Voting Systems Performance and Test Standards: An Overview

This document provides an overview of the Voting System Standards (the "Standards"), developed by the Federal Election Commission (FEC). This overview serves as a companion document for understanding and interpreting both Volume I, the performance provisions of the Standards, and Volume II, the testing specifications.

Background

The program to develop and implement performance and test Standards for electronic voting equipment is over 25 years old. However, national interest in this program has been renewed as a result of the 2000 Presidential election.

In 1975, the National Bureau of Standards (now the National Institute of Standards and Technology) and the Office of the Federal Elections (the Office of Election Administration's predecessor at the General Accounting Office) produced a joint report, *Effective Use of Computing Technology in Vote Tallying*. This report concluded that a basic cause of computer-related election problems was the lack of appropriate technical skills at the state and local level to develop or implement sophisticated Standards against which voting system hardware and software could be tested. A subsequent Congressionally-authorized study produced by the FEC and the National Bureau of Standards cited a significant number of technical and managerial problems affecting the integrity of the vote counting process. The report detailed the need for a federal agency to develop national performance Standards that could be used as a tool by state and local election officials in the testing, certification, and procurement of computer-based voting systems.

In 1984, Congress appropriated funds for the FEC to develop voluntary national Standards for computer-based voting systems. During this developmental period more than 130 participants, including state and local election officials, independent technical experts, election system vendors, Congressional staff, and other interested parties, attended numerous public hearings and reviewed the proposed criteria for the draft Standards. Prior to final issuance, the FEC published the draft Standards in the *Federal Register* and requested that all interested parties submit formal comments. After reviewing all responses and incorporating corrections and suitable suggestions, the FEC formally approved the *Performance and Test Standards for Punchcard, Marksense and Direct Recording Electronic Voting Systems*[1] in January 1990.

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[1] This document is generally referred to as the *Voting Systems Standards.*

The national testing effort is overseen by NASED's Voting Systems Board, which is composed of election officials and independent technical advisors *(see attachment)*.[2] NASED has established a process for vendors to submit their equipment to an Independent Test Authority (ITA) for evaluation against the Standards. To date, Wyle Laboratories, Inc., CIBER, Inc., and SysTest Labs are certified by NASED to serve as program ITAs for the testing of hardware and the examination of software. [3]

Since NASED's testing program was initiated in 1994, more than 30 voting systems or components of voting systems have gone through the NASED testing and qualification process. In addition, many systems have subsequently been certified at the state level using the Standards in conjunction with functional and technical requirements developed by state and local policymakers to address the specific needs of their jurisdictions.

As the qualification process matured and as qualified systems were used in the field, the Voting Systems Board, in consultation with the ITAs, was able to identify certain testing issues that needed to be resolved. Moreover, rapid advancements in information and personal computer technologies have introduced new voting system development and implementation scenarios not contemplated by the 1990 Standards.

In 1997, NASED briefed the FEC on the necessity for continued FEC involvement, citing the importance of keeping the Standards current in its reflection of modern and emerging technologies employed by voting system vendors. Following a Requirements Analysis released in 1999, the Commission authorized the Office of Election Administration to revise the Standards to reflect contemporary needs of the elections community.

Issues Addressed by the Revised Standards

The primary goal of the Standards is to provide a mechanism for state and local election officials to assure the public of the integrity of computer-based election systems; this has remained unchanged since 1990. However, the methods for achieving this goal have broadened over the last decade.

The revised Standards provide a common set of requirements across all voting technologies, using technology-specific requirements only where essential to address the specified technology's impact on voting accuracy, integrity, and reliability. The original Standards classified systems as either Punchcard and Marksense (P&M) or Direct Recording Electronic (DRE) and defined separate Standards for each technology. The new document revises this terminology to specify standards for two separate categories: paper-based voting systems and DRE voting systems.

Paper-based systems encompass both punchcards and optically scanned ballots. Electronic systems include a broad range of DRE systems, such as those that use touch screens and/or keyboards to record votes. In addition, voting systems that use electronic ballots and transmit official vote data from the polling place to another location over a public network are now designated as Public Network DRE Voting Systems and are subject to the standards applicable to other DRE systems, and to requirements specific to systems that use public network telecommunications.

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[2] The FEC's Director of the Office of Election Administration and representatives from IEEE, Wyle Laboratories, SysTest, and Ciber serve as *ex-officio* members.
[3] NASED also continues to encourage other qualified testing facilities to request certification as Independent Test Authorities.

Revised Performance Features

The revised Standards provide new or expanded coverage of the following functional and technical system capabilities:

- **Election Management Functions:** Performance requirements are specified for components that define, develop and maintain election databases; perform election definition and setup functions; format ballots; count votes; consolidate and report results; and maintain audit trails.

- **Feedback to Voter:** Performance requirements are defined for DRE systems and for paper-based precinct-based systems in order to provide direct feedback to the voter that indicates when an undervote or overvote is detected.

- **Accessibility:** Performance requirements are defined for voting systems so that a system can meet the specific needs of voters with disabilities. These requirements were developed by the Access Board, a federal agency responsible for developing accessibility standards. The requirements are based on the accessibility standards for electronic and information technology established in *36 CFR Part 1194 - Electronic and Information Technology Accessibility Standards*, which implement Section 508 of the Rehabilitation Act Amendments of 1998. The requirements provide common standards that must be met by all voting devices claiming accessibility and specific standards related to various types of DRE voting systems.

- **Audit Trails:** Performance requirements for audit trails are strengthened to address the full range of election management functions, including such functions such as ballot definition and election programming.

- **Telecommunications:** Performance requirements are defined for hardware and software components of voting systems that transmit voting-related information using public telecommunications components. These requirements apply to systems where data is carried between devices at a single site, and systems where data is carried between devices in two geographically distinct locations. Systems must be designed to provide the secure transfer of many distinct types of vote data, including lists of eligible voters, voter authentication information, ballot definition information, and vote transmission and tabulation information. Due to the limits of existing technology to prevent unauthorized use of data, the Standards include some blanket prohibitions against the communications or transfer of certain types of data via telecommunications under any circumstances.

- **Broadcasting of Unofficial Results:** Performance requirements are defined for the content and labeling of data provided to the media and other organizations (in reports, data files, or postings to official Web sites) prior to the canvass and certification of election results.

Revised Test Features

The revised Standards also provide a restructured and expanded description of the tests performed by ITAs:

- **Expanded Testing Standards:** Additional tests are defined to address the expanded functional and technical requirements for voting systems.

- **Stages in the Test Process:** The test process is re-defined in terms of pre-testing, testing, and post-testing activities.

- **Distinction Between Initial Tests and Testing of Modifications to Previously Tested Systems:** A voting system remains qualified as long as no modifications are made. Any changes to a system must be submitted to the appropriate ITA. The proper course of action to evaluate the implication of a modification to a system, including the possibility of requiring additional testing, depends on the nature of the changes made by the vendor. Some criteria for determining the scope of testing for modifications are defined in the Standards, but the ITA has full discretion to evaluate this criteria against modifications made to the system.

- **Documentation Submitted by Vendors:** The description of documentation provided by vendors as part of the Technical Data Package (TDP) is refined to support the collection of all information required by the ITAs to conduct the expanded testing.

Revised Organizational Features

The Standards have been reorganized and edited to better suit the needs of different user groups and to improve readability. These changes include:

- **Multiple Volumes:** While the original Standards was published as a single document, the revision is divided into two distinct volumes. *Volume I, Voting System Performance Standards*, provides an introduction to the Standards. It describes the functional and technical requirements for voting systems, and provides a summary of the ITA's testing process. This volume is intended for a general audience including the public, the press, state and local election officials, and prospective vendors, as well as the ITAs and current vendors already familiar with the Standards and the testing process. *Volume II, Voting System Test Standards*, is written specifically for jurisdictions purchasing a new system, vendors, and ITAs. This volume provides details of the test process, including the information to be submitted by the vendor to support testing, the development of test plans by the ITAs for initial system testing, the testing of modifications to the system, the conduct of system qualification tests by the ITAs, and the test reports generated by the ITAs.

- **Standards, Guidelines and Fundamental System Development Techniques:** The revised Standards clearly identify individual elements as mandatory requirements or recommended guidelines. Such requirements are designated in the Standards by the term "shall."The Standards no longer provide descriptions of basic professional system developmental and managerial techniques, which were included in the 1990 version of the Standards. However, they do provide references to common industry practices, and require the vendors to submit documentation of its processes for some topics such as quality assurance and configuration management.

- **Human Interface and Usability Standards:** Recent controversy over the design of the Presidential ballot in certain jurisdictions has highlighted the importance of ballot design and system usability by both election officials and the general public. Human interface and usability issues are addressed in Appendix C to Volume I. This appendix provides guidelines to vendors and election officials to aid in the design and procurement of systems that are easy to use by the general public. Additionally, the FEC has begun the development testable human factors standards that will be incorporated into the Standards upon completion.

- **Inclusion of Selected Test Procedure Details:** Volume II of the Standards specify the procedure for certain hardware tests for voting devices and vote counting devices. However, many tests of hardware and software in a voting system can not be developed without examining the design and configuration of the specific system seeking qualification. Because of this, the Standards give the

ITAs wide latitude to develop and perform appropriate tests to fully evaluate a system against the Standards.

Issues Not Addressed by the Revised Standards

This revisions to the Standards do not provide sufficient guidance for a number of important issues. Some of these issues are outside the scope of the Standards, some are only partially addressed by the Standards, and some will be addressed in future modules of the Standards. These issues include:

- **Administrative Functions:** The revised Standards do not address administrative and managerial practices outside the direct control of the vendor. Election officials have long recognized that adequate Standards and test criteria are only part of the formula for ensuring that votes are cast and counted in an accurate manner. The other key component that is often overlooked in the rush to embrace technological solutions to election problems is efficient and consistent administration and management. Effective administration at the local level requires the adoption and implementation of consistent and effective procedures for acquiring, securing, operating and maintaining a voting system. Although the Standards mandate that vendors document many components of optimal managerial practices, the execution of such procedures are not included in a Standards document that focuses on the system itself.

- **Integration with the Voter Registration Database:** Local and statewide automated voter registration databases have become more common in recent years as election officials throughout the country attempt to harness innovations in network computing to address the needs of increasingly complex voter registration information requirements. In some instances, a voter registration database will contain many data fields common to other election administration applications. These applications include campaign finance recording, election worker management, and the reporting of election results. Although many of these applications are co-dependent, the testing of the design and interface between the voting system and the voter registration database has been specifically excluded from this update of the Standards for practical reasons. First, because there is such a variety of databases and interfaces being used among the various states and within the localities of each individual state, there is no practical and systematic way to test a voting system against all possible combinations and configurations. Second, many of the voting systems being used today still do not include an electronic interface with the voter registration database. At such time when the majority of voting systems and voter registration databases become more seamlessly integrated, a module will be added to the Standards covering their performance, functionality, and testing.

- **Commercial Off-the-Shelf (COTS) Products:** Some voting systems use one or more readily-available COTS hardware devices (such as card readers, printers, or personal computers) or software products (such as operating systems, programming language compilers, or database management systems). These devices and software are exempted from certain portions of the qualification testing process so long as such products are not modified in any manner for use in a voting system.

- **Internet Voting:** A recent report[4] conducted by the Internet Policy Institute and sponsored by the National Science Foundation in cooperation with the University of Maryland stated:

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[4] *"Report of the National Workshop on Internet Voting: Issues and Research Agenda"* March, 2001. Internet Policy Institute.

> "Remote Internet voting systems pose significant risk to the integrity of the voting process and should not be fielded for use in public elections until substantial technical and social science issues have been addressed. The security risk associated with these systems are both numerous and pervasive and, in many cases, cannot be resolved using even today's most sophisticated technology."

The findings of this and other studies on internet voting have led the FEC and NASED to conclude that controls cannot be developed at the present time to make remote Internet voting sufficiently risk-resistant to be confidently used by election officials and the voting public. Therefore, the Standards can not be written for the testing and qualification of these systems for widespread use in general elections. However, the Standards do not prohibit the development and use of these systems for special populations such as military and civilian government employees based outside the United States. In addition to Federal Voting Assistance Program use of Internet voting, States are encouraged to conduct pilot tests and demonstration projects in accordance with applicable state regulations.

The Standards contemplate the development of systems that integrate public telecommunications networks other than the Internet at the poll site setting. These voting systems are considered public network direct recording electronic (DRE) voting systems and must meet the same revised Standards for security, accuracy, and reliability as other similarly defined voting systems. Such systems must additionally meet requirements specific to systems that integrate certain telecommunications components.

- **Human Error Rate vs. System Error Rate:** In the Standards, the term "error rate" applies to errors introduced by the system and not by a voter's action, such as the failure to mark a ballot in accordance with instructions. The updated accuracy standard is defined as a ballot position error rate. The error rate applies to specific system functions, such as recording a vote, storing a vote and consolidating votes into vote totals. Each location on a paper ballot card or electronic ballot image where a vote may be entered represents a ballot position. The Standards set two error rates:

  1. **Target error rate**: a maximum of one error in 10,000,000 ballot positions, and

  2. **Testing error rate**: a maximum acceptable rate in the test process of one error in 500,000 positions.

This system error rate applies to data that is entered into the system in conformance with the applicable instructions and specifications. Further research on human interface and usability issues is needed to enable the development of Standards for error rates that account for human error.

Summary of Content of Volume I

Volume I contains performance standards for electronic components of voting systems. In addition to containing a glossary (Appendix A) and applicable references (Appendix B), Volume I is divided into nine sections:

- **Section 1- Introduction:** This section provides an introduction to the Standards, addressing the following topics:

  - Objectives and usage of the Standards;

- Development history for initial Standards;

- Update of the Standards;

- Accessibility for individuals with disabilities;

- Definitions of key terms;

- Application of the Standards and test specifications; and

- Outline of contents.

- **Section 2 - Functional Capabilities:** This section contains Standards detailing the functional capabilities required of a voting system. This section sets out precisely what it is that a voting system is required to do. In addition, this section sets forth the minimum actions a voting system must be able to perform to be eligible for qualification. For organizational purposes, functional capabilities are categorized by the phase of election activity in which they are required:

  - **Overall Capabilities**: These functional capabilities apply throughout the election process. They include security, accuracy, integrity, system auditability, election management system, vote tabulation, ballot counters, telecommunications, and data retention.

  - **Pre-voting Capabilities**: These functional capabilities are used to prepare the voting system for voting. They include ballot preparation, the preparation of election-specific software (including firmware), the production of ballots or ballot pages, the installation of ballots and ballot counting software (including firmware), and system and equipment tests.

  - **Voting Capabilities**: These functional capabilities include all operations conducted at the polling place by voters and officials including the generation of status messages.

  - **Post-voting Capabilities**: These functional capabilities apply after all votes have been cast. They include closing the polling place; obtaining reports by voting machine, polling place, and precinct; obtaining consolidated reports; and obtaining reports of audit trails.

  - **Maintenance, Transportation and Storage Capabilities**: These capabilities are necessary to maintain, transport, and store voting system equipment.

For each functional capability, common standards are specified. In recognition of the diversity of voting systems, some of the standards have additional requirements that apply only if the system incorporates certain functions (for example, voting systems employing telecommunications to transmit voting data) or configurations (for example, a central count component). Where system-specific standards are appropriate, common standards are followed by standards applicable to specific technologies (i.e., paper-based or DRE) or intended use (i.e., central or precinct count).

The requirement that voting systems provide access to individuals with disabilities is one of the most significant additions to the Standards. The FEC has incorporated specifications that were developed by the Access Board and are based on the accessibility Standards for electronic and information technology established in *36 CFR Part 1194 - Electronic and Information Technology Accessibility Standards*, which implement Section 508 of the Rehabilitation Act Amendments of 1998.

- **Section 3 - Hardware Standards:** This section describes the performance requirements, physical characteristics, and design, construction, and maintenance characteristics of the hardware and related components of a voting system. This section focuses on a broad range of devices used in the design and manufacture of voting systems, such as:

    - For paper ballots: printers, cards, boxes, transfer boxes, and readers;

    - For electronic systems: ballot displays, ballot recorders, precinct vote control units;

    - For voting devices: punching and marking devices and electronic recording devices;

    - Voting booths and enclosures;

    - Equipment used to prepare ballots, program elections, consolidate and report votes, and perform other elections management activities;

    - Fixed servers and removable electronic data storage media; and

    - Printers.

    The Standards specify the minimum values for the relevant attributes of hardware, such as:

    - Accuracy;

    - Reliability;

    - Stability under normal environmental operating conditions and when equipment is in storage and transit;

    - Power requirements and ability to respond to interruptions of power supply;

    - Susceptibility to interference from static electricity and magnetic fields;

    - Product marking; and

    - Safety.

- **Section 4- Software Standards:** This section describes the design and performance characteristics of the software embodied in voting systems, addressing both system level software and voting system application software, whether COTS or proprietary. The requirements of this section are intended to ensure that the overall objectives of accuracy, logical correctness, privacy, system integrity, and reliability are achieved. Although this section emphasizes software, the software standards may influence hardware design in some voting systems.

The requirements of this section apply to all software developed for use in voting systems, including:

- Software provided by the voting system vendor and its component suppliers; and

- Software furnished by an external provider where the software is potentially used in any way during voting system operation.

The general standards in this section apply to software used to support the broad range of voting system activities, including pre-voting, voting and post-voting activities. System specific Standards are defined for ballot counting, vote processing, the creation of an unalterable audit trail, and the generation of output reports and files. Voting system software is also subject to the security requirements of Section 6.

- **Section 5 - Telecommunications Standards**: This section describes the requirements for the telecommunications components of voting systems. Additionally, it defines the acceptable levels of performance against these characteristics. For the purpose of the Standards, telecommunications is defined as the capability to transmit and receive data electronically regardless of whether the transmission is localized within the polling place or the data is transmitted to a geographically distinct location. The requirements in this section represent functional and performance requirements for the transmission of data that is used to operate the system and report official election results. Where applicable, this section specifies minimum values for critical performance and functional attributes involving telecommunications hardware and software components.

  This section addresses telecommunications hardware and software across a broad range of technologies such as dial-up communications technologies, high-speed telecommunications lines (public and private), cabling technologies, communications routers, modems, modem drivers, channel service units (CSU)/data service units (DSU), and dial-up networking applications software.

  Additionally, this section applies to voting-related transmissions over public networks, such as those provided by regional telephone companies and long distance carriers. This section also applies to private networks regardless of whether the network is owned and operated by the election jurisdiction. For systems that transmit data over public networks, this section applies to telecommunications components installed and operated at settings supervised by election officials, such as polling places or central offices.

- **Section 6 - Security Standards:** This section describes the essential security capabilities for a voting system, encompassing the system's hardware, software, communications, and documentation. The requirements of this section recognize that no predefined set of security Standards will address and defeat all conceivable or theoretical threats. However, the Standards articulate requirements to achieve acceptable levels of integrity, reliability, and inviolability. Ultimately, the objectives of the security Standards for voting systems are to:

  - Establish and maintain controls that can ensure that accidents, inadvertent mistakes, and errors are minimized;

  - Protect the system from intentional manipulation and fraud;

  - Protect the system from malicious mischief;

  - Identify fraudulent or erroneous changes to the system; and

  - Protect secrecy in the voting process.

These Standards are intended to address a broad range of risks to the integrity of a voting system. While it is not possible to identify all potential risks, the Standards identify several types of risk that must be addressed, including:

- Unauthorized changes to system capabilities for defining ballot formats, casting and recording votes, calculating vote totals consistent with defined ballot formats, and reporting vote totals;

- Alteration of voting system audit trails;

- Altering a legitimately cast vote;

- Preventing the recording of a legitimately cast vote,

- Introducing data for a vote not cast by a registered voter;

- Changing calculated vote totals;

- Preventing access to vote data, including individual votes and vote totals, to unauthorized individuals; and

- Preventing access to voter identification data and data for votes cast by the voter such that an individual can determine the content of specific votes cast by the voter.

- **Section 7 - Quality Assurance:** In the Standards, quality assurance is a vendor function with associated practices that confirms throughout the system development and maintenance life-cycle that a voting system conforms with the Standards and other requirements of state and local jurisdictions. Quality assurance focuses on building quality into a system and reducing dependence on system tests at the end of the life-cycle to detect deficiencies.

  This section describes the responsibilities of the voting system vendor for designing and implementing a quality assurance program to ensure that the design, workmanship, and performance requirements of the Standards are achieved in all delivered systems and components. These responsibilities include:

  - Development of procedures for identifying and procuring parts and raw materials of the requisite quality, and for their inspection, acceptance, and control.

  - Documentation of hardware and software development processes.

  - Identification and enforcement of all requirements for in-process inspection and testing that the manufacturer deems necessary to ensure proper fabrication and assembly of hardware, as well as installation and operation of software or firmware.

  - Procedures for maintaining all data and records required to document and verify the quality inspections and tests.

- **Section 8 - Configuration Management:** This section contains specific requirements for configuration management of voting systems. For the purposes of the Standards, configuration management is defined as a set of activities and associated practices that assures full knowledge and control of the components of a system, beginning with its initial development, progressing

throughout its development and construction, and continuing with its ongoing maintenance and enhancement. This section describes activities in terms of their purpose and outcomes. It does not describe specific procedures or steps to be employed to accomplish them—these are left to the vendor to select.

The requirements of this section address a broad set of record keeping, audit, and reporting activities that include:

- Identifying discrete system components;

- Creating records of formal baselines of all components;

- Creating records of later versions of components;

- Controlling changes made to the system and its components;

- Submitting new versions of the system to ITAs;

- Releasing new versions of the system to customers;

- Auditing the system, including its documentation, against configuration management records;

- Controlling interfaces to other systems; and

- Identifying tools used to build and maintain the system.

Vendors are required to submit documentation of these procedures to the ITA as part of the Technical Data Package for system qualification testing. Additionally, as articulated in state or local election laws, regulations, or contractual agreements with vendors, authorized election officials or their representatives reserve the right to inspect vendor facilities and operations to determine conformance with the vendor's reported configuration management procedures.

- **Section 9 - Overview of Qualification Tests**: This section provides an overview for the qualification testing of voting systems. Qualification testing is the process by which a voting system is shown to comply with the requirements of the Standards and the requirements of its own design and performance specifications. The testing also evaluates the completeness of the vendor's developmental test program, including the sufficiency of vendor tests conducted to demonstrate compliance with stated system design and performance specifications, and the vendor's documented quality assurance and configuration management practices.

The qualification test process is intended to discover errors that, should they occur in actual election use, could result in failure to complete election operations in a satisfactory manner. This section describes the scope of qualification testing, its applicability to voting system components, documentation that is must be submitted by the vendor, and the flow of the test process. This section also describes differences between the test process for initial qualification testing of a system and the testing for modifications and re-qualification after a qualified system has been modified.

Since 1994, the testing described in this section has been performed by an ITA that is certified by NASED. The testing may be conducted by one or more ITAs for a given system, depending on the nature of tests to be conducted and the expertise of the certified ITA. The testing process involves the assessment of:

- Absolute correctness of all ballot processing software, for which no margin for error exists;

- Operational accuracy in the recording and processing of voting data, as measured by the error rate articulated in Volume I, Section 3;

- Operational failure or the number of unrecoverable failures under conditions simulating the intended storage, operation, transportation, and maintenance environments for voting systems, using an actual time-based period of processing test ballots;

- System performance and function under normal and abnormal conditions; and

- Completeness and accuracy of the system documentation and configuration management records to enable purchasing jurisdictions to effectively install, test, and operate the system.

Summary of Volume II Content

- **Section 1 - Introduction:** This section provides an overview of Volume II, addressing the following topics:

  - The objectives of Volume II;

  - The general contents of Volume II;

  - The qualification testing focus;

  - The qualification testing sequence;

  - The evolution of testing; and

  - The outline of contents

- **Section 2 - Technical Data Package:** This section contains a description of vendor documentation relating to the voting system that shall be submitted with the system as a precondition for qualification testing. These items are necessary to define the product and its method of operation; to provide the vendor's technical and test data supporting the its claims of the system's functional capabilities and performance levels; and to document instructions and procedures governing system operation and field maintenance.

  The content of the Technical Data Package (TDP) is intended must contain a complete description of the following information about the system:

  - Overall system design, including subsystems, modules, and interfaces;

  - Specific functional capabilities;

  - Performance and design specifications;

  - Design constraints and compatibility requirements;

  - Personnel, equipment, and facilities necessary for system operation, maintenance, and logistical support;

  - Vendor practices for assuring system quality during the system's development and subsequent maintenance; and

- Vendor practices for managing the configuration of the system during development and for modifications to the system throughout its life-cycle.

- **Section 3 - Functionality Testing:** This section contains a description of the testing to be performed by the ITA to confirm the functional capabilities of a voting system submitted for qualification testing. It describes the scope and basis for functional testing, the general sequence of tests within the overall test process, and provides guidance on testing for accessibility. It also discusses testing of functionality of systems that operate on personal computers.

- **Section 4 - Hardware Testing:** This section contains a description of the testing to be performed by the ITAs to confirm the proper functioning of the hardware components of a voting system submitted for qualification testing. This section requires ITAs to design and perform procedures that test the voting system hardware for both operating and non-operating environmental tests.

  Hardware testing begins with non-operating tests that require the use of an environmental test facility. These are followed by operating tests that are performed partly in an environmental facility and partly in a standard test laboratory or shop environment. The non-operating tests are intended to evaluate the ability of the system hardware to withstand exposure to various environmental conditions incidental to voting system storage, maintenance, and transportation. The procedures are based on test methods contained in Military Standards (MIL-STD) 810D, modified where appropriate, and include such tests as: bench handling, vibration, low and high temperature, and humidity.

  The operating tests involve running the system for an extended period of time under varying temperatures and voltages. This ensures that the hardware meets or exceeds the minimum requirements for reliability, data reading, and processing accuracy contained in Section 3 of Volume I. Although the procedure emphasizes equipment operability and data accuracy, it is not an exhaustive evaluation of all system functions. Moreover, the severity of the test conditions has in most cases been reduced from that specified in the Military Standards to reflect commercial, rather than military, practice.

- **Section 5 - Software Testing:** This section contains a description of the testing to be performed by the ITAs to confirm the proper functioning of the software components of a voting system submitted for qualification testing. It describes the scope and basis for software testing, the initial review of documentation to support software testing, and the review of voting system source code.

  The software qualification tests encompass a number of interrelated examinations. The examinations include selective review of source code for conformance with the vendor's stated standards, and other system documentation provided by the vendor. The code inspection is complemented by a series of functional tests to verify the proper performance of all system functions controlled by the software.

- **Section 6 - System Level Integration Testing:** This section contains a description of the testing conducted by the ITAs to confirm the proper functioning of the fully integrated components of a voting system submitted for qualification testing. It describes the scope and basis for integration testing, testing of internal and external system interfaces, testing of security capabilities, testing of accessibility features, and the configuration audits, including the evaluation of claims made in the system documentation.

  System-level qualification tests address the integrated operation of hardware, software and telecommunications capabilities (where applicable) to assess the system's response

to a range of both normal and abnormal conditions in an attempt to compromise the system.

- **Section 7 - Examination of Vendor Practices for Configuration Management and Quality Assurance:** This section contains a description of examinations conducted by the ITAs to evaluate the extent to which vendors meet the requirements for configuration management and quality assurance. It describes the scope and basis for the examinations and the general sequence of the examinations. It also provides guidance on the substantive focus of the examinations.

  In reviewing configuration management practices, the ITAs examine the vendor's:
  - configuration management policy;
  - configuration identification policy;
  - baseline, promotion and demotion procedures;
  - configuration control procedures;
  - release process and procedures; and
  - configuration audit procedures.

  In reviewing quality assurance practices, the ITAs examine the vendor's:
  - quality assurance policy;
  - parts and materials tests and examinations;
  - quality conformance plans, procedures and inspection results; and
  - voting system documentation.

Conclusion

Almost eighty percent of the States have adopted the Standards. The Commission recommends that individual States continue to decide how best to adopt and implement the Standards to aid in the procurement of electronic voting systems. States are also encouraged to develop and implement individual certification processes to make sure that qualified voting systems can meet the unique and particular demands of the purchasing jurisdiction.

As a whole, implementation of the original Standards, combined with NASED's national testing program, has allowed election officials to be more confidant than ever that the voting systems they procure will work accurately and reliably. Although the requirements for voting systems and the technologies used to build them have evolved over the past decade, the revised Standards will close the gaps in the Standards for system performance and testing. In order to prevent technology gaps in the future, the FEC and NASED are committed to making the Standards a living document capable of being updated in an expedited manner to respond to constantly evolving technology. Such technological innovation should be embraced in order to maintain a sophisticated and robust voting systems industry.

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