



The
Elections
Group

Pre-Election Testing of Election Systems

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The Purpose of Testing

Technology has redefined what it means to “test” before an election due to the introduction of a variety of technological components used by election officials.

Before the advent of some of these technological advances, election officials primarily focused their testing on the equipment used to cast a ballot and tabulate voted ballots. This testing became known as logic and accuracy testing, LAT, or L&A.

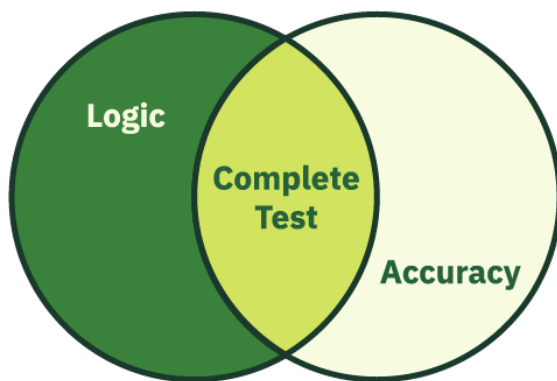
Why is it called logic and accuracy testing?

Logic testing....

ensures that a vote cast for a particular candidate or option is correctly recorded and tallied for that candidate or option. In other words, a voter’s selection for Candidate 1 is tabulated as a vote for Candidate 1, while a voter’s selection for Candidate 2 is tabulated as a vote for Candidate 2.

Accuracy testing...

verifies that the voting system accurately counts votes. The system is tested by feeding it a known set of inputs (such as a predetermined set of votes) and then checking that the outputs (the vote counts) match the expected results exactly.



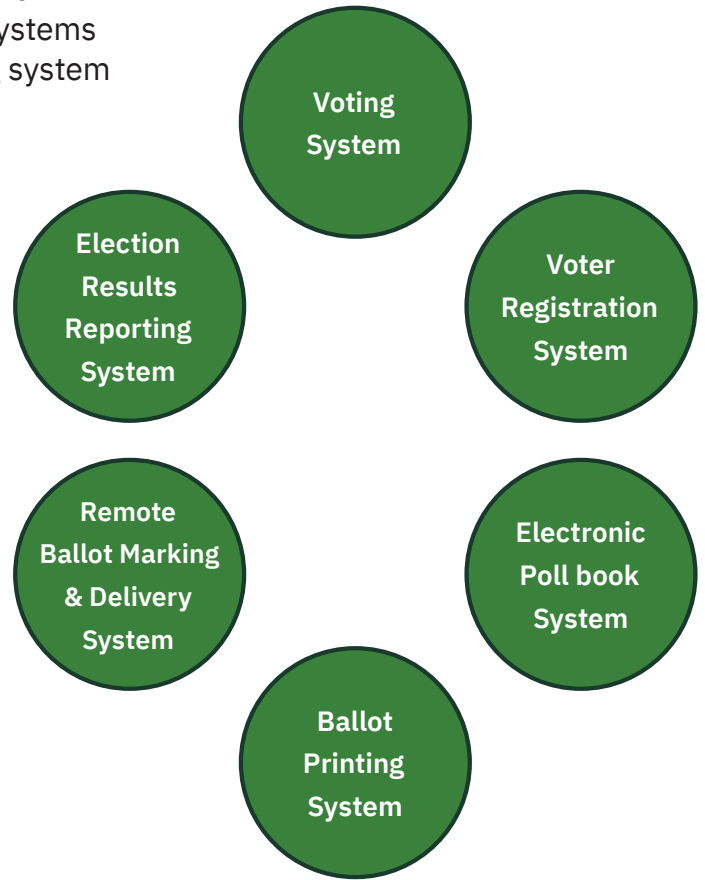
Today, pre-election testing is more involved because it has expanded beyond just the voting system and equipment to other systems.

Consider Your Systems

Start by identifying what you use to conduct an election. Below is a list of standard systems used by election officials today. Please note that some of these systems may be combined. For example, a ballot printing system may be a part of the voting system.

Here is a non-exhaustive list of the systems that election officials utilize:

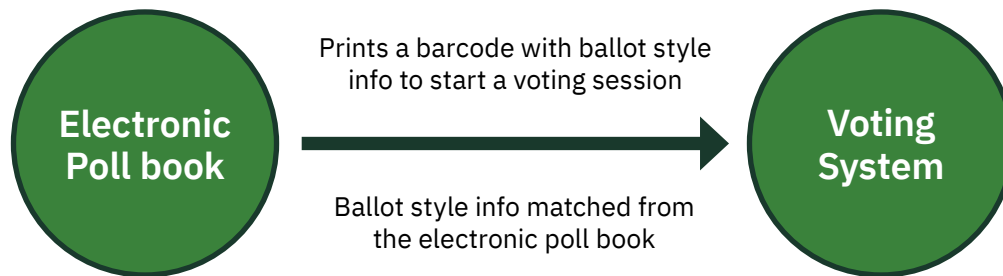
- A **voting system** which may include:
 - Ballot scanners
 - Ballot marking devices
 - Tabulation and adjudication computers
- A **voter registration system**, which includes exports that are imported into other systems, imports from other systems, and may include:
 - Mail/absentee ballot tracking
 - Signature verification for mail/absentee ballots
 - Petition processing
 - Candidate filing
 - Voting history
- An **electronic poll book system**, which may include the following components or peripheral functions:
 - Access card programming
 - Communication network used to sync or transmit information between individual poll book terminals and between the poll book terminals and the elections office
- A **ballot printing system**
- A **remote ballot marking and delivery system**
- An **election results reporting system**



There are, of course, other systems an elections office will use. The key is to understand what systems are in place and how one system may rely on information or data from another to work properly. This leads us to system interoperability.

Understanding System Interoperability

Once you have identified the systems, determine how each system relates to other systems. Interoperability is used to describe the relationship between the systems and the correlation some systems have to one another.



Consider the function of an electronic poll book and the voting system.

Electronic Poll Book

Electronic poll books may be capable of performing the following functions:

- Records voter check-ins.
- Prints a barcode or receipt with ballot style information that corresponds to the ballot the voter must receive.
- Programs an access card that the voter uses to initiate a voting session on ballot marking devices.
- Contains a security code to program access cards that match security codes from the voting system.
- Enables poll workers to make updates to voter registration records for jurisdictions that use same day registration

Voting System

Likewise, a voting system requires the ballot style information in the voting system to match the ballot style information associated with each voter record.

The functions of the electronic poll book listed above contain items that are dependent on data or information from the voting system. Therefore, it is crucial to conduct a comprehensive and thorough test of the voting system's information as imported into or used by the electronic poll books.

System interoperability must be considered in the testing planning process. Often, one system needs to be ready and tested before another is programmed.

For example, a remote (or accessible) ballot delivery system typically relies upon artifacts from the voting system to create the ballot. Therefore, before the remote ballot system can be programmed, the voting system must be tested and finalized. If this is not done, the process would be inefficient and costly in terms of time and human resources.



Consider This

A jurisdiction programs their electronic poll books for a general election. The electronic poll book prints a barcode on a ballot card which is then inserted into the ballot marking device. The ballot style information generated in the barcode must correspond to the voter's ballot.

While some testing was conducted, a slight error in the mapping of the ballot style information caused most of the voters in the jurisdiction to get the wrong ballot. For example, a voter in precinct 8, split 1, receives the ballot for precinct 7, split 2. This caused some disruption and issues on Election Day for the election administrators, poll workers, and voters.

Testing each ballot style by printing a barcode on the electronic poll book for each ballot style may have alerted administrators to the error.

The Importance of End-to-End Testing

Equally important as interoperability testing is end-to-end testing. This related testing practice is illustrated below using the voting system testing as an example.

1. Program and create election definition files
2. Load memory devices with election definition files
3. Conduct testing using test deck and test script
 - Ballot scanners
 - Ballot marking devices
 - Other equipment
4. Examine and ensure accuracy of results
5. Remove memory devices and import the results into the EMS (or transfer results to EMS)
6. Perform necessary adjudication to ensure proper function
7. Review compiled test results from all equipment
 - Export results to election night reporting program, if used
 - Verify accuracy of the imported results in the election night reporting system.
 - Load memory devices and clear results
8. Lock and seal the necessary compartments and doors on all voting equipment
9. Record seal numbers on chain of custody documentation

While the list above is a high-level overview of the steps involved in testing the voting system, it shows the various areas where comprehensive testing may bring some errors to light at a time when it is more convenient to fix them, rather than while live voting is occurring. End-to-end testing, if thoroughly conducted, does not take anything for granted. The interoperability between the voting system and the election night reporting system, for example, are tested to ensure accuracy of the reported results. Likewise, testing of the various components of the voting system itself, such as the testing of the adjudication component, are performed.

When designing the plan and process for testing, ensure a comprehensive, end-to-end test is performed.

Develop a Testing Process Timeline and Plan

Since testing involves more than just the voting system, election officials need to plan sufficient time and human resources to accomplish these testing tasks.

Timelining the Tests

Below is an example timeline to serve as a guide for planning purposes:

Some dates may require adjustments to align with state and jurisdiction laws/policies.



Once you have established the testing dates, be sure to add contingency time frames in the event further testing is required.

As the timeline is created, here are some things to keep in mind:

- Once you have established the testing dates, be sure to add contingency time frames in the event further testing is required.
- Each system used in the live environment must undergo testing before it is used. For example, if the electronic poll book is used in the early voting process, you must test the system and the units utilized.

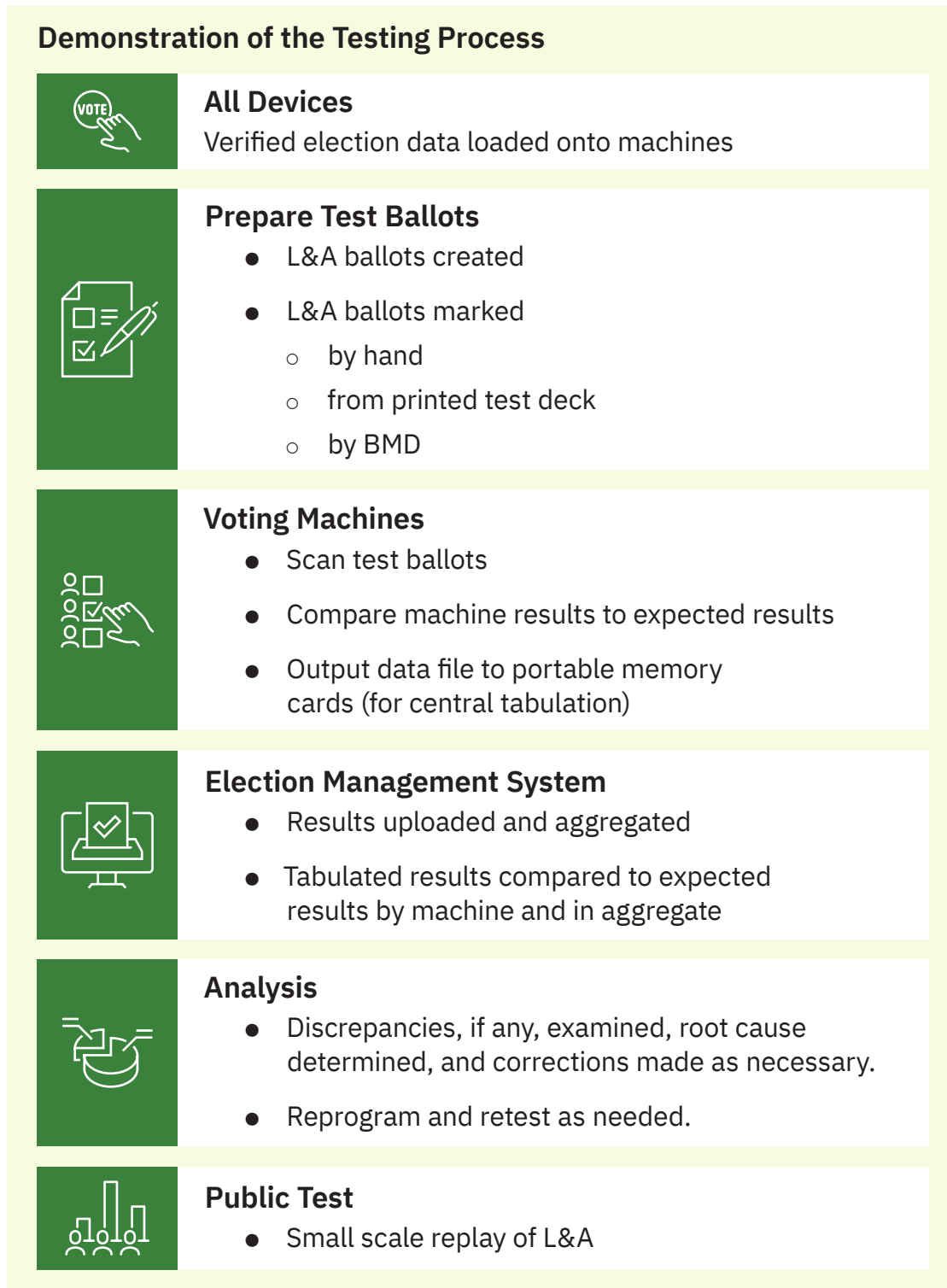


Important Reminder

Equipment re-testing is required when the election definition file is changed or a programming adjustment is made to the logic of any system.

Establishing the Plan

Developing a testing plan for every system does not have to be difficult. Consider the testing of your voting system itself. Below is a diagram that outlines the stages involved after the election definition and setup of the ballot management system is complete and ballots are proofed.



Gathering Materials for Testing

One crucial step is identifying all the materials necessary for the testing. This helps to stay on track and conduct the testing without interruptions in a timely manner.

Here is an example of what to get ready for testing:

<input type="checkbox"/>	Create or update the testing checklist
<input type="checkbox"/>	Activation for ballot cards or smart-card activation <ul style="list-style-type: none"><input type="checkbox"/> Cards should be activated in election day mode, testing any relevant equipment (electronic poll books with activation devices; printer to print barcode) to prove the logic
<input type="checkbox"/>	Necessary memory cards (i.e., portable data storage media used to prepare BMDs and other devices)
<input type="checkbox"/>	Ballots and ballot stock <ul style="list-style-type: none"><input type="checkbox"/> Pre-printed but unmarked ballots and blank ballot stock (i.e., for ballot on demand)<input type="checkbox"/> Pre-marked test ballots
<input type="checkbox"/>	Test scripts for marking ballots (i.e., how to prepare ballots to create the expected pattern and all possible error conditions.) <ul style="list-style-type: none"><input type="checkbox"/> For pre-printed test ballots<input type="checkbox"/> For marking test ballots<input type="checkbox"/> For BMD/accessible device
<input type="checkbox"/>	Pens (various colors as well as various ink types)
<input type="checkbox"/>	Expected test results
<input type="checkbox"/>	Keys, locks, tamper-evident seals

While the list above applies primarily to voting system testing, a similar list can also be created for other systems, for example, testing electronic poll books would require looking up specific records. Staff must be assigned to provide the necessary documents or records for testing.

Starting the Testing

Once the systems are programmed and ready for testing, it is important to start small. Early on in the process, when what is considered a final version of the software is available for testing, test on only a few equipment units. Take for example, the voting system.

Once the election definition file is deemed ready for testing, do the following:

- 1 Load the election file (.pdf) into the ballot printing system
- 2 Print a small test deck of 3-10 precincts or ballot styles
- 3 Hand mark the ballots using a test script
- 4 Load the election definition file to the scanners and ballot marking devices
- 5 Run zero reports and review the information on the report for accuracy
- 6 Scan the test deck through both the central count and precinct-based scanners
- 7 Perform a test using the test script on a ballot marking device
- 8 Print reports on each unit tested
- 9 Close the units and remove the memory devices
- 10 Process the memory devices in the election management system
- 11 Verify that other election management system components, such as ballot replication and adjudication applications, are working correctly
- 12 Print and review the reports from the election management system
- 13 Verify the accuracy of reports against the test deck results

This “small” test will allow you to make adjustments prior to loading and testing **all** of the units. If a mistake is found after all that testing is done, a change would require retesting all the units and a reinvestment of precious time and human resources.

Once the initial testing is complete, the rest of the units, including any standby or spare units, must be tested.

As you get ready for testing, here are some important considerations:

- Schedule testing well in advance and allow ample time for interoperability testing and end-to-end testing
- Develop a plan and process for testing
- Train the staff involved in testing
- Utilize a checklist and require sign-offs in the process



Recap

Here are some important reminders:

- Schedule testing well in advance and allow ample time for interoperability testing and end-to-end testing
- Develop a plan and process for testing
- Train the staff involved in testing
- Utilize a checklist and require sign-offs in the process

Securing the Equipment

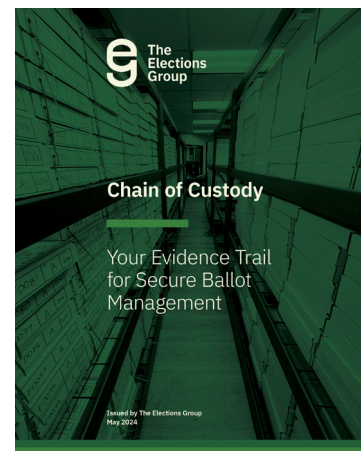
The conclusion of testing marks the last time the units are “touched” before they are used for the upcoming election. Therefore, part of the testing process is securing the equipment units by locking and sealing. This is also the time to perform final checks to ensure all supplies, such as extra paper rolls, extension cords, and other items deemed necessary for proper equipment functioning throughout the day, are included in the transport cases or bags.

The securing process should be incorporated into the testing checklist as a best practice.

Documentation of security seal numbers and other identifying information related to the security of the equipment units will be performed at this time. Provide clear instructions to staff to ensure this crucial step is performed efficiently and accurately. Direct supervision and double-checks should be performed to ensure this information is recorded and the steps are performed.

Ultimately, this information will be transferred to custody logs used during transportation. Please review *our Chain of Custody Guide: Your Evidence Trail for Secure Ballot Management* for more information.

Below is an example checklist of what securing the equipment may look like. When performing these steps, remember to follow the vendor guidelines and recommendations, as well as state and jurisdictional laws and policies.



Final Thoughts

Control the Environment

Testing must take place in a secured environment where access is limited and controlled. Individual staff involved in the testing process must be properly trained and must be trusted to protect and secure the equipment tested. The area of the facility used must be a location that is locked and ideally under surveillance to monitor the activities of staff. The process must be done in plain view so that any cameras are able to clearly record staff actions. As a best practice, review the surveillance footage at the conclusion of the test.

It is also important to assign someone to supervise and “be in charge” of the process. This person will ensure that checklists are utilized, that staff have answers to questions that arise, and ensure that the process is carried out properly. This individual will also ensure that tested equipment is properly secured and made ready for use in the “live” election environment.

Utilize public-facing handouts

Our template for a public-facing handout is a helpful guide to clearly communicate the purpose and process of Logic and Accuracy Testing.



Pre-Election Ballot and Equipment Testing

Before every election, bipartisan teams perform tests to ensure that ballots are free of errors and that all voting equipment is working properly. Election officials call this procedure “Logic and Accuracy” testing or “L&A” for short. Members of the public are welcome to watch.

Why is it called “Logic and Accuracy” testing?

The name is a holdover from our voting past. When lever-style voting machines were introduced in the late 19th century, officials tested them for accuracy. The levers pulled in the voting booth had to accurately reflect voters’ choices. In the 1960s, when computer-based voting systems arrived, officials added tests to verify the computer logic or, in other words, to verify that the computer hardware and software were operating as expected. The votes tabulated by the computer-based system had to accurately reflect voters’ choices. Today, “Logic and Accuracy” and “L&A” are old school terms that election officials use to describe pre-election ballot and equipment testing.

How does pre-election ballot and equipment testing work?

Before the ballots and voting equipment are tested, ballots are proofed or carefully reviewed using best practices to check candidate names, political party affiliations, jurisdictions, ballot styles and language. Once ballots are proofed, they are ready for testing along with every single piece of voting equipment to ensure that voters’ selections are recorded accurately. Every device has its own testing requirements and will not be used for the election unless it passes the test.



Examples

BALLOT MARKING DEVICES Where voters use touchscreen displays or other ballot marking devices to cast ballots, pre-election testing ensures that their printed ballot accurately reflects the choices they make. To test ballot marking devices, officials load ballots so they appear on the screen and check that all races and candidates are listed correctly. Individuals testing the devices make choices on screen that were determined before testing began. Once testers submit their ballots, they are printed and compared to the on-screen choices. Testers repeat this process until a set of test ballots is created, which are later used to test the ballot scanners for that polling place as well as the tabulation system. If choices made on-screen match the choices on the printed ballot, the ballot marking device passes its pre-election equipment test.

BALLOT SCANNERS Scanners located at polling places for each precinct and central count scanners are tested for accuracy before every election. Testers insert the test ballots created during the ballot marking device or touchscreen testing into the scanners. Testing ensures that the ballot paper is the correct size and thickness. It also ensures that every ballot style available to voters in a precinct can be counted by the scanner. Any test ballots with errors, such as smudges, marks in the margins, tear and overvoted races, are removed from the stack and set aside for review and replication by officials to ensure all ballots are counted. If the results collected and totaled using the scanners match the choices on the paper ballots scanned, the scanners pass their pre-election equipment test.

TABULATION SYSTEMS This system tallies votes marked on paper ballots and scanned using different scanners. It is tested by collecting and adding together results from each scanner. Each scanner has a removable media, such as a flash drive, that is used to load the results into the central tabulation system. The tabulation system adds the results from all the other scanners together. The tabulation system results are compared combined with the expected results. If the totals match, the tabulation system passes its pre-election equipment test.

ELECTION NIGHT REPORTING SYSTEM While it is not part of the voting system, this system is part of pre-election testing because it is used to display election results to the public on the internet. Officials use this system to show vote totals as precincts report them throughout the night; results are not official until the election is certified. To test the reporting system, officials transfer results data from the tabulation system on a secure memory device, then load it onto a separate computer. If the results displayed match the expected results from the tabulation system, the election night reporting system passes its pre-election test.

Vocabulary

OVERVOTE If a voter marks more than the allowed number of choices on their ballot for a particular race, it is an overvote. Overvoting is not permitted, so the choices in that race are not counted, but all other choices on the ballot that are not overvotes are counted. Example: A voter who votes for two candidates in a race when the instructions permit only one vote has overvoted, and that ballot cannot be counted for the overvoted race.

RACE OR CONTEST These terms are used to describe a section of the ballot where individual candidates are listed together because they are running for the same office or seat. Example: The candidates running against each other for president are listed together on the ballot as part of that race or contest.

OUTSTACKED When a ballot is outstacked, it is removed from the stack of ballots and reviewed by officials. A ballot may be outstacked if it is torn, smudged or has marks in the margins, which could affect scanning. To ensure the votes are counted, bipartisan officials copy the choices made on the outstacked ballot onto a blank ballot and then return it to the stack of ballots to be scanned. This ensures that the votes cast on that ballot are counted.

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