New York State Board of Elections Voting System Verification Testing

Clear Ballot ClearVote 2.4
Master Test Report v4.0

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Revision History

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June 9th, 2023	2.0	M. Santos	Updated for NYSTEC comments
June 16th, 2023	3.0	M. Santos	Updated table 4
June 26th, 2023	4.0	M. Santos	Updated for discrepancy resolution

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1   INTRODUCTION

1.1   Project Overview

The New York State Board of Elections (NYSBOE) requires that before any voting system may be eligible to be purchased in New York State (NYS), it must be certified by the NYSBOE that such system(s) meet the requirements of the NYS Election Law, Section 6209 of Subtitle V of Title 9 of the Official Compilation of Codes, Rules and Regulations of the State of New York, and the federal 2005 Voluntary Voting System Guidelines (VVSG), Volumes 1 and 2.

SLI Compliance has been engaged by the NYSBOE to provide verification testing services to support the process of voting system certification by the NYSBOE.

1.2   Purpose

The purpose of this Final Master Test Report (defined as Deliverable 10: Final Master Test Report) is to create documentation of the testing that SLI Compliance, as NYSBOE's Independent Test Authority (ITA), performed throughout the course of voting system verification testing.

1.3   References

The following key documents were used in preparing this test plan.

1. SLI VSTL Quality System Manual, v 3.0, February 13, 2019.
2. Voluntary Voting System Guidelines (2005 VVSG)
3. NYS 2022 Election Law
4. NYS 6209 Regulations

1.4   Terms and Abbreviations

The following terms and abbreviations were used throughout this document:

Table 1 – Terms and Abbreviations

Term	Abbreviation	Definition
Ballot Marking Device	BMD	An accessible computer-based voting system that produces a marked ballot (usually paper) that is the result of voter interaction with visual or audio prompts.
Commercial Off the Shelf Software	COTS	Computer software that is ready-made and available for sale, lease, or license to the general public

Term	Abbreviation	Definition
Direct Recording Electronic	DRE	Voting systems that, using Touch Screen or other user interfaces, directly record the voter's selections in each race or contest on the ballot in electronic form.
Election Assistance Commission	EAC	An independent, bipartisan commission created by the Help America Vote Act (HAVA) of 2002 that operates the federal government's voting system certification program.
Election Management System	EMS	Typically, a database management system used to enter jurisdiction information (district, precincts, languages, etc.) as well as election specific information (races, candidates, voter groups (parties), etc.). In addition, the EMS is also used to layout the ballots, download the election data to the voting devices, upload the results and produce the final results reports.
Functional Configuration Audit	FCA	The testing activities associated with the Functional testing of the system
Independent Test Authority	ITA	This is a test lab that is not connected with the vendor or manufacturer of the voting system.
Institute of Electrical and Electronics Engineers	IEEE	A non-profit organization, IEEE is the world's leading professional association for the advancement of technology.
National Institute of Standards and Technology	NIST	NIST is a non-regulatory federal agency within the U.S. Dept. of Commerce. Its mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life.
National Voluntary Laboratory Accreditation Program	NVLAP	A division of NIST that provides third-party accreditation to testing and calibration laboratories.
New York State	NYS	Acronym for the State of New York
New York State Board Of Elections	NYSBOE	The New York State Board of Elections is a bipartisan agency vested with the responsibility for administration and enforcement of all laws relating to elections in New York State.
New York State Technology Enterprise Corporation	NYSTEC	NYSTEC is a private, not-for-profit engineering company with offices in the state of New York. It acts as a trusted technology advisor to government agencies and private institutions.

Term	Abbreviation	Definition
Physical Configuration Audit	PCA	The testing activities associated with the physical aspects of the system (hardware, documentation, builds, source code, etc.)
Request For Information (form)	RFI	A form used by testing laboratories to request, from the NYSBOE, interpretation of a technical issue related to testing of voting systems.
Requirements Matrix	N/A	This is the matrix created by and maintained by SLI Compliance that traces the requirements to the various test cases, test steps, and test methods.
Technical Data Package	TDP	This is the data package that is supplied by the vendor and includes: Functional Requirements, Specifications, End-user documentation, Procedures, System Overview, Configuration Management Plan, Quality Assurance Program, and manuals for each of the required hardware, software, firmware components of each voting system.
Voluntary Voting Systems Guidelines Volumes 1 & 2	VVSG	A set of specifications and requirements against which voting systems can be tested to determine if the systems provide all of the basic functionality, accessibility and security capabilities required of these systems.
Voting System Test Lab	VSTL	This is a designation for a test lab that is accredited by the Election Assistance Commission.
Voting System Under Test	VSUT	The designation for a voting system that is currently being tested.

1.5 Scope of Testing

SLI Compliance provided verification testing on the ClearVote 2.4 system identified by the NYSBOE based on the guidelines and test approach established for voting system verification testing as defined by the NYSBOE (please see section 1.6 – Approved Project Testing Approach).

This effort included the testing required to demonstrate testing of ClearVote 2.4 against all the applicable requirements of the 2005 VVSG and NYS laws and regulations, as specified in the project Requirements matrix (Attachment A – NYS Clear Ballot ClearVote 2.4 System Requirements Matrix w Test Cases).

For the voting system identified for verification, Voting System Specific Test Reports (defined as Deliverable 9: Voting System Specific Test Reports) were developed by SLI Compliance to address the areas of Source Code Review, Security Source Code Review, Functional Testing and Security Functional Testing.

1.6 Approved Project Testing Approach

Per the testing approach approved for the Clear Ballot ClearVote 2.4 project, by NYSBOE (see "Attachment B - SLI Testing Approach for Clear Ballot ClearVote 2.4 - Finalized 12132022"), the following details dictated the approach of the project:
"

Based on review/approval by NYSBOE/NYSTEC:

- All previous EAC source code review to VVSG requirements will be accepted as a first round of review.
- All previous EAC functional testing to SHALL VVSG requirements will be accepted and leveraged.
- All previous EAC security testing to SHALL VVSG requirements will be accepted and leveraged.
- All previous EAC hardware testing to SHALL VVSG requirements will be accepted and leveraged.

A secondary source code review to VVSG requirements will be conducted by SLI Compliance.

- A 10% sample review will be conducted against all VVSG SCR requirements and will include:
  - o a manual review to higher risk VVSG requirements.
  - o a run of automated tool against all applicable VVSG requirements.
- A diff will be conducted and all source code changes not included in EAC certification, will be reviewed at 100%.
- Source code changes will be compared to the Change Notes to attempt to detect unidentified changes.
- A full source code review will be done against NYSBOE requirements.

A trusted build/s will be conducted by SLI Compliance, if needed.

Security testing will be conducted by SLI Compliance to include the following:
- Error messaging and Auditing will be tested against the VVSG
- A full security test will be done against NYSBOE requirements

Functional testing will be conducted by SLI Compliance to include the following:
- An end-to-end test will be conducted to verify the build and to attempt to detect unidentified changes.
- All functional testing of applicable SHOULD VVSG requirements will be tested as SHALL, as needed.
- All functional changes not included in EAC certification, will be tested along with any testing deemed necessary to confirm that the changes didn't affect other areas or cause issues around the changes made.
- Conduct upgrade testing and identify issues found.

Documentation review will be conducted by SLI Compliance to include the following:
- A diff will be conducted and all documentation changes not included in the EAC certification, will be reviewed at 100%.
- Documentation changes will be compared to the Change Notes to attempt to detect unidentified changes.

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1.7 Final Master Test Report Attachments

The following attachment(s) are an integral part of this Final Master Test Report:
- Attachment A – NYS Clear Ballot ClearVote 2.4 System Requirements Matrix w Test Cases
- Attachment B - SLI Testing Approach for Clear Ballot ClearVote 2.4 - Finalized 12132022
- Attachment C – NYS Clear Ballot ClearVote 2.4 Master JIRAs (Confidential)

1.8 Scope of ClearVote 2.4 System

This section provides a description of the scope of ClearVote 2.4 voting system components.

The **ClearVote 2.4** system represents a set of software applications for pre-voting, voting and post-voting election project activities for jurisdictions of various sizes and political division complexities.

ClearDesign EMS functions include:
- o Defining the political divisions of the jurisdiction and organizing the election with its hierarchical structure, attributes, and associations.
- o Defining the election events with their attributes such as the election name, date, and type, as well as contests, candidates, referendum questions, voting locations and their attributes.
- o Producing the election definition and auditing reports.
- o Providing administrative management functions for user, database, networking, and system management.
- o Preparing and producing ballots for polling place and absentee voting or by-mail voting.
- o Preparing media for precinct voting devices and central count devices.
- o Configuring and programming the **ClearMark, ClearCast** and **ClearCount** scanners for marked paper ballots.
- o Import of the Cast Vote Records from **ClearCast** scanners.
- o Preview and validation of the election results.
- o Producing election results tally according to voting variations and election system rules.
- o Producing a variety of reports of the election results in the desired format.

- Publishing of the official election results. Auditing of election results including ballot images and log files.

- **ClearCast** devices are precinct ballot counters (tabulators) that are used in conjunction with an external ballot box. The units are designed to scan marked paper ballots, interpret and record voter marks on the marked paper ballot and deposit the ballots into the secure ballot box.
- The **ClearMark** device is a standalone precinct level Ballot Marking Device (BMD) which also includes an Audio Tactile Interface (ATI), which allows voters who cannot complete a paper ballot to generate a machine-readable and human readable paper ballot, based on vote selections made, using the ATI.
- **ClearCount** is a high-speed, central ballot scanning systems used for high-volume processing of ballots (such as vote by mail). The unit is based on COTS scanning hardware coupled with custom Clear Ballot-developed ballot processing application software which resides on an attached workstation.

Table 3 – Clear Ballot ClearVote 2.4 Custom Software Components

System Component	Application(s)	Version
ClearDesign EMS	Election Management Software and Central Count Location Tabulation and ReportSoftware	2.4
ClearCount	Central count application software	2.4
ClearCast	Scanner Firmware	2.4
ClearMark	BMD Firmware	2.4

Table 4 – Clear Ballot ClearVote 2.4 Custom Hardware Components

System Component	Description
ClearCast	Poll Place Scanner and Tabulator that scans voter selections from both sides of the ballot simultaneously
ClearMark	Standalone precinct level Ballot Marking Device

2 TEST ITEMS AND PASS/FAIL CRITERIA

2.1 Requirements to be Tested

The SLI requirements management tool stores the following:
- Requirements Matrix containing:
  - o 2005 VVSG, Volume 1
  - o 2005 VVSG, Volume 2
  - o NYS 2022 Election Law
  - o NYS 6209 Regulations
- Traceability from Requirements to test cases

2.2 Test Item Pass/Fail Criteria

Testing was conducted as an independent verification and validation across the ClearVote 2.4 system. System performance to pass/fail criteria was measured against expected results for each test case and related set of test procedures as defined by the Requirements Matrix. Each feature passed or failed depending upon the results of the testing performed. If the actual output from an action was equal to the expected output specified by a test case, then the action passed; if not, it failed.

3 TEST TASKS

NYSBOE Verification Testing included detailed testing required to ensure compliance to the approved Requirements Matrix are provided in this section. It should be noted that the results and discrepancy reports for each of the review/assessment and test activities are documented and maintained throughout each activity until the activity has been completed. Upon completion of the verification test engagement, all results are provided in the Clear Ballot ClearVote 2.4 Specific Test Reports and archived with all testing artifacts.

3.1 Physical Configuration Audit

3.1.1 Documentation Review

Clear Ballot ClearVote 2.4 documentation was reviewed as applicable to the approved Test Approach (please see section 1.6 – Approved Project Test Approach) in the delivery of the ClearVote 2.4's New York TDP, as well as all NYSBOE Election Law requirements).

General Documentation Review

As applicable to the approved Test Approach (please see section 1.6 – Approved Project Test Approach), the SLI Compliance test process included conducting a TDP review of the TDP (Technical Data Package).

Clear Ballot ClearVote 2.4 documentation that was included in EAC certifications and State certifications was accepted as meeting all relevant 2005 VVSG requirements, including those requirements in Volume 1, Section 8.7, and 2005 VVSG Volume 2, Section 2 and Section 5.

Security Documentation Review

Clear Ballot ClearVote 2.4 documentation that was included in EAC certifications and State certifications was accepted as meeting all relevant 2005 VVSG Security requirements.

The documentation review process consisted of an automated search through all documents followed by manual review.
A string search utility was leveraged in a custom script written to scan all documents and report a list of findings based on a preconfigured wordlist.
A copy of the script source code, all wordlists used, and the resulting artifacts generated are included in the associated testing artifacts.
Following the generation of a comma-separated value (CSV) document during the automated script's execution, a manual review was conducted to evaluate the results and verify all documentation-related requirements are sufficiently met.
For additional information, please review the Security Test Report and artifacts.
No documentation discrepancies were noted.

3.1.2 Source Code Review

ClearVote 2.4 source code was accepted for all applicable 2005 VVSG requirements, as per the "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.
A review to NYS 2022 Election Law and 6209 Regulations was performed. See "NYSBOE Clear Ballot ClearVote 2.4 Source Code Review Test Report" and "NYSBOE Clear Ballot ClearVote 2.4 Security Source Code Review Test Report" for additional details.
Discrepancies found during testing may be found in ""NYSBOE Clear Ballot ClearVote 2.4 Source Code Review Test Report"" "Attachment D - Source Code Review Discrepancy Review Forms (Confidential)":

3.1.3 Trusted Build

One Trusted Build was performed during this certification examination.

3.1.4 Software and Hardware Configuration Audit

The Software and Hardware Audit compared the voting system components (hardware and software) to the TDP submitted by Clear Ballot voting systems.
The provided configurations conformed to Clear Ballot voting systems specifications of the system under test, including TDP documentation, and was consistent with configurations listed within the ClearVote 2.4 EAC certification.

3.2 Functional Configuration Audit

3.2.1 Review of Prior ITA Test Cases and Results

No prior verification testing completed by previous NYSBOE ITAs was submitted for review.

3.2.2 Review of EAC Certifications

SLI Compliance accepted and leveraged all prior verification testing completed by previous EAC certifications, as per the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.

3.2.3 Review of Other State Verification Testing or Risk Analysis Results

No State certification reports for the ClearVote 2.4 voting system test were submitted for review and accepted.

3.2.4 Review of Prior Hardware Environmental Testing

Hardware environmental testing completed by NVLAP or A2LA accredited test labs, within an EAC certification, for overall system capabilities, voting, and post-voting functions as well as adherence to hardware environmental and EMC standards was accepted as per the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.

3.2.5 Hardware Environmental Testing

All hardware environmental testing completed against the EAC 2005 VVSG hardware environmental and EMC test requirements, within EAC certifications, was accepted, as per the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.

3.2.6 Module Testing

SLI Compliance designed module test cases to provide coverage of the applicable requirements, as per the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.

3.2.7 System Testing

System Testing involved exercising the specific functions of ClearVote 2.4 to the requirements, as per the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.
Formal Test Execution was performed, within the provided environment of the ClearVote 2.4 system, to verify all modifications and pertinent requirements, as defined in "Attachment A – NYS Clear Ballot ClearVote 2.4 System Requirements Matrix w Test Cases.
This includes validation of the voting system in a true end-user environment, following all pre-election day, election day, and post-election day voting rules and processes. The intent is to provide verification that a system can be used to perform its job following the

exact set of processes and steps that would be used by the target customer or end-user.

The following types of system testing were not employed for ClearVote 2.4, as they were covered by EAC certification testing:

- Nominal Conditions
- Failure Injection
- Data Driven
- Usability

- Data Referential Integrity
- Regression
- Volume Test
- Stress Tests

- Accessibility Test
- Performance Tests
- Recovery

Regression Testing

No Regression testing was performed, as no new Trusted Builds were performed during the ClearVote 2.4 examination, after the initial Trusted Build.

Formal Functional Test Execution

SLI Compliance performed the Formal Functional Test Execution testing which included functional, NY Law verification applicable to the scope of the campaign, as per the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document and "Attachment A – NYS Clear Ballot D-Suite 5.16 Requirements Matrix w Test Cases". This is the formal functional test of the system to ensure that all Clear Ballot voting systems modifications work, and existing features work as expected.
See "NYSBOE Clear Ballot ClearVote 2.4 Functional Test Report" for details of functional testing performed.

End to End

End to End testing was performed, utilizing General and Primary elections during the NYS ClearVote 2.4 examination, which encompassed system utilization from creating an election definition, preparing election media and artifacts, opening of polls, processing ballots, as well as the accumulation, adjudication, tallying and reporting of results.

3.2.8 Security Testing

SLI Compliance performed the Security testing applicable to the scope of the campaign, as per "Attachment A – NYS Clear Ballot D-Suite 5.16 Requirements Matrix w Test Cases" and the NYSBOE "Attachment B - Testing Approach for Clear Ballot ClearVote 2.4" document.
See "NYSBOE Clear Ballot ClearVote 2.4 Security Functional Test Report" for details of Security functional testing performed.

The following types of Security testing for ClearVote 2.4, utilized a combination of leveraging EAC certification testing in conjunction with SLI examination as per the approved testing approach (see section 1.6). Portions covered by SLI are listed below:
- Role
    - (Was examined as a part of the "Access" section of the penetration test, which included investigation Role-based access controls (RBAC))

- Access
    - o (Was examined as a part of the "Access" section of the penetration test, which included a review of physical security)
- System Security
    - o (Was examined to verify executable resilience against tampering as a part of the "Privilege Escalation" section of the penetration test)
- System Log
    - o (Was examined as a part of the "Defense Evasion" section of the penetration test to verify file integrity)
- Audit Records
    - o (Was examined as a part of the "Defense Evasion" section of the penetration test, which included tampering with logging processes)
- Software Security
    - o (Was examined to verify that software files could not be modified and that unauthorized software was prevented from being installed on devices as a part of the "Execution" section of the penetration test)
- Threat Protection
    - o (Was examined as a part of the "Execution" section of the penetration test, evaluating the susceptibility to malware)
- Audit Log
    - o (Was examined as a part of the "Defense Evasion" section of the penetration test to modify or delete log files and data)
- Vote Count Integrity
    - o (Was examined within the "Execution", "Exfiltration", and "Cryptography" sections of the penetration test)
- Data Protection
    - o (Was examined within the "Execution", "Exfiltration", and "Cryptography" sections of the penetration test)
- External Access
    - o (Was examined within the "Execution", "Exfiltration", and "Cryptography" sections of the penetration test)

3.2.9 Review for Known Vulnerabilities

Any known vulnerabilities provided by Clear Ballot Voting Systems are included in the Security testing process. All vulnerabilities are listed within the Security test report and associated attachments, including detailed vulnerability information and review of the potential for exploitation. For additional information, please review the "NYSBOE Clear Ballot ClearVote 2.4 Security Functional Test Report".

4 Conclusion

This section summarizes the conclusions for each of the areas of examination within this project.

This section details issues that were encountered during the project, listing the issues as "JIRA"s, where JIRA is the discrepancy tracking application utilized by SLI Compliance.

By the conclusion of this project, all issues, except for one, were resolved after delivery of updates or by consultation with the NYSBOE.

All specific details for each area can be found in the that areas specific test report and accompanying documentation.

4.1 TDP Review

SLI Compliance reviewed the ClearVote 2.4 TDP against the New York State Requirements and 6209 Election Law. During the course of review, SLI Compliance found 11 documentation issues during this documentation review. These requirement issues were documented in JIRA; CV24-1, CV24-2, CV24-3, CV24-4, CV24-5, CV24-6, CV24-7, CV24-8, CV24-9, CV24-10, CV24-48, CV24-64.

All issues were resolved with the submission of modified documentation.

All issues discovered during testing have been addressed and all Jira's marked as resolved.
No open issues remain for this area of review.

Additional TDP Review details can be found in the "TDP Review for Clear Ballot ClearVote 2.4" and accompanying documentation.

4.2 Clear Ballot Voting Systems Functional Testing

SLI has completed functional testing of the **Clear Ballot ClearVote 2.4** system against the referenced 2005 VVSG and NY 2022 Election Law requirements. There were thirteen findings, JIRAs: CV24-16, CV24-19, CV24-20, CV24-21, CV24-23, CV24-25, CV24-33. CV24-34, CV24-37, CV24-44, CV24-49, CV24-50, CV24-51, CV24-52, CV24-57, CV24-59, CV24-60, CV24-61, CV24-62, CV24-63.

All Functional Jira issues have been resolved.

Additional Functional Testing details can be found in the "NYSBOE Clear Ballot ClearVote 2.4 Functional Test Report", Attachment C – NYS Clear Ballot ClearVote 2.4 Functional JIRAs (Confidential) and accompanying documentation.

4.3 Hardware Testing

SLI has completed Hardware testing of the **Clear Ballot ClearVote 2.4 system** against the referenced 2005 VVSG and NY 2022 Election Law requirements, as per "SLI Testing Approach for Clear Ballot ClearVote 2.4".

All components of the ClearVote 2.4 system had all hardware requirements accepted from EAC certifications.

There are no open issues for this area of review.

4.4 Source Code Review

SLI has completed the source code review of the **Clear Ballot ClearVote 2.4 system** against the referenced 2005 VVSG, Clear Ballot Voting Systems declared standards and NY 2022 Election Law requirements, as per "SLI Testing Approach for Clear Ballot ClearVote 2.4".

No modified source code was found that could not be attributed to a listed modification. No discrepancies were noted.

Additional Source Code Review details can be found in the "NYSBOE Clear Ballot ClearVote 2.4 Source Code Review Test Report" and accompanying documentation.

4.5 Security Source Code Review

SLI has completed the security source code review of the **Clear Ballot ClearVote 2.4** system against the referenced NY Election law, security concerns, and potential vulnerabilities. All findings resulting from the security source code review are included in this report and accompanying documentation.

Review of the findings resulted in determinations of potential vulnerabilities found. Manual review of those potential vulnerabilities determined these potential vulnerabilities would be exploitable only by a vendor insider attack.

No open issues remain for this area of review.

Additional Security Source Code Review details can be found in the "NYSBOE Clear Ballot ClearVote 2.4 Security Source Code Review Test Report" and accompanying documentation.

4.6 Security Functional Testing

SLI has completed Security functional testing of the **Clear Ballot ClearVote 2.4** system against the referenced 2005 VVSG and NY 2022 Election Law requirements. All findings are included in this report and accompanying documentation.

Fourteen documentation discrepancies were noted, CV24-18, CV24-22, CV24-27, CV24-28, CV24-29, CV24-30, CV24-35, CV24-41, CV24-42, CV24-43, CV24-53, CV24-54, CV24-56, CV24-58.

All Security documentation issues were resolved with updated documentation.

Ten Functional Discrepancies were noted, CV24-13, CV24-17, CV24-24, CV24-31, CV24-32, CV24-38, CV24-39, CV24-40, CV24-46, CV24-47.

All Security issues have been addressed.

All issues discovered during testing have been addressed and all Jira's marked as resolved.

No open issues remain for this area of review.

Additional detail is included in the "NYSBOE Clear Ballot ClearVote 2.4 Security Functional Test Report", Attachment C - NYS Clear Ballot ClearVote 2.4 Security Jira Issues (CONFIDENTIAL) and accompanying documentation.

End of Master Test Report