy testing could last up to six weeks. The process on the current system takes two days for the testing of all machines.

## C. Findings Related to Security and Technology (Pros):

1. Redundancy built in using two USB drives and ballot itself.
2. Uses Windows 10 OS and Windows Server 2016.
3. Testing includes source code and system level using Nessus for system level vulnerabilities.
4. Follow NIST[13] and FIPS[14] validate procedures for data integrity.
5. Follows DISA STIG[15] guidelines for the hardening of the COTS based hardware/software.
6. Implements MFA (multi-factor authentication) on all scanner and back office functions.
7. Wireless connections are physically removed from the devices.
8. Member of and participates in various election security industry groups (EI-ISAC[16], among others).

## D. Findings Related to Security and Technology (Cons):

1. Use of barcodes to tabulate voters' choices.
2. Foreign vendors/manufacturers could be indirectly involved in the process of building the system due to the use of COTS devices.
3. Use of COTS software (Windows server 2016, MS-SQL, etc.) provides a greater baseline attack surface than alternative software choices.
4. Details regarding the SLI (security) tests for Pennsylvania are unknown at this writing.
5. Use of standard antivirus (Windows Defender and AVAST) on the computer systems is average malware protection.

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[13] National Institute of Standards and Technology is a research laboratory that works with industry and other government agencies to develop information technology standards through voluntary consensus.

[14] Federal Information Processing Standards are standards developed by the United States federal government for non-military agencies for purposes such as computer security.

[15] Defense Information Systems Agency Security Technical Implementation Guides are the published U.S. Department of Defense configuration standards for information systems.

[16] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

**E. Findings Related to Americans with Disabilities Act (ADA) Considerations (Pros):**

1. Americans with Disabilities (ADA) Act system is contained in all-in-one cart which is adaptable for wheelchair users with printer below.
2. ADA ballots are indistinguishable from non-ADA ballots.
3. System has an adjustable screen.

**F. Findings Related to Americans with Disabilities Act (ADA) Considerations (Cons):**

1. Vendors appeared to have technical difficulties when demonstrating ADA machine at the public demonstrations, raising concerns for poll workers to be able to utilize it for ADA-voters.
2. ADA keypad has too many components making navigation difficult.
3. If an ADA voter chooses to change the type of accommodation during their voting, a poll worker must reset the system and the voter will need to start over.
4. ADA voter must disclose their specific disability in order for the appropriate accommodation to be made, providing less independence in the voting process.

**Election Systems & Software Configuration # 1**

Elections Systems & Software (ES&S) presented four device configurations for consideration. All four systems operate using Electionware® election management software.

The first configuration, Express Vote Ballot Marking Device, is a paper-based voting device that provides touch screen voting and incorporates the printing of the voter's selections as cast vote record (CVR). With this option, the internal tabulator is disabled. Once a voter has made his or her selections, the CVR is printed and reviewed. If the CVR is accurate, the voter proceeds to a precinct-based tabulation scanner and inserts the CVR for tabulation. This is a fully-accessible device.

A.  **Findings Related to Administration of Elections (Pros):**

1.  System is tested and certified by the federal Elections Assistance Commission (EAC) for a 10,000 candidate per election contest limit.
2.  System is compatible with all features of the county's election night results reporting system (Scytl), including the voter by contest feature.
3.  Vendor indicated during presentation that it can support risk limiting audits and other audits to ensure accuracy of results.
4.  Vendor is largest of proposers and has been the supplier of the county's voting system for the past 13 years. System is also similar to the machine currently used, the iVotronic.
5.  System has export options and multiple output sources.
6.  System notifies the voter of overvotes and undervotes before the paper record is printed.
7.  System uses 70% less paper than traditional paper-based voting systems.

B.  **Findings Related to Administration of Elections (Cons):**

1.  Proprietary hardware may increase future costs of maintenance.
2.  Operating system (Windows 7) is dated on certain components.
3.  Produces a paper record with bar codes.
4.  Like with all other non-hand-marked ballot systems, there is a Department of State directive requiring the printing of a set percentage of emergency ballots for each election.

C.  **Findings Related to Security and Technology (Pros):**

1.  Vendor offers education/training of election officials regarding best practices for securing election equipment and processes.
2.  Internal team performs penetration testing of hardware and software.
3.  Full "end to end voting configuration" of software and hardware was submitted to Idaho National Laboratory (INL) for testing.

4. USB drives used to transport data between the voting systems and the backend systems are verified through a digital signature and are also encrypted. The USBs themselves are manufactured in the United States.
5. System uses a custom operating system that is based off of Linux Ubuntu 18.04. The proposal from the vendor suggests it has been hardened.
6. Vendor has weekly Department of Homeland Security "cyber-hygiene scans" of its external web presence.
7. Vendor has joined multiple election information technology/security groups such as EI-ISAC[17] and IT-ISAC[18].

### D. Findings Related to Security and Technology (Cons):

1. Results of "end to end voting configuration" of software and hardware submitted to Idaho National Laboratory (INL) for testing are unknown.
2. Use of barcodes to tabulate voter's choices.
3. Foreign-made machines.
4. Uses Windows 7 operating system.
5. Guidelines or steps used to harden the underlying Linux Ubuntu operating system have not been found or provided.

### E. Findings Related to Americans with Disabilities Act Considerations (Pros):

1. Nuance speech recognition system.
2. Instruction panel has clear directions displayed on the machine that are easy to follow.
3. A front access panel contains headphone jack and sip+puff and is very visible with braille.
4. Easy-to-understand ADA keypad with braille.
5. For ADA users, the system has a rolling kiosk with height adjustment to accommodate both standing and seated voters.
6. Ballot design ADA ballots are not distinguishable from non-ADA ballots.

### F. Findings Related to Americans with Disabilities Act Considerations (Cons):

1. None

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[17] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

[18] Information Technology – Information Sharing and Analysis Center: A corporation formed by members within the Information Technology sector as a unique and specialized forum for managing risk and corporations' IT infrastructure.

**Election Systems & Software Configuration # 2**

Elections Systems & Software (ES&S) presented four device configurations for consideration. All four systems operate using Electionware® election management software.

The second configuration, Express Vote XL, is a hybrid paper-based voting device that provides touch screen voting and incorporates the printing of the voter's selections as cast vote record (CVR) and tabulation scanning into a single unit. This is a full ballot unit with all contests displayed on one large touch screen. Once a voter has made his or her selections, the CVR is printed and reviewed. If the CVR is accurate, the voter then processes the CVR for tabulation. The device would store all tabulated vote summary cards in a secure card container attached to the device. This is a fully-accessible device and would be used by all voters.

A. **Findings Related to Administration of Elections (Pros):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) for a 10,000 candidate per election contest limit.
2. System is compatible with all features of the county's election night results reporting system (Scytl), including the voter by contest feature.
3. Vendor indicated during presentation that it can support risk limiting audits and other audits to ensure accuracy of results.
4. Vendor is largest of proposers and has been the supplier of the county's voting system for the past 13 years.
5. System has export options and multiple output sources.
6. System can handle a large number of voters which may reduce the number of devices requires.
7. Entire ballot is presented to the voter on one screen.
8. Resembles old-style lever machines used in the county, making older residents more comfortable with the use of the new machines.
9. Privacy curtain allows secrecy when casting your vote.

B. **Findings Related to Administration of Elections (Cons):**

1. Proprietary hardware may increase future costs of maintenance.
2. Operating system (Windows 7) is dated on certain components.
3. Machines are heavy, large, and difficult and expensive to store, ship and set-up.
4. The 32" touch screen could be damaged easily.
5. Like with all other non-hand-marked ballot systems, there is a Department of State directive requiring the printing of a set percentage of emergency ballots for each election.

**C. Findings Related to Security and Technology (Pros):**

1. Vendor offers education/training of election officials regarding best practices for securing election equipment and processes.
2. Internal team performs penetration testing of hardware and software.
3. Full "end to end voting configuration" of software and hardware was submitted to Idaho National Laboratory (INL) for testing.
4. USB drives used to transport data between the voting systems and the backend systems are verified through a digital signature and are also encrypted. The USBs themselves are manufactured in the United States.
5. System uses a custom operating system that is based off of Linux Ubuntu 18.04. The proposal from the vendor suggests it has been hardened.
6. "Albert," a security monitoring tool, is installed within their "hosted voter registration environments."
7. Vendor has weekly Department of Homeland Security "cyber-hygiene scans" of its external web presence.
8. Vendor has joined multiple election information technology/security groups such as EI-ISAC[19] and IT-ISAC[20].

**D. Findings Related to Security and Technology (Cons):**

1. Results of "end to end voting configuration" of software and hardware submitted to Idaho National Laboratory (INL) for testing are unknown.
2. Use of barcodes to tabulate voter's choices.
3. Foreign-made machines.
4. Uses Windows 7 operating system.
5. Guidelines or steps used to hard the underlying Linux Ubuntu operating system have not been found or provided.

**E. Findings Related to Americans with Disabilities Act Considerations (Pros):**

1. Nuance speech recognition system.
2. Instruction panel has clear directions displayed on the machine that are easy to follow.
3. A front access panel contains headphone jack and sip+puff and is very visible with braille.
4. Easy-to-understand ADA keypad with braille.

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[19] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

[20] Information Technology – Information Sharing and Analysis Center: A corporation formed by members within the Information Technology sector as a unique and specialized forum for managing risk and corporations' IT infrastructure.

5. ADA ballots are indistinguishable from non-ADA ballots.
6. There is no need for separate ADA equipment.
7. The system has a fully ADA compliant configuration.
8. Ballot design ADA ballots are not distinguishable from non-ADA ballots.


F. **Findings Related to Americans with Disabilities Act Considerations (Cons):**

1. None

**Election Systems & Software Configuration # 3**

Elections Systems & Software (ES&S) presented four device configurations for consideration. All four systems operate using Electionware® election management software.

The third configuration, Express Vote with Tabulator, is a hybrid paper-based voting device that provides touch screen voting and incorporates the printing of the voter's selections as cast vote record (CVR) and tabulation scanning into a single unit. The device utilizes a multi-page touchscreen which the voter would page through until the ballot is finished. Once a voter has made his or her selections, the CVR is printed and reviewed. If the CVR is accurate, the voter would process the CVR for tabulation by reinserting it into the device. This is a fully-accessible device and would be used by all voters.

A. **Findings Related to Administration of Elections (Pros):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) for a 10,000 candidate per election contest limit.
2. System is compatible with all features of the county's election night results reporting system (Scytl), including the voter by contest feature.
3. Vendor indicated during presentation that it can support risk limiting audits and other audits to ensure accuracy of results.
4. Vendor is largest of proposers and has been the supplier of the county's voting system for the past 13 years.
5. System has export options and multiple output sources.
6. Machine is similar to iVotronic currently used in the county.
7. No need to purchase precinct scanners due to in-unit tabulation, would use 70% less paper than traditional paper-based voting system.
8. System notifies the voter of overvotes and undervotes before paper record is printed.

B. **Findings Related to Administration of Elections (Cons):**

1. Proprietary hardware may increase future costs of maintenance.
2. Operating system (Windows 7) is dated on certain components.
3. Like with all other non-hand-marked ballot systems, there is a Department of State directive requiring the printing of a set percentage of emergency ballots for each election.

C. **Findings Related to Security and Technology (Pros):**

1. Vendor offers education/training of election officials regarding best practices for securing election equipment and processes.
2. Internal team performs penetration testing of hardware and software.

3. Full "end to end voting configuration" of software and hardware was submitted to Idaho National Laboratory (INL) for testing.
4. USB drives used to transport data between the voting systems and the backend systems are verified through a digital signature and are also encrypted. The USBs themselves are manufactured in the United States.
5. System uses a custom operating system that is based off of Linux Ubuntu 18.04. The proposal from the vendor suggests it has been hardened.
6. "Albert," a security monitoring tool, is installed within their "hosted voter registration environments."
7. Vendor has weekly Department of Homeland Security "cyber-hygiene scans" of its external web presence.
8. Vendor has joined multiple election information technology/security groups such as EI-ISAC[21] and IT-ISAC[22].

### D. Findings Related to Security and Technology (Cons):

1. Results of "end to end voting configuration" of software and hardware submitted to Idaho National Laboratory (INL) for testing are unknown.
2. Use of barcodes to tabulate voter's choices.
3. Foreign-made machines.
4. Uses Windows 7 operating system.
5. Guidelines or steps used to hard the underlying Linux Ubuntu operating system have not been found or provided.
6. Ballot is inserted back into the same device that printed it.

### E. Findings Related to Americans with Disabilities Act Considerations (Pros):

1. Nuance speech recognition system.
2. Instruction panel has clear directions displayed on the machine that are easy to follow.
3. A front access panel contains headphone jack and sip+puff and is very visible with braille.
4. Easy-to-understand ADA keypad with braille.
5. ADA ballots are indistinguishable from non-ADA ballots.
6. There is no need for separate ADA equipment.
7. For ADA users, the system has a rolling kiosk with height adjustment to accommodate both standing and seated voters.

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[21] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

[22] Information Technology – Information Sharing and Analysis Center: A corporation formed by members within the Information Technology sector as a unique and specialized forum for managing risk and corporations' IT infrastructure.

8. Ballot design ADA ballots are not distinguishable from non-ADA ballots.

**F. Findings Related to Americans with Disabilities Act Considerations (Cons):**

1. None

**Election Systems & Software Configuration # 4**

Elections Systems & Software (ES&S) presented four device configurations for consideration. All four systems operate using Electionware® election management software.

The fourth configuration, DS200 Precinct Based Scanner, is a precinct, paper-based scanner which tabulates both hand-marked paper ballots and cast vote records (CVR) from the Express Vote Ballot Marking Device. The device has a touch screen to notify the voter of overvotes and undervotes. The DS200 cannot be used alone but would have to be used in conjunction with at least one of the ADA-compliant hybrid paper-based voting systems.

A. **Findings Related to Administration of Elections (Pros):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) for a 10,000 candidate per election contest limit.
2. System is compatible with all features of the county's election night results reporting system (Scytl), including the voter by contest feature.
3. Vendor indicated during presentation that it can support risk limiting audits and other audits to ensure accuracy of results.
4. Vendor is largest of proposers and has been the supplier of the county's voting system for the past 13 years.
5. System has export options and multiple output sources.
6. System can scan hand-marked paper ballots and Express Vote paper records.
7. System can accommodate up to 19" ballot.
8. A touch screen on the scanner would notify voters of overvotes and undervotes and allow them to spoil their ballot.

B. **Findings Related to Administration of Elections (Cons):**

1. Proprietary hardware may increase future costs of maintenance.
2. Operating system (Windows 7) is dated on certain components.
3. Large ballot box adds time and resources to transport.
4. Device is top heavy and, when transported, has the potential to fall over when attached to the ballot box.

C. **Findings Related to Security and Technology (Pros):**

1. Vendor offers education/training of election officials regarding best practices for securing election equipment and processes.
2. Internal team performs penetration testing of hardware and software.
3. Full "end to end voting configuration" of software and hardware was submitted to Idaho National Laboratory (INL) for testing.

4. USB drives used to transport data between the voting systems and the backend systems are verified through a digital signature and are also encrypted. The USBs themselves are manufactured in the United States.
5. System uses a custom operating system that is based off of Linux Ubuntu 18.04. The proposal from the vendor suggests it has been hardened.
6. "Albert," a security monitoring tool, is installed within their "hosted voter registration environments."
7. Vendor has weekly Department of Homeland Security "cyber-hygiene scans" of its external web presence.
8. Vendor has joined multiple election information technology/security groups such as EI-ISAC[23] and IT-ISAC[24].

**D. Findings Related to Security and Technology (Cons):**

1. Results of "end to end voting configuration" of software and hardware submitted to Idaho National Laboratory (INL) for testing are unknown.
2. Use of barcodes to tabulate voter's choices.
3. Foreign-made machines.
4. Uses Windows 7 operating system.
5. Guidelines or steps used to hard the underlying Linux Ubuntu operating system have not been found or provided.

**E. Findings Related to Americans with Disabilities Act Considerations (Pros):**

1. Nuance speech recognition system.
2. Instruction panel has clear directions displayed on the machine that are easy to follow.
3. A front access panel contains headphone jack and sip+puff and is very visible with braille.
4. Easy-to-understand ADA keypad with braille.
5. For ADA users, the system has a rolling kiosk with height adjustment to accommodate both standing and seated voters.

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[23] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

[24] Information Technology – Information Sharing and Analysis Center: A corporation formed by members within the Information Technology sector as a unique and specialized forum for managing risk and corporations' IT infrastructure.

F. **Findings Related to Americans with Disabilities Act Considerations (Cons):**

    1. Ballot design ADA ballots are distinguishable from non-ADA ballots.

**Hart InterCivic Precinct/Verity**

Hart InterCivic presented two options for consideration which run Verity Election Management Software.

Option # 1, Precinct/Verity, is a hand-marked paper ballot system with a ballot marking device (BMD) for ADA voters. When voters are satisfied with their selections, they deposit their voted ballot into a precinct level optical-scan and tabulation device.

A. **Findings Related to Administration of Elections (Pros):**

1. Export files are compatible with the county's Scytl results tabulation software; however, the voter by contest feature may not be supported.
2. Vendor indicated during presentation that the system can support risk-limiting audits and other audits to ensure accuracy of results.
3. Vendor has been in business for over 100 years and producing voting systems since 1998. It is the second largest of four proposers.
4. Ballot creation seems easier than other systems with an ability to toggle between paper and touch screen.
5. Some commercial off-the-shelf (COTS) items available for printing.
6. Can use non-proprietary paper stock (28 lb.) and are able to print ballots at polling place.
7. Easy set up. Collapsible ballot box and small suitcase design for scanner and BMD should reduce storage and transportation costs.

B. **Findings Related to Administration of Elections (Cons):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 5,000 candidates for each election.
2. As of this writing, the system is unable to support regional tabulation and remote transmission of election results.
3. Export files are compatible with county's Scytl results tabulation software; however, the voter by contest function may not be supported.
4. Proprietary equipment includes battery and scanner. Battery has only a two-hour life, is external and weighs 10 lbs.
5. Unique number system log-in for voter.

C. **Findings Related to Security and Technology (Pros):**

1. Bar codes are not used to record or tabulate ballot selections. Voters' choices are read by optical scan of a hand-marked paper ballot or a ballot marking device. Ballot has a barcode, but it is not used for ballot choices. Barcode on ballot is used as a unique identifier so that ballot cannot be scanned a second time.
2. Systems are designed, engineered and manufactured in the United States and include custom-built hardware with no network connectivity.
3. Embedded custom operating system.

4. Ability for multiple reporting runs at same time.
5. Uses "whitelisting" technology for security and has highest level of security for stopping unauthorized software such as malware.
6. USB hardening applied to only recognize authorized USB devices.
7. Underlying operating system (OS) is Windows 7 embedded (not Windows 7 Pro). According to vendor, it is supported through 2025 which allows vendor to pick the components of the OS that it needs without including the fully functioning OS and the inherent vulnerabilities that may come with the "retail" version of Windows 7.
8. Devices employ "secure boot" for tamper notification to the system.
9. Vendor member of and participates in many election security groups (EI-ISAC[25], IT-ISAC[26]), contributed to the CIS handbook on election security and other similar ventures have been documented in their materials.

**D. Findings Related to Security and Technology (Cons):**

1. Details regarding the SLI (security) tests for Pennsylvania are unknown at this writing.

**E. Findings Related to Americans with Disabilities Act Considerations (Pros):**

1. ADA ballots are indistinguishable from non-ADA ballots.
2. Easy to use ADA keypad (two button device with select wheel that voter rotates to scroll through ballot including braille and audio jacks).
3. Printer has animated green arrow to indicate where to insert ballot in scanner; visually impaired voters can do this independently.
4. Supports voters with cognitive impairments by reducing complexity- limited use of icons, plain instructions and few buttons on ADA keypad.

**F. Findings Related to Americans with Disabilities Act Considerations (Cons):**

1. Presenter recommended ONLY voters with disabilities to use Touch Writer.
2. Touch screen cannot be adjusted to change the angle for easier viewing.
3. Wheel used for ADA accommodation in system could be difficult to control for navigation of the ballot.

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[25] Elections Infrastructure – Information Sharing and Analysis Center:  A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

[26] Information Technology – Information Sharing and Analysis Center: A corporation formed by members within the Information Technology sector as a unique and specialized forum for managing risk and corporations' IT infrastructure.

**Hart InterCivic Verity Duo**

Hart InterCivic presented two options for consideration which run Verity Election Management Software.

Option # 2, Verity Duo, is a ballot marking device for paper ballots. All voters make their selection by using a touch screen and then, when they are satisfied with their selections, print their completed ballot via an integrated printer. The voter then takes the ballot to a precinct level tabulation device for scanning. The system is ADA compliant and can be used for all voters.

A. **Findings Related to Administration of Elections (Pros):**

1. Export files are compatible with the county's Scytl results tabulation software; however, the voter by contest feature may not be supported.
2. Vendor indicated during presentation that the system can support risk-limiting audits and other audits to ensure accuracy of results.
3. Vendor has been in business for over 100 years and producing voting systems since 1998. It is the second largest of four proposers.
4. Ballot creation seems easier than other systems with an ability to toggle between paper and touch screen.
5. Some commercial off-the-shelf (COTS) items available for printing.
6. Can use non-proprietary paper stock (28 lb.) and are able to print ballots at polling place.
7. Easy set up and collapsible ballot box and small suitcase design for scanner and BMD should reduce storage and transportation costs.

B. **Findings Related to Administration of Elections (Cons):**

1. System is tested and certified by the federal Elections Assistance Commission (EAC) to meet 5,000 candidates for each election.
2. As of this writing, the system is unable to support regional tabulation and remote transmission of election results.
3. Export files are compatible with county's Scytl results tabulation software; however, the voter by contest function may not be supported.
4. Proprietary equipment includes battery and scanner. Battery has only a two-hour life, is external and weighs 10 lbs.
5. Unique number system log-in for election worker adds another step and can slow down the process.
6. Requires a Verity Controller device, adding to the amount of hardware required, but not necessary.
7. Like with all other non-hand-marked ballot systems, there is a Department of State directive requiring the printing of a set percentage of emergency ballots for each election.

C. **Findings Related to Security and Technology (Pros):**

1. Bar codes are not used to record or tabulate ballot selections. Voters' choices are read by optical scan of a hand-marked paper ballot or a ballot marking device. Ballot has a barcode, but it is not used for ballot choices. Barcode on ballot is used as a unique identifier so that ballot cannot be scanned a second time.
2. Systems are designed, engineered and manufactured in the United States and include custom-built hardware with no network connectivity.
3. Embedded custom operating system.
4. Ability for multiple reporting runs at same time.
5. Uses "whitelisting" technology for security and has highest level of security for stopping unauthorized software such as malware.
6. USB hardening applied to only recognize authorized USB devices.
7. Underlying operating system (OS) is Windows 7 embedded (not Windows 7 Pro). According to vendor, it is supported through 2025 which allows vendor to pick the components of the OS that it needs without including the fully functioning OS and the inherent vulnerabilities that may come with the "retail" version of Windows 7.
8. Devices employ "secure boot" for tamper notification to the system.
9. Vendor member of and participates in many election security groups (EI-ISAC[27], IT-ISAC[28]), contributed to the Center for Internet Security (CIS) handbook on election security and other similar ventures have been documented in their materials.
10. Does not scan a barcode, but actual text of the voter's choices.

D. **Findings Related to Security and Technology (Cons):**

1. Details regarding the SLI (security) tests for Pennsylvania are unknown at this writing.

E. **Findings Related to Americans with Disabilities Act Considerations (Pros):**

1. ADA ballots are indistinguishable from non-ADA ballots.
2. Easy to use ADA keypad (two button device with select wheel that voter rotates to scroll through ballot including braille and audio jacks).
3. Printer has animated green arrow to indicate where to insert ballot in scanner; visually impaired voters can do this independently.
4. Supports voters with cognitive impairments by reducing complexity- limited use of icons, plain instructions and few buttons on ADA keypad.

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[27] Elections Infrastructure – Information Sharing and Analysis Center: A program within the Center for Internet Security, Inc. operated to support information sharing among United States' state, local and territorial governmental elections entities.

[28] Information Technology – Information Sharing and Analysis Center: A corporation formed by members within the Information Technology sector as a unique and specialized forum for managing risk and corporations' IT infrastructure.

**F. Findings Related to Americans with Disabilities Act Considerations (Cons):**

1. Presenter recommended ONLY voters with disabilities to use Touch Writer.
2. Touch screen cannot be adjusted to change the angle for easier viewing.
3. Wheel used for ADA accommodation in system could be difficult to control for navigation of the ballot.

**Appendix A:**          **ADA Criteria**

In reviewing the proposed systems for Americans with Disabilities (ADA) Act accommodations, the following criteria were considered:

Operability

- o   Accessing the machine and physical space;
- o   Voting input mechanisms and speech input;
- o   Verification and submission of the ballot-Able to review and make changes to ballot; and,
- o   Assistive listening devices.

 Adjustability

- o   Standard default values;
- o   Customizable settings;
- o   Size/font, contrast, color adjustment;
- o   Audio- volume and tempo;
- o   Headphone jack; and,
- o   Option to mask ballot for extra privacy if using strictly audio (visual impaired voters).

Discernibility

- o   Display of information;
- o   Timing and response;
- o   Controls and keys;
- o   Audio content and interface;

Understandability

- o   All instructions are clear and straightforward;
- o   All able to access help when needed;
- o   Alerts/warnings for under/over votes;
- o   All self-explanatory;
- o   Simplistic language;
- o   All provide a summary of the voter's selection for review;
- o   Easy second-chance voting; and,

Voters can mark, verify and cast their ballot privately and independently.

**Appendix B:    Financial Analysis Summary**

Pricing from responding vendors is summarized in the table below.  The committee asked for best and final pricing from each vendor.

| System | Final Purchase Price | Yearly Software Costs |
|---|---|---|
| Clear Ballot | $12,122,080 | $513,911 |
| Dominion Voting ICX-BMD Touchscreen | $14,545,806 | $489,487 |
| Dominion Voting ICP-All Paper | $ 9,257,165 | $309,819 |
| ES&S* Configuration # 1 | $19,855,327 | $422,270 |
| ES&S* Configuration # 2 | $18,992,596 | $235,275 |
| ES&S* Configuration # 3 | $19,307,697 | $358,150 |
| ES&S* Configuration # 4 | $10,588,499 | $240,165 |
| Hart InterCivic Precinct/Verity | $12,951,315 | $444,057 |
| Hart InterCivic Verity Duo | $22,825,402 | $765,847 |

*Election Systems & Software (ES&S)

Note: All systems have ballot printing cost estimates ranging from $0.23 to $0.30 per ballot.

All systems also have lease options of various lengths and interest rates which break the final purchase price down into yearly payment installments.

**Appendix C:    Public Demonstration Summary**

Allegheny County held eight public voting machine demonstrations to allowed voters to review the proposed systems and ask questions of the vendors. Total attendance for all eight events was 478.

Attendees were encouraged to fill out a comment form after the event asking which voting system they most preferred.  Attendees returned 226 comment forms:

| Vendor | # of Attendees Selecting Vendor as First Choice |
| --- | --- |
|  |  |
| Clear Ballot | 81 |
| Dominion Voting | 35 |
| Election Systems & Software | 63 |
| Hart InterCivic | 22 |
|  |  |
| NOTE:  26 attendees recommended multiple systems, or did not have a first choice | |

**Appendix D:    Summary of Pennsylvania County's Systems Selections**

The following tables present selections made by counties within Pennsylvania:

| Vendors | |
|---|---|
| ES&S | 26 |
| Dominion | 7 |
| Clear Ballot | 4 |
| Unisyn | 2 |
| Hart | 1 |
| Undecided | 27 |
| **Total** | **67** |

| Configurations | |
|---|---|
| Precinct Scan + 1 BMD | 32 |
| Precinct Scan + Full BMD | 8 |
| Full Face | 2 |
| Central Scan | 3 |
| Undecided | 22 |
| **Total** | **67** |

| Deployments | |
|---|---|
| May 2019 | 10 |
| November 2019 | 35 |
| April 2020 | 17 |
| Undecided | 5 |
| **Total** | **67** |

**Appendix E:     EAC Tested and Certified Metrics**

**Clear Ballot**

|  | Allegheny County Requirements | EAC Tested and Certified to meet |
|---|---|---|
| Ballot Styles | 4,000 | 3,200 |
| Candidate Positions | 10,000 | 3,200 |
| Contests | 7,000 | 3,200 |
| Precincts | 1,350 | 3,200 |

**Dominion Voting**

|  | Allegheny County Requirements | EAC Tested and Certified to meet |
|---|---|---|
| Ballot Styles | 4,000 | 3,000 |
| Candidate Positions | 10,000 | 10,000 |
| Contests | 7,000 | 1,000 |
| Precincts | 1,350 | 1,000 |

**Election Systems & Software (ES&S)**

|  | Allegheny County Requirements | EAC Tested and Certified to meet |
|---|---|---|
| Ballot Styles | 4,000 | 15,000 |
| Candidate Positions | 10,000 | 10,000 |
| Contests | 7,000 | 10,000 |
| Precincts | 1,350 | 9,900 |

Hart InterCivic

|  | Allegheny County Requirements | EAC Tested and Certified to meet |
|---|---|---|
| Ballot Styles | 4,000 | Unknown* |
| Candidate Positions | 10,000 | 5,000 |
| Contests | 7,000 | 2,000 |
| Precincts | 1,350 | 3,000 |

*Limits stated in terms of parties, languages, and precincts.