ClearVote 1.4 EAC

Quality Assurance Program

ClearVote Quality Assurance Program

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Document history

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Preface

This section defines the purpose of this document. It contains the following subsections.

- About this document
- Scope of this document
- Intended audience

About this document

This document outlines the general quality assurance policies that Clear Ballot follows in producing the ClearVote system. The information corresponds to the *VVSG 2005, Volume 2, Section 2.12* requirements of the Technical Data Package (TDP).

A ClearVote™ system can comprise the ClearAccess™, ClearAudit™, ClearCast™, ClearCount™, and ClearDesign™ products. Jurisdictions are not required to purchase all products. You can ignore references to any ClearVote components that are not part of your voting system. Also ignore implementation options that are not relevant to your policies and procedures.

Scope of this document

This document provides information about the quality assurance program for the ClearVote system.

- Overview
- The ClearVote system
- Hardware
- Integration with EMS
- Test plans

Intended audience

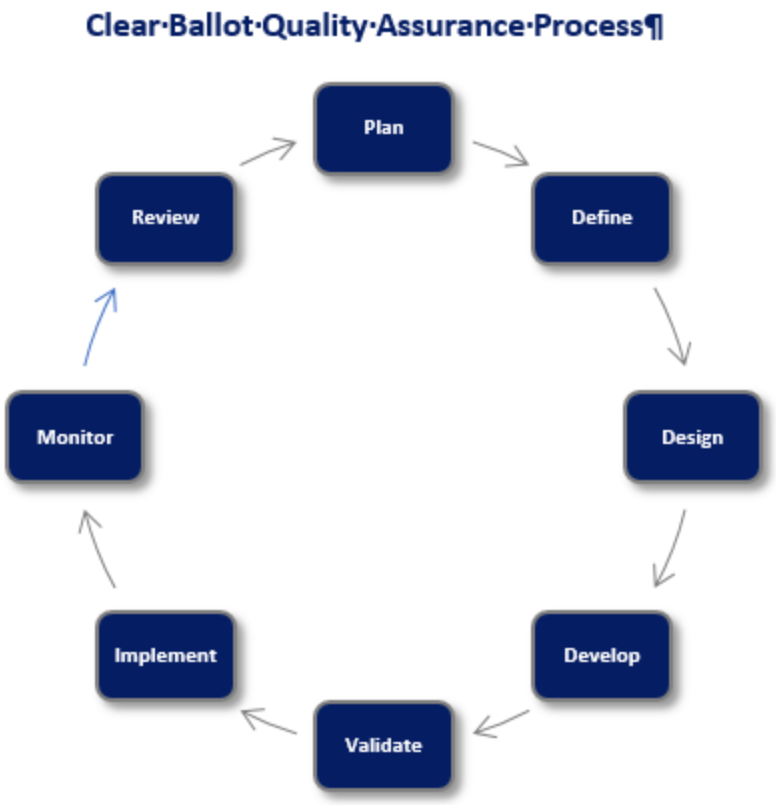
This document is intended for state and federal election officials and their voting system test laboratories as part of the Technical Data Package (TDP) required to certify the ClearVote voting system for use. This document is also used by Clear Ballot personnel who support election officials and election staff.

Chapter 1. Overview

Clear Ballot is committed to delivering reliable high-quality products to its customers in the election industry. The entire Clear Ballot team works together to ensure that it achieves the specified requirements for all ClearVote systems and components. The primary goals of the quality assurance (QA) program are to:

- Maintain best practices throughout the entire product development lifecycle
- Ensure that the hardware, software and testing meet VVSG 1.0 requirements as published by the US Election Assistance Commission (EAC)
- Adhere to requirements regarding development, testing, documentation, submission and distribution
- Verify the performance of each product's components
- Comply with state-level certification requirements

Clear Ballot's approach to quality assurance is a cyclical endeavor that seeks to continually monitor, evaluate and improve the product development processes.



Plan—Clear Ballot senior management meets annually to outline the product roadmap for the upcoming year, and then meets monthly thereafter to review and revise the plan as necessary. The roadmap is a high-level schedule of feature and maintenance releases for Clear Ballot's suite of products.

Define—The Product Management and Engineering teams collaborate to define the scope and detailed requirements of each product release. Requirements definitions rely upon customer and field support feedback, regulatory compliance, company strategy, and market analysis. Weekly meetings ensure that requirements are reviewed and revised as necessary to align with scope and schedule. Additionally, triage meetings occur weekly to ensure that each release includes as many product enhancements and bug fixes as possible.

Design—The Product Management, Engineering, and Quality Assurance teams work together to design and test software, and select and test hardware to meet the defined requirements and provide the best viable solution.

Develop—The Engineering teams create and deliver release candidates that meet the requirements and design specifications.

Validate—The Product Management and Quality Assurance teams evaluate and test the release candidates and hardware to ensure they meet the specified requirements. This is an iterative process until the Product Management team determines that the software and hardware have met the specified requirements and are ready for customer implementation.

Implement—The Customer Support team installs the product on-site with the customers, and conducts end-to-end system testing. Implementation also includes customer training, performance testing, and logic and accuracy testing, as well as customer feedback.

Monitor—The Quality Assurance and Customer Support teams record customer feedback and product issues in the field. Enhancement requests and bugs are logged in the Trac system. Customers can also enter feedback directly into Clear Ballot's customer portal, or via e-mail or telephone. The Customer Support team monitors each customer case to resolution. Weekly triage meetings are held to review product issues, perform root cause analysis, and determine corrective measures. When necessary, the Product Management team issues a field service bulletin to notify customers about product issues and corrective measures.

Review—The Product Management team leads a review of each aspect of the product development lifecycle in search of process improvement opportunities to incorporate into the next release cycle. These opportunities are reviewed with each team and implemented into Clear Ballot's best practices, either via standard operating procedures or the product roadmap.

1.1 Scope of the quality assurance program

The QA program encompasses all aspects of development and testing of Clear Ballot's proprietary software for ballot design, tabulation, accessible voting sessions, and results reporting in conjunction with specific commercial off-the-shelf (COTS) hardware (such as, computers, scanners, printers, routers, external hard drives). It also includes manufacturing oversight and testing of Clear Ballot's ClearCast precinct-voting hardware.

Clear Ballot establishes specific requirements and release criteria for each product's components, and conducts thorough validation testing to ensure conformance. The QA program follows product testing lifecycle best practices in the following areas:

- Requirements analysis
- Test planning
- Test case development
- Environment setup
- Test execution
- Results reporting

1.1.1 Items in scope

The major areas of the QA program at Clear Ballot are as follows:

- The requirements definition, design, and process documentation of the ClearVote software programs
- Determining the specifications that COTS hardware must meet to provide the level of quality (workmanship) and performance necessary for the individual ClearVote products
- The requirements definition, design, and process documentation of the ClearCast hardware
- The requirements and process for integrating other EMS information into the ClearVote system (primarily creating and validating the BDF)
- Validation and verification of the function, performance, and integration of the ClearVote system, which consists of COTS hardware, the ClearDesign election management system (EMS), the ADFs and BDFs created in ClearDesign or adapted from third-party EMS, the ClearAccess accessible voting system, the ClearCast precinct-count system, and the ClearCount tabulation and reporting system

1.1.2 Items out of scope

The following items are out of scope for the Clear Ballot QA program:

- Predelivery tests or maintenance records for third-party hardware
- Development of third-party election management systems
- Hardware development, manufacture, and testing (with the exception of the ClearCast unit)

Information about the hardware manufacturers' quality programs can be found in their documentation.

Chapter 2. The ClearVote system

The ClearVote system includes the following products:

- ClearDesign—Election management system
- ClearAccess—Accessible voting solution
- ClearCast—Precinct voting solution
- ClearCount—Central tabulation, consolidation and reporting

With ClearDesign, Clear Ballot's election management system (EMS), election department staff can design ballots independently and interactively, proof their design (including accessible ballots), lay out and review one or all ballot styles (including HTML-based accessible ballots), generate PDFs for ballot-printing companies and ballot-on-demand printers, and generate the election definition files that program the other components.

ClearAccess is an accessible-voting and ballot-marking application that allows voters with sight or mobility limitations to vote in an unassisted manner. The software runs on a touchscreen computer installed with an accessible keypad and a sip-and-puff device. The voter can make ballot selections by touching the monitor, pressing buttons on the keypad, or using the sip-and-puff device. Ballot selections can be presented on the computer's display, played back over audio headphones, or presented on the screen with audio. After the voter has finished voting, selections are printed to a paper ballot.

ClearCast is ClearBallot's precinct-count optical-scan voting system. The unit quickly scans and tabulates ballots using its integrated Intel® NUC Mini PC. Scanned ballots are securely deposited into a durable, detachable ballot box.

ClearCount is a central-count, paper-based optical-scan system. The ClearCount tabulation system captures voter intent and retains ballot provenance to improve election reporting and administration. Its vote and ballot visualizations allow marginal votes to be identified and corrected by authorized officials without requiring extensive retabulation, providing a higher level of visibility and transparency for reviewing election results.

2.1 Product requirements

The *ClearCount Functionality Description* provides the general functional requirements for the ClearCount system. The VVSG 1.0 requirements in regard to accuracy (Volume 2, Appendix C.5) were also considered when designing and performing stress tests. VVSG 1.0 requirements for security, accuracy, error recovery, and integrity, as described in Volume 1, Section 2.1, were taken into account in all cases.

The *ClearCast Functionality Description* describes the ClearCast system and is responsive to VVSG 1.0.

The *ClearAccess Functionality Description* describes the ClearAccess system and is responsive to VVSG 1.0.

The *ClearDesign Functionality Description* describes the ClearDesign system and is responsive to VVSG 1.0.

2.2 Documentation of quality procedures

General

Clear Ballot's internal ticketing system, Trac, is the system of record for product requirements, functional problems, design issues, enhancement requests, and tasks. (See the *ClearVote Test and Verification Specification* for more information.) Clear Ballot's internal wiki contains information about functional and process standards.

Information from Trac tickets and the wiki are incorporated into the *ClearVote Configuration Management Plan* and additional Technical Data Package (TDP) documents as appropriate. As the *ClearVote Test and Verification Specification* details, this information is also incorporated into test plans and test cases. Each major or minor build undergoes acceptance testing. Bug fixes are verified by QA. The QA staff also performs smoke testing based on which components have changed.

ClearCast

Clear Ballot maintains clearly defined procedures for specifying, procuring, inspecting, accepting, and controlling parts and raw materials for the manufacture and assembly of its ClearCast precinct-count product by its manufacturer, Flex Limited.

These procedures are version-controlled and are stored in a shared repository with the manufacturer. Any changes to the procedures require an engineering change order (ECO), which is a written formal request that must be approved by all pertinent parties at Clear Ballot and Flex. Approved ECOs are time-stamped and stored in the shared repository.

2.3 Quality responsibilities

The director of quality engineering is responsible for the quality assurance program at Clear Ballot. Additionally, the director of product management (under the vice president of engineering), the director of quality assurance, the quality assurance manager, and the quality assurance analysts all assist in the definition and enforcement of quality in the ClearVote products.

2.4 Tests and verification

The *ClearVote Test and Verification Specification* describes test plans (explaining the test approach) and test cases (detailing the test categories) for the ClearVote system.

2.5 Documentation feedback and process review

The assembly of the TDP documentation and corresponding testing and analysis of the ClearVote software identifies areas where the QA program requires review. The director of product management convenes a series of meetings to institute additional levels of feedback and peer review into the QA program. These meetings occur periodically, and updated processes are documented on the Clear Ballot internal wiki, as well in subsequent versions of this document.

Chapter 3. Hardware

As described in the hardware specifications for the individual products, system hardware components, including computers and scanners, undergo extensive validation and verification. Hardware validation and verification follow the same waterfall development process as software development and testing.

3.1 Hardware specification review

All ClearVote hardware components must meet stringent requirements for reliability, ease of use, availability of support, durability, and their ability to meet VVSG 1.0 requirements (for example, operation in specified temperature ranges). Clear Ballot only considers manufacturers that are ISO 9000-certified, such as Intel and Fujitsu. Such manufacturers have established quality assurance and quality control programs that adhere to rigorous industry standards. These programs are fully described in the manufacturers' corporate literature.

Clear Ballot staff reviews the specifications for all proposed hardware and conducts in-depth research with the manufacturer. In addition, certifying different hardware models at different price points is frequently a requirement to meet the needs of jurisdictions of various sizes.

3.1.1 Computer review and requirements

As described in the *ClearVote Approved Parts List*, the requirements for the computers used involve the operating system, CPU, and memory. Different models are therefore selected for the ScanServer and for the ScanStation and election administration station clients. The servers and clients were used in an extended series of in-house and field tests, including a million ballot performance and stress test that exercised each computer for approximately ten hours as it tabulated the card images for 100,000 ballots (ten ScanStations were used in the test).

ClearAccess uses all-in-one form factor computers or tablets. Selection and testing of these computers follows the same process as used with ClearCount computers, with specific ClearDesign and ClearAccess requirements added to the selection considerations.

3.1.2 Scanner review and requirements

For ClearCount tabulation, the major scanner requirements are:

- Scanners must be able to accept all ballot weights.
- Scanners must scan a range of sizes between 8.5" x 5" and 8.5" x 22".
- The scanner must produce acceptable quality images (200 or 300 dpi) as JPEGs for correct analysis by the Tabulator.
- Scanners must simultaneously scan both sides of ballots.
- Scanner settings, such as contrast, must be configurable.

- The scanner software must be able to rename the images when provided with the target card's bar code, and to deposit the scanned images into a designated folder.
- Scanner performance must be acceptable for extended periods of time of continuous use.
- Scanner performance must degrade only slightly (and ideally not at all) when scanning folded ballots. Accuracy of results must not be affected.
- Scanners must have sensitive and accurate capabilities for detecting size and width irregularities, multifeeds, and so on. Recovery must be clear and immediate.

3.1.3 ClearCast review and requirements

Clear Ballot has defined and documented minimal acceptable standards for all ClearCast component parts, including packaging materials. Clear Ballot uses a traditional original equipment manufacturer (OEM)/contract manufacturer relationship for the manufacture of the ClearCast unit. The manufacturer is, by signed agreement, responsible for compliance to Clear Ballot bills of materials, assembly drawings, and methods of construction. Clear Ballot retains responsibility at all times for the bills of materials and assembly drawings, although these are sometimes produced in collaboration with the manufacturer.

Software control is managed according to Clear Ballot's configuration management process. Software builds are exchanged with the manufacturer via a secure server that is password-protected. Software hash values are validated in each unit prior to beginning the production burn-in process, which occurs during test and prior to unit shipment. The manufacturer uses a companion document to the bill of materials, called a software configuration matrix, to maintain and record the proper software load for the ClearCast product. Clear Ballot staff review and sign the matrix prior to the start of a subsequent production run, if the matrix is changed.

Clear Ballot orders parts for the manufacturing process according to the bill of materials, and typically through the contract manufacturer. The manufacturer, Flex Limited, receives the parts; verifies their identity; performs, at minimum, a visual inspection; and inventories the parts. Upon completion of verification testing, parts are then designated for production. The components are assembled into a unit according to established assembly methods. Each unit undergoes documented testing to verify that it complies with performance specifications. Units that do not meet specifications (and any component parts at receiving and on the production line) are removed from the production process and later dispositioned. Flex apprises Clear Ballot of any anomalies to, or failures of, the established specifications.

The production and assembly process is documented in a collaborative effort by Flex and Clear Ballot staff, and is validated by building at least one unit prior to the commencement of actual production. Assembly procedures are reviewed and approved by both Clear Ballot and Flex.

Unit factory testing includes accuracy, performance, and (on selected units, such as the first units in a new revision) reliability testing, as well as visual inspection for compliance to cosmetic specifications. Clear Ballot reviews all inspection and test reports on at least a quarterly basis.

Flex also performs in-process inspection and testing of the ClearCast components to ensure proper fabrication and assembly of the final hardware. The Intel NUC motherboard, AC-to-DC power supply, and UPS board are programmed and tested prior to assembly into a unit.

Finished goods are packaged for delivery to a customer by the manufacturer. Upon receipt of a finished product, the customer performs a physical inspection, followed by acceptance testing. Clear Ballot then conducts preliminary performance testing prior to the customer's first official logic and accuracy testing.

3.1.3.1 ClearCast COTS requirements

The key hardware components that comprise the ClearCast system include the mini PC, the scanner, the touchscreen, and the printer. Each component was selected after extensive research, and incorporated after rigorous and thorough testing.

In particular, the Intel NUC Mini PC was selected for its computing power and memory sufficient to provide reliable tabulation. It also meets the requirement of three ports—two for USB drives and an optional one for keyboard/mouse. In addition, its small footprint is required to fit securely within the ClearCast shell.

3.1.4 Assistive device requirements

In addition to its touchscreen, ClearAccess includes a modifed keypad (with or without braille), a sip-and-puff input device, and optional keyboard and mouse. These devices are selected for compliance with VVSG 1.0 accessibility requirements and cost-effectiveness.

3.1.5 Printer requirements

The ClearAccess system includes an integrated printer for printing voter's marked ballots. QA verifies that ballots generated from ClearAccess are indistinguishable from ballots of nondisabled voters.

The ClearCast system incorporates a tape printer that logs election states and vote tallies.

3.1.6 Router or switch requirements

The router or switch used to connect the components in the closed network of the ClearVote system must be a gigabit router with a minimum of four ports.

3.2 Hardware responsibilities

COTS hardware

The director of product management is responsible for the selection of the COTS hardware, with input and assistance from the chief technology officer and the chief executive officer. A dedicated components engineer researches specifications and sourcing, and evaluates COTS candidates to ensure that VVSG and Clear Ballot requirements are met. Upon selection, COTS equipment is submitted to QA for testing. The QA staff verifies that the hardware meets VVSG 1.0 requirements for ClearVote and jurisdictions.

The components engineer obtains advance notice of end-of-life status for each hardware component, and identifies replacement hardware, as required.

ClearCast hardware

The ClearCast quality manager develops and documents stringent specifications for the ClearCast manufacturing processes and procedures. The director of product management serves as the purchasing and control manager for the ClearCast manufacturing process. He or she works closely with the manufacturer to ensure that each part, component, and finished product adheres to Clear Ballot's defined specifications.

3.3 Future development and COTS integration

Clear Ballot continues to work with Fujitsu and other vendors to ensure functions required for the ClearVote system are included in future scanner models, incorporating them in the scanner configuration software.

Clear Ballot staff is committed to making ClearVote available on the latest models of COTS computers with the latest operating systems. Clear Ballot continues to test (and submit for certification as appropriate) as new versions of Microsoft Windows become available.

Chapter 4. Integration with EMS

ClearDesign is Clear Ballot's complete election management system (EMS) solution. Users can import existing data, such as voter counts, and export data required by ClearCount for tabulation (the BDF and ballot PDFs). The *ClearVote Test and Verification Specification* provides additional information.

The *ClearCount Software Design and Specification* provides information about ballot definition files (BDFs). Content includes election-specific information, such as vendor, ballot size, number of contests, choices per contest, languages on the ballot, and so on.

The *ClearDesign Software Design and Specification* contains information about the contents of the BDF and how it corresponds to the tables in the election database.

4.1 PDF review and creation of the BDF for third-party EMS

The following process does *not* apply to BDFs created through ClearDesign.

The development staff at Clear Ballot is responsible for analyzing the ballot PDFs sent from a jurisdiction and translating them into the zipped BDF file. Each ballot style and precinct must be analyzed, and the contests and choices translated into a set of virtual coordinates required for tabulation.

Additional information, such as ballot size, may be required from the jurisdiction if the information cannot be interpreted from the PDFs.

4.2 BDFs and election creation

A BDF is required for creating an election database that contains tabulated ballot data. If the BDF does not contain all the required tables, the election database is not created. Any test of the system that involves tabulation requires a valid BDF.

4.3 BDF testing and validation

Any given BDF is tested through election creation and tabulation. In addition, some user interface (UI) tests compare the contents of reports to the data in the BDF.

Spot-checking of the ballot or card image content against some of the UI reports, such as the Contests report, serves as a validation that the BDF content is correct.

BDFs created in ClearDesign are compared to ClearDesign election data. PDF reports exported from ClearCount are compared to the ClearDesign web reports and the ClearDesign data.

4.4 Integration responsibilities

The development team at Clear Ballot is responsible for the testing and direct verification of the BDF creation process and the validation of the BDF content.

The QA staff validates the BDFs through election creation and the review of tabulation results and UI reports, including comparison with ClearDesign data where applicable.