Report to the
Office of the Attorney General

Election Systems & Software
iVotronic w/RTAL
Voter-verified Paper Record System
Assessment

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I. Summary

a. Introduction

The Attorney General's Office issued "Criteria for Voter-Verified Paper Record for Direct Recording Electronic Voting Machines" (the Criteria), and requested New Jersey Institute of Technology (NJIT) to test Voter-Verified Paper Record Systems (VVPRS) against certain items in the Criteria.

NJIT is New Jersey's Science and Technology University. Testing was developed and performed by experts with extensive experience and knowledge in computers, networks, electronics, security, data hiding, forensics and statistics. The project team was managed by the Center for Information Age Technology, which, since 1983, has advised government agencies on technology and related issues.

Election Systems & Software (ES&S) supplied three iVotronic w/RTAL machines to test, plus documentation, peripheral equipment and technical staff. Testing occurred in a secure NJIT lab. Vendor staff assisted the test team in understanding the machine and documentation, and was not involved in or present for the testing. Vendor documentation was maintained on a secure server.

This VVPRS uses a design referred to as a real-time audit log system in which each voter's selection is printed as the voter makes each selection on the DRE rather than after the voter makes all his or her selections in all contests on the DRE. Each transaction (selected, deselected, or changed) is printed immediately after the choice is made. Undervotes are not indicated at this time. A change or deselection of any prior choice can be made at any time before the "Vote" button is pressed. The voter has "unlimited" opportunities to change a vote selection and review the printout (one line or more) of an individual selection.

However, at no time can the voter review a paper record of the complete ballot that is to be cast. The ballot - with all the contest selections, and contests where no or incomplete contest selection is made (undervotes) - is printed only after the "VOTE" button is pressed. At that point, the voter does not have an opportunity to reject the final printout of the ballot.

"Voter-verified paper record ("VVPR" or "paper record")" is defined in the Criteria (Section I: Definition) as:

> "Physical piece of paper on which the voter's ballot choices are recorded, cast, and preserved for later use in any recount or manual audit."

For testing purposes, this definition is interpreted as referring to the entirety of the printout on the paper roll of the voting session of a voter. The cast ballot printed on the paper roll, which cannot be rejected, is referred to as the vote summary. This vote summary is electronically saved in the text format referred to as the voter image, which is essentially referred to in the Criteria as the electronic record or the electronic ballot image record of the final and official ballot of the voter.

b. Testing

To appropriately test against the Criteria, and to fully exercise the machines, several testing approaches were designed and utilized: Single Test, 1200-vote Test, and 14-hour Test. The latter two are considered and referred to as Volume Tests. Testing was developed and performed based on accepted scientific practices and methodologies.

The **52-vote test,** to test the case in which the paper record extends to multiple pages, was not conducted because it did not apply to this machine since it has rolling paper for printing paper ballots ("Continuous"), not individual sheets of paper.("Cut and Drop").

The **Single Test** is a one-time examination, inspection or review of equipment (e.g. printer, paper records display unit, seals, and locks), operations and configurations (e.g., certain mock elections with one or a few votes cast, paper records, electronic records, barcodes, error correction codes, digital signatures), and vendor documentation (e.g., technical manuals, operations guides, specifications).

The **14-hour Test** emulates voting situations during a typical election day. A long ballot is used, with completely balanced votes covering elections, questions, write-ins, undervotes and voided votes. Random shuffled scenarios cards are given to voters. Tally reports, close-poll reports, and reports from scanned paper records are examined and compared with the paper records.

The **1200-vote Test** entails having the machine generate 1200 votes continuously through a scripted program. At the time of testing, ES&S did not have a script capability to enable programming this 1200-vote Test, and it was thus conducted manually. This number of votes is chosen to exceed the guideline of one machine for 750 registered voters. This test uses a short ballot, with major party and supplemental voting scenarios; each voted multiple times to reach, collectively, 1200 votes. Results generated in paper records, scanned paper records, and barcodes are examined and compared.

c. Results

The iVotronic w/RTAL does not comply with the tested criteria as noted in the following 12 exceptions:

Exception #	Criteria and Result
1	**II.B.2** "The VVPRS shall be designed to allow the voter to easily review, accept, or reject his or her paper record." **II.B.2.a** "The DRE shall not record the electronic record until the paper record has been approved by the voter." **III.B.2** "If the paper record cannot be viewed entirely in the Display Unit at one time, the voter shall have the opportunity to verify the entire paper record prior to the electronic or the paper ballot being stored and recorded." **IV.C.5.** "The paper records shall distinguish between accepted and non-accepted ballots." **IV.C.5.a.** "The voter shall have the opportunity to accept or reject the contents of his or her paper record." **IV.C.5. a.(1)** "If the voter rejects the contents of the paper record, he or she may recast the ballot up to two additional times. This procedure is consistent with current State law, which limits the amount of time a voter has to cast a ballot. (See N.J.S.A. 19:52-3)." **IV.C.5.a.(2)** "Before the voter causes a third and final paper record to be printed, the voter shall be presented with a warning notice on the machine that the selections on the DRE will be final. The voter will see and verify a printout of the votes, but will not be given additional opportunities to change any vote. The third ballot cast shall constitute the final and official ballot of such a voter." **IV.C.5.a.(3)** "Upon rejecting a paper record, the voter shall be able to modify and verify the selections on the DRE without having to reselect all choices in all contests on the ballot."
	• Only one paper record (vote summary) is printed per voter. The voter does not have opportunities to recast the ballot up to two additional times as required by the Criteria. • The voter has unlimited opportunities to review each individual line as it is printed immediately after each selection, deselection or change. However, undervotes are not printed in that line-by-line printing following individual selections, deselections or changes, and therefore the voter cannot see or review undervotes at that point on the printout. • The voter can then completely review the completed ballot on the screen and, if acceptable, press the "VOTE" button on top of the DRE screen, causing the ballot to be cast. The vote summary showing the entire ballot cast is then printed on the paper record, but is not reviewable by the voter, since it rapidly advances to the 'take-up' spindle. Even if the voter were able to read the vote summary in that short period of time, there is no mechanism for the voter to reject the paper record and to recast the ballot.

Exception #	Criteria and Result
2	**II.B.1** "The VVPRS may be designed in various configurations. In all configurations, prior to casting the ballot, the voter shall have the ability to verify his or her selections on a paper record in a private and independent manner." **II.B.3.b** ""Continuous Spool" Method: The voter views the paper record on a spool-to-spool paper roll. This method shall be used in a manner that fully protects the secrecy of all votes cast." **III.B.1** "The paper record shall be displayed in a way that allows the voter to privately and independently inspect it." **IV.C.2** "Voter privacy shall be preserved during the process of recording, verifying, and auditing ballot selections. This includes a voter who uses an audio voting device. Voters using an audio voting device shall also be able to verify votes privately and independently."
	Two side panels exist, but by themselves they do not provide privacy. An observer may be able to read the screen or Paper Record Display Unit by standing behind or next to the voter.
3	**II.B.4** "No electronic or paper record shall indicate the identity of a voter or be maintained in a way that allows a voter to be identified." **II.B.5** "The electronic and paper records shall be created and stored in ways that preserve the privacy of the record." **IV.C.2** "Voter privacy shall be preserved during the process of recording, verifying, and auditing ballot selections. This includes a voter who uses an audio voting device. Voters using an audio voting device shall also be able to verify votes privately and independently."
	Once the voter presses the "VOTE" button to cast the ballot, the printer prints out the vote summary with the exact date and time (YYYY/MM/DD - HH:MM:SS) of the voting session on the paper record. If this timestamp information is compared to the Poll Log which records the time when the voter checks in, the ballot paper record could be matched to the specific voter, therefore compromising voter privacy.
4	**III.A.1** "The printer shall be designed to have a sufficient amount of paper, ink, toner, and ribbon or like supply for use in an election; taking into account an election district should have at least one voting machine per 750 registered voters."
	Paper replacement is expected for an election with more than 120 votes. Each selection, deselection or change generates one or two lines of print plus blank space equal to approximately four lines.

Exception #	Criteria and Result
5	**II.B.3.b** “"Continuous Spool" Method: The voter views the paper record on a spool-to-spool paper roll. This method shall be used in a manner that fully protects the secrecy of all votes cast.” **III.A.1.a** “If any addition or replacement of paper, ink, toner, ribbon or other like supply is required, it shall be done with minimal disruption to voting and without circumvention of the security features of the Printer and Storage Unit which protect cast ballots and the secrecy of the vote.” **III.A.3** “The printer shall be secured by security seals or locking mechanisms to prevent tampering. The printer shall be accessed only by those election officials authorized by the county commissioner of registration.” **III.D.1** “Security protections including, but not limited to, security seals or locking mechanisms, shall be built into the Storage Unit to prevent tampering at *all times, including pre-election*, election day, *and post-election. The Attorney General, through the Department of Law and Public Safety ("LPS"), will issue chain of custody guidelines regarding the Storage Unit.” (RED or italics indicates items not tested).* **V.E** “The printer shall be connected to the voting machine either by completely concealing the printer connection or via a security tag to prevent tampering.”
	• The roll of printed paper records is accessible upon unlocking the printer cover. • The cable connecting the VVPRS to the DRE is exposed and can be easily disconnected from the printer port on the top of the DRE.
6	**III.A.2** “The VVPRS shall have a low-paper indicator that will allow for the timely addition of paper so that each voter can fully verify, without disruption, all of his or her ballot selections.”
	If the amount of paper reaches the minimum limit during a voting session, the DRE does not give the voter the opportunity to finish voting and the DRE automatically voids the vote. That is, the system cancels the selections and locks the screen, and the voter has to restart the voting session
7	**III.A.4** “The VVPRS shall be capable of showing the information on the paper record in a font size of at least 3.0 mm and should be capable of showing the information in at least two font ranges, 3.0-4.0 mm and 6.3-9.0 mm, under the control of the voter or poll worker. This criteria can be met by providing a magnification device with the VVPRS.”
	The VVPRS cannot show the information in font range of 6.3-9.0mm. The maximum size with the vendor supplied magnification device is in the 3.0-5.0mm range.

Exception #	Criteria and Result
8	**IV.B.1** "The electronic ballot image record and paper records shall be linked by including unique identifiers so that an individual paper record can be determined with its corresponding electronic record. Unique identifiers are tools that will allow LPS to measure the reliability and accuracy of the voting system, as necessary. The electronic ballot image and the paper record shall not reveal the identity of the voter." **IV.B.3.e** "The voting system vendor shall provide full documentation of procedures for exporting electronic ballot image records and reconciling those records within the paper records."
	The vendor documentation does not provide the procedure to reconcile the electronic ballot image records within the paper record. However, the project team determined that the electronic ballot image records are saved in the ascending order of the Election Identification Number (EIN) (a memory address pointer referred by the vendor); the EIN is printed on the paper record and contained in the barcode of the corresponding paper record. Thus, the EIN is the linkage of electronic ballot image record to the corresponding paper record. However, matching the electronic ballot image records to the corresponding paper records is difficult for a large volume of votes, and is possible only if no paper records are lost.
9	**IV.C.5.a.(4)** "If a mechanical error in recording or printing a paper record occurs, the record shall be counted as a spoiled paper record. It will not be counted as one of the voter's three attempted votes." **V.F.** "The DRE shall detect and notify the election officials at the polling place of any errors and malfunctions, such as paper jams or low supplies of consumables (e.g. paper) that may prevent paper records from being correctly displayed, printed, or stored." **V.G** "If a mechanical error or malfunction occurs (such as, but not limited to, a paper jam or running out of paper), the DRE and VVPRS shall suspend voting operations, not record votes, and present a clear indication of the malfunction to the voter and election officials."
	Neither the DRE nor the VVPRS can detect a paper jam. When a paper jam occurs, the voter can still make or change selections on the DRE and cast the ballot as normal. However, the printer keeps printing over the same area on the paper roll, making it illegible. No audio or visual warning signal is given to either the voter or the poll official. The vote is electronically recorded and counted. The paper jams were observed in both single tests and the two volume tests. One paper jam during the 14-hour test even resulted in paper torn apart, in which case selections and barcodes were not printed.

Exception #	Criteria and Result
10	**IV.C.5. a.(4)** "If a mechanical error in recording or printing a paper record occurs, the record shall be counted as a spoiled paper record. It will not be counted as one of the voter's three attempted votes." **V.H** "If the connection between the voting machine and the printer has been broken, the voting machine shall detect and provide notice of this event and record it in the DRE's internal audit log. Voting operations shall be suspended and no votes shall be recorded."
	If the printer cable is disconnected after the voter presses the "VOTE" button, the ballot is electronically recorded and counted in the close-poll report. Yet, no barcode is printed on the paper record, and the cancellation of the ballot is indicated on the DRE screen and in the Event Log report.
	Miscellaneous Exceptions **(not associated with any particular Criteria)**
11	A person who possesses a supervisor Personalized Electronic Ballot (PEB[1]) can activate a ballot in a few seconds without any cross-checking with the Poll Log. Using a supervisor PEB, any person can cast as many ballots as he or she wants.
12	During the volume tests, after approximately 250 votes had been cast, the DRE machine produced a warning message when the same supervisor PEB was once again inserted to activate the subsequent ballots. This warning message continued for subsequent votes. While this warning did not preclude the voter from voting, the event log showed a warning message that was not understandable.

[1] According to ES&S iVotronic System Operations Procedures, a Personalized Electronic Ballot (PEB) is a portable cartridge fitted with an infrared communications window and a flash memory chip. Supervisor PEBs contain specific ballot data for each election. They open the polls, load the ballot onto a voter terminal and enable the service mode for administrative functions.

II. Project Scope and Approach

a. Project Background

The Attorney General's Office issued "Criteria for Voter-Verified Paper Record for Direct Recording Electronic Voting Machines" (the Criteria), to be used by the Voting Machine Examination Committee as one measure of whether to certify the overall machines for elections in New Jersey.

According to the Criteria, direct electronic voting machines with voter-verified paper record systems must each include a printer and a display unit that allows voters to view their votes before recording their electronic ballots. No vote should be recorded until the paper record is viewed and approved by the voter. If a voter rejects the contents of the paper records, he or she may recast a ballot up to two additional times. The paper receipts must then be stored securely in the machine. Lastly, electronic records and paper records must match and must both reflect the voters' actual votes.

New Jersey Institute of Technology (NJIT) was requested by the Attorney General's Office to test Voter-Verified Paper Record Systems (VVPRS) against certain items in the Criteria. NJIT is New Jersey's Science and Technology University. Testing was developed and performed by NJIT experts with extensive experience and knowledge in computers, networks, electronics, security, data hiding, forensics and statistics.

Three professors led the planning and testing efforts, assisted by four advanced Ph.D. candidates. Mock voting was performed by students. The entire project team was managed by NJIT's Center for Information Age Technology, which, since 1983, has advised government agencies on technology, project management, and business processes.

b. Test Environment

A secure lab was established at NJIT, dedicated to this project. The room was completely emptied before the project began. The door lock code was set to a new combination. Individual alarm codes were given to each project participant. Glass doors and panels to the hallway were covered with paper. Sign-in sheets were used for all team members, from the overall Project Manager down to mock voters. No visitors were allowed. The machines were brought directly into the lab. All electronic vendor documentation was maintained on a secure server, and physical items were kept under lock and key. Confidentiality agreements were executed between the participants and the University.

ES&S supplied three iVotronic w/RTAL machines to test. In addition, peripheral equipment was supplied, such as laptop with software, bar code reader, audio unit and voting cards. Vendor documentation included technical manuals, operations guides,

equipment specifications, and various documents in response to questions. Vendor technical staff provided assistance in understanding the machine and documentation. They were available by telephone, email and in person. While at NJIT, they were not involved in or present for any testing. Vendor documentation was maintained on a secure server.

c. Test Approaches

To test whether each machine type has satisfied the various requirements set forth according to the Criteria, four testing approaches have been designed and conducted: Single Test, 1200-vote Simulated Test, 14-hour Test, and 52-vote Test. The latter two tests (1200-vote, and 14-hour) are considered Volume Tests. Testing was developed and performed based on accepted scientific practices and methodologies.

The **Single Test**, a one-time examination or review against a specific criteria, is conducted through different means; it is requirement specific/dependent. It can be a physical inspection of various components of the DRE and VVPR voting system such as the printer, the Paper Record Display Unit, the paper supply, the paper record storage unit, and the placement of seals and locks. It can also be an examination of the basic operations and various configurations of the VVPRS, in which case a mock election with one or a few votes is conducted. In many cases, paper records, electronic records, and barcodes are retrieved, studied, and compared. For instance, the deployment of error correction codes and digital signatures may be verified via close examination of these records. In some cases, incidental and procedural "hindrances" such as a paper jam are "forced" and then observed. Close examination of vendors' documents are often required.

The **14-hour test** emulates actual physical voting situations over a total time period of 14 hours, representing an entire election day. A number of mock voters are recruited to cast various voting scenarios; each voter votes for a 1- to 2-hour time slot. The test adopts the long ballot with 12 major voting testing scenarios: eight major party voting scenarios and four supplementary voting scenarios. These voting scenarios are completely balanced with respect to two parties for seven positions and yes/no votes for seven questions and designed to test all kinds of possibilities including write-ins and undervotes.

Furthermore, additional scenarios involving voided votes are included. Each mock voter is given a set of shuffled voting scenarios cards derived from eight sets of eight major party voting scenarios and one set of four supplementary voting scenarios. Some questionnaire cards are randomly inserted into the voting scenarios to ask the voter questions with respect to the last voting scenario. Finally, the tally reports from the cast voting scenarios, the close-poll reports, the electronic record reports, and the reports generated from the scanned paper records are examined and compared.

The **1200-vote simulated test** for each machine entails having the machine generate 1200 votes continuously based on the short ballot through a scripted program. However, at the time of testing, ES&S did not have the script capability to perform this test, and thus it was carried out by having mock voters cast 1200 votes manually. This number of votes is chosen to exceed the guideline limit of one machine for 750 registered voters.

This test uses twelve vote testing scenarios, which are split into two parts:

(i) eight major party voting scenarios
(ii) four supplementary voting scenarios

Each of the eight major party voting scenarios is generated 125 times, while each of the four supplementary voting scenarios 50 times, totaling, collectively, 1200 votes. Results generated in paper records, electronic records, and barcodes are examined and compared.

The **52-vote test,** designed to test the special case in which the paper record extends to multiple pages, did not apply to the ES&S machine since it has rolling paper for printing paper ballots ("Continuous") – not individual sheets of paper ("Cut and Drop").

III. Testing Results

a. Equipment Configuration

Hardware configuration (observed and tested by NJIT)[2]

Vendor	DRE Hardware Model	DRE Hardware Version	DRE Firmware Version	DRE Machine ID	VVPRS Printer Model	VVPRS Printer Driver Version	VVPRS Printer Interface
ES&S	iVotronic 15" ADA voter terminal with 4 Button Audio	4.0.0.0 (Utility) IV 1.25.15a (ES&S Code)	9.2.0.0zj	V5163953	FutureLogic PSA-80H-DRE (RTAL printer)	V11	DB-9 Three-wire RS232 Serial Port
					Seiko[3] DPU-3445 (results printer)	V1.1	
ES&S	iVotronic 15" ADA voter terminal with 4 Button Audio	4.0.0.0 (Utility) IV 1.26.15arETS (ES&S Code)	9.2.0.0zj	V5174624	FutureLogic PSA-80H-DRE (RTAL printer)	V11	DB-9 Three-wire RS232 Serial Port
					Seiko DPU-3445 (results printer)	V1.1	
ES&S	iVotronic 15" ADA voter terminal with 4 Button Audio	4.0.0.0 (Utility) IV 1.25.15ar (ES&S Code)	9.2.0.0zj	V5151339	FutureLogic PSA-80H-DRE (RTAL printer)	V11	DB-9 Three-wire RS232 Serial Port
					Seiko DPU-3445 (results printer)	V1.1	

[2] Information inspected by NJIT was verified by observing the printer label (i.e., VVPRS printer model, VVPRS firmware version, VVPRS printer driver version), DRE label (i.e., DRE hardware version), and paper record (i.e., DRE firmware version).

[3] Seiko DPU-3445 results printer is a stand-alone printer that separately prints the results from the DRE in addition to those printed by the RTAL printer.

Hardware configuration (tested and certified by ITA on September 25, 2006) [4]

Vendor	DRE Hardware Model	DRE Hardware Version	DRE Machine ID	DRE Firmware Version	VVPRS Printer Model	VVPRS Printer Driver Version	VVPRS Printer Interface
ES&S	iVotronic 15" ADA voter terminal with 4 Button Audio	3.0.1.1 (Utility)	Not found[5]	9.1.6.4	FutureLogic PSA-80H-DRE (RTAL printer)	V11	DB-9 Three-wire RS232 Serial Port
		Not found[6] (ES&S code)			Seiko Model not found[7] (results printer)	V1.1	

[4] Information obtained from ITA reports submitted to Attorney General's Office by ES&S

[5] The DRE Machine ID has not been found on the ITA report (Hardware & Software Qualification Report Amendment B: iVotronic Firmware Update, Election Systems & Software ES&S Unity 3.0.1.1 Voting System (REV 01), qualified under NASED Qualification Number N-2-02-22-22-007 (2002))

[6] The ES&S Code of the tested machine has not been found on the ITA report (Hardware & Software Qualification Report Amendment B: iVotronic Firmware Update, Election Systems & Software ES&S Unity 3.0.1.1 Voting System (REV 01), qualified under NASED Qualification Number N-2-02-22-22-007 (2002))

[7] The printer model of the Seiko result printer has not been found on the ITA report (Hardware & Software Qualification Report Amendment B: iVotronic Firmware Update, Election Systems & Software ES&S Unity 3.0.1.1 Voting System (REV 01), qualified under NASED Qualification Number N-2-02-22-22-007 (2002))

b. Volume Tests

Two types of volume testing were done by conducting mock elections.

- The first test, called **14-hour test**, consists of manual voting by mock voters to represent a large volume of votes over a 14-hour period by using a long ballot with 19 items to be voted upon. In case of the ES&S iVotronic w/RTAL machine, this test resulted in 302 voters. A test of the fleeing voter capabilities of the ES&S machine was also included in the 14-hour test.

- The second test, called **1200-vote test**, consists of electronic voting to represent 1200 voters by using a short ballot with 9 items to be voted upon. In case of the ES&S machine tested, since electronic voting option was not available, a manual voting was conducted by using mock voters to cast the votes to represent 1200 voters.

Since the ES&S machine has rolling paper for printing paper ballots, it was not necessary to conduct a test to check the multiple-page ballot. The ES&S machine does have a provision for fleeing voters after voter inactivity for 300 seconds.

14-hour Test

As indicated above, the long ballot for the **14-hour test** contains 19 items to be voted upon. The number of different ways a voter could vote on these 19 items is in millions; **12 voting scenarios** were designed to represent all possible choices for the long ballot as shown in Tables 1 and 2.

Table 1 contains 8 major party voting scenarios that are completely balanced with respect to:

(i) the 2 parties for the 7 positions,
(ii) yes/no votes for the 7 questions, and
(iii) the 10 names listed for the charter study commission.

In the case of the 8 major party voting scenarios, each position gets 4 Democratic and 4 Republican candidate votes. Similarly, each question gets 4 yes and 4 no votes. For the charter study commission, each of the 10 listed names is voted twice and 3 names are written in. Scenario 6 is no vote (i.e., undervote) for the charter study commission.

Table 2 contains 4 supplementary voting scenarios that are designed to test the possibilities that are not included in the balanced 8 major party voting scenarios. For the President, it includes a scenario with a vote for each of the 2 petition candidates, write-in, and no vote. For the other 6 positions it includes write-in/no vote. None of the questions are voted. For the charter study commission, one scenario is no vote and the other 3 scenarios split the 10 names among them. For the charter study commission, none of the scenarios include any write-ins, since they are tested in the eight major party voting scenarios.

1200-vote Test

For the short ballot used in the **1200-vote test, 12 voting scenarios** were designed to represent all possible choices for the short ballot as shown in Tables 3 and 4. The short ballot does not include the charter study commission.

Table 3 contains 8 major party voting scenarios that are completely balanced with respect to:

(i) the 2 parties for the 5 positions and
(ii) yes/no votes for the 4 questions.

In the case of the eight major party voting scenarios, each position gets 4 Democratic and 4 Republican candidate votes. Similarly, each question gets 4 yes and 4 no votes.

Table 4 contains 4 supplementary voting scenarios that are designed to test the possibilities which are not included in the balanced 8 major party voting scenarios. For the U. S. Senator, it includes a scenario with a vote for each of the 2 petition candidates, write-in, and no vote. For the other 4 positions it includes write-in/no vote. None of the questions are voted.

Changing Selections

The following two scenarios are used to test the capability of changing selections as a part of the 14-hour test:

1. Voter voids the first set of selections and casts a vote for the second set of selections
2. Voter voids the first two sets of selections and cast a vote for the final selection

Paper Jams

Paper jams occurred during the 14-hour and 1200-vote volume tests. In particular, one paper jam during the 14-hour test even resulted in the paper being torn apart. While the printer was printing, the paper was seen jammed and then torn apart inside the VVPRS system. At that point, no paper was displayed on the Paper Record Display Unit.

- The paper jam occurred at the print head section, and the printed paper record was rolled in the take-up spindle. There was no paper on the paper path between the print head and the take-up spindle.

- The ballot was not completely printed and no barcode was printed. The EIN was produced but not completely printed. No error message or beeping sound was given to the voter and the official. The ballot was electronically recorded.

PEB Warning Message

During the volume tests, after approximately 250 votes had been cast, the DRE machine produced a warning message when the same supervisor PEB was once again inserted to activate the subsequent ballots. This warning message continued for subsequent votes. While this warning did not preclude the voter from voting, the event log showed a warning message that was not understandable.

- The message read "Warning: PEB Data Anomaly Detected (Vote data in terminal is not affected). Contact Election Supervisor. The last write operation to the PEB was interrupted. The failed operation was [sic] "" starting at block 15625. Suggested Recovery Action:. Press the "VOTE" Button to continue. Remove the PEB to end operations."

- When the tester pressed the "VOTE" button, the voting process continued as normal. Two warning messages, reading "Warning – PEB I/O flag set" and "Warning – I/O flagged PEB will be used", were displayed on the DRE screen and recorded in the Event Log.

  When the tester removed the supervisor PEB, the DRE shut down. Only one warning message, reading "Warning – PEB I/O flag set" was displayed and recorded in the Event Log.

Table 5 lists the requirements and discusses the results of the 14-hour volume test in terms of meeting or not meeting the specific requirements in the Criteria.

Results of Changing Selections Test

Table 6 gives the number of votes cast for the following two scenarios used for testing the capability of changing selections:

- Voter voids the first set of selections and casts a vote for the second set of selections
- Voter voids the first two sets of selections and cast a vote for the final selection

As shown in Table 6, all of these votes were recorded correctly on the paper ballots and the final versions of these votes were reflected correctly in the tallies from the scanned paper ballots, electronic records, and the tally from poll close.

Results of Fleeing Voters Test

The machine was programmed to detect a fleeing voter after there had been no voter activity for 300 seconds. Ten fleeing voters were simulated; in each case after the 300-seconds gap of no voter activity, the beeping sound alerted the "poll worker", who was able to either cast the vote as it was left by the voter or cancel the vote. Both options were tried and they worked as intended.

Summaries of Vote Results

For each of the two types of tests (i.e., 14-hour and 1200-vote), summaries of the following were prepared:

- Paper ballots cast,
- Scanned records of the paper ballots cast,
- Electronic records, and
- Tally from poll close.

Each of these summaries gives a count of the number of votes cast for each candidate for a specific position or a question. These 4 sets of counts are described below for each of the 2 types of volume tests.

Counts of 14-hour Volume Test

For the 14-hour volume test, **Table 7** gives the counts of the paper ballots along with the tallies of the scanned paper ballots, electronic records, and the tally from poll close. During the electronic 14-hour test, there were 3 paper jams that resulted in the lack of complete printing of 4 paper ballots. Due to the loss of these 4 paper ballots, the first 2 sets of counts (paper ballots cast and scanned records of the paper ballots) could not be matched with the other two sets of counts (electronic records and tally from poll close). However, the counts of paper ballots cast matched with the counts of scanned records of the paper ballots. Similarly, the counts of electronic records matched with the counts of tally from poll close.

Counts of 1200-vote Volume Test

For the 1200-vote volume test, **Table 8** gives the counts of the paper ballots along with the tallies of the scanned paper ballots, electronic records, and the tally from poll close. During the manual voting for the 1200-vote test, a paper jam resulted in the lack of printing of barcodes for 3 paper ballots. Due to the loss of these barcodes for 3 paper ballots, the first 2 sets of counts (paper ballots cast and scanned records of the paper ballots) could not be matched with the other two sets of counts (electronic records and tally from poll close). However, the counts of paper ballots cast matched with the counts of scanned records of the paper ballots. Similarly, the counts of electronic records matched with the counts of tally from poll close.

Overall Summary for Volume Test

For both the 14-hour test and the 1200-vote test, the counts of paper records matched those of scanned paper records. Similarly, the counts of electronic records matched those of close poll. The only exception is the occurrence of paper jams during the 14-hour test and the 1200-vote test, which resulted in the loss of complete printing of 4 votes and 3 votes, respectively.

Table 1. Long Ballot - Eight Major Party Voting Scenarios

Scenario Number									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Position	**PRES**	R	D	D	D	D	R	R	R
	US-S	D	R	D	D	R	R	R	D
	US-H	R	R	D	R	D	R	D	D
	F 3-YR-1	R	R	D	D	R	D	D	R
	F 3-YR-2	D	R	D	R	D	D	R	R
	F 2-YR	R	D	D	R	R	D	R	D
	TOWNSHIP	D	D	D	R	R	R	D	R
Question	**1**	NO	YES	NO	NO	YES	YES	NO	YES
	2	NO	NO	YES	NO	NO	YES	YES	YES
	3	NO	YES	NO	YES	NO	YES	YES	NO
	4	NO	YES	YES	NO	YES	NO	YES	NO
	5	NO	NO	NO	YES	YES	NO	YES	YES
	6	NO	YES	YES	YES	NO	NO	NO	YES
	7	NO	NO	YES	YES	YES	YES	NO	NO
Charter	**1**	N1	N6	N1	N4	N10		N6	N8
	2	N2	N7	N2	N5	W1		N7	N9
	3	N3	N8	N3		W2		W3	N10
	4	N4	N9						
	5	N5							
No. of Charter Voted		5	4	3	2	3	0	3	3

Notes:

1. For each position, R and D stand for a vote for a Republican or a Democratic name, respectively. A blank space means no vote for that position.
2. For the charter study commission, N1, N2, …, N10, stand for a vote for Name1, Name2,…, Name 10, respectively. W1, W2, and W3 are the three write-in names for the charter study commission. A blank space means no vote for that position.

Table 2. Long Ballot - Four Supplementary Voting Scenarios

Scenario Number					
		9	**10**	**11**	**12**
Position	**PRES**	PET1	PET2		WRITE-IN
	US-S	WRITE-IN		WRITE-IN	
	US-H	WRITE-IN		WRITE-IN	
	F 3-YR-1	WRITE-IN		WRITE-IN	
	F 3-YR-2		WRITE-IN	WRITE-IN	
	F 2-YR	WRITE-IN		WRITE-IN	
	TOWNSHIP	WRITE-IN		WRITE-IN	
Question	**1**				
	2				
	3				
	4				
	5				
	6				
	7				
Charter	**1**	N1	N6	N9	
	2	N2	N7	N10	
	3	N3	N8		
	4	N4			
	5	N5			
No. of Charter Voted		5	3	2	0

Notes:

1. For each position, R and D stand for a vote for a Republican or a Democratic name, respectively. A blank space means no vote for that position.
2. For each question, a blank space means no vote for that question.
3. For the charter study commission, N1, N2, …, N10, stand for a vote for Name1, Name2,…, Name 10, respectively. W1, W2, and W3 are the three write-in names for the charter study commission. A blank space means no vote for that position.

Table 3. Short Ballot - Eight Major Party Voting Scenarios

Scenario Number									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Position	**US-S**	R	D	D	D	D	R	R	R
	US-H	D	R	D	D	R	R	R	D
	F 3-YR-1	R	R	D	R	D	R	D	D
	F 3-YR-2	R	R	D	D	R	D	D	R
	SHERIFF	D	R	D	R	D	D	R	R
Question	**1**	NO	YES	NO	NO	YES	YES	NO	YES
	2	NO	NO	YES	NO	NO	YES	YES	YES
	3	NO	YES	NO	YES	NO	YES	YES	NO
	4	NO	YES	YES	NO	YES	NO	YES	NO

Notes:

1. For each position, R and D stand for a vote for a Republican or a Democratic name, respectively. A blank space means no vote for that position.

Table 4. Short Ballot - Four Supplementary Voting Scenarios

Scenario Number					
		9	**10**	**11**	**12**
Position	**US-S**	PET1	PET2		WRITE-IN
	US-H	WRITE-IN		WRITE-IN	
	F 3-YR-1	WRITE-IN		WRITE-IN	
	F 3-YR-2	WRITE-IN		WRITE-IN	
	SHERIFF		WRITE-IN	WRITE-IN	
Question	**1**				
	2				
	3				
	4				

Notes:

1. For each position, R and D stand for a vote for a Republican or a Democratic name, respectively. A blank space means no vote for that position.
2. For each question, a blank space means no vote for that question.

Table 5. Results of the Volume Testing for ES&S iVotronic w/RTAL

No.	Requirement	Results for Election Systems & Software iVotronic with RTAL
2.0.20	II.B.9. The VVPRS shall mark the paper record precisely as indicated by the voter on the DRE and produce an accurate paper record and corresponding electronic record of all votes cast.	• VVPRS does mark each selection or de-selection on the paper records as indicated by the voters on the DRE and does produce accurate vote summaries on paper records after votes are cast. • The tally of the votes from the paper records does match the corresponding electronic records of all votes cast.
2.0.21	II.B.10. DRE electronic ballot image records shall include all votes cast by the voter, including write-ins and under votes.	• DRE electronic ballot image records do include all votes cast by the voters. Write-ins and undervotes are also included. • The tally of the votes from the paper records does match the corresponding electronic records of all votes cast including write-ins and undervotes.
2.0.24	II.B.11. An electronic ballot image record shall have a corresponding paper record.	• The paper record of each voting session per voter contains a unique Election Identification Number (EIN), an index described by the vendor. • The electronic ballot image records are listed in ascending order of EIN, which is printed on the paper records and contained in the barcode on each cast paper record. • All the cast paper records are marked with "Voter Accepted Ballot" and contain a series of barcodes. • By sorting all the paper records in ascending order of EIN, each electronic ballot image record can then be matched to the corresponding paper record. • Each electronic ballot image record does have a corresponding paper record provided no paper record is lost. • The occurrence of paper jams during the 14-hour test and the 1200-vote test resulted in the loss of complete printing of 4 votes and 3 votes, respectively.

2.0.26	II.B.11.b. The DRE electronic ballot image record shall correspond to the paper record in a manner that does not reveal the voter's identity.	• The electronic ballot image record contains the corresponding selected information for each candidate, answers, write-ins and undervotes in text format. No information in the electronic ballot image record reveals the voter's identity. • The electronic ballot image records are saved in ascending order of EIN. The EIN is printed on the paper record and contained in the barcode of the corresponding paper record. "EIN" is the linkage of the electronic ballot image record to the corresponding paper record provided no paper record is lost. In this way, the DRE electronic ballot image records correspond to the paper records without revealing the voter's identity. • The vote summary is printed with the exact date and time (YYYY/MM/DD - HH:MM:SS) of the voting session on the paper record. If this timestamp information is compared to the Poll Log which records the time when the voter checks in, the ballot paper record could be matched to the specific voter, therefore compromising voter privacy.
2.0.27	II.B.11.c. The paper record shall contain all voter selection information stored in the electronic ballot image record.	The paper records do contain all voter selection information stored in the electronic ballot image records.
3.0.2	III.A. The printer shall be designed to have a sufficient amount of paper, ink, toner, ribbon or like supply for use in an election, taking into account an election district should have at least one voting machine per 750 registered voters.	• The only supply needed is the paper roll for paper records. • A paper roll provided by the vendor is sufficient for about 120 paper records. • Paper replacement is expected for an election with more than approximately120 voters.
4.0.8	IV.A.3. For the "Cut and Drop" Method, if the paper record cannot be displayed in its entirety on a single page, each page of the record shall be numbered and shall include the total count of pages for that ballot.	The voting machine uses the "Continuous Spool" method.
4.0.9	IV.A.4. The image created on the paper record shall include every contest that is displayed to the voter	All selected contests that are displayed to and reviewed by the voter on the DRE screen are accurately printed in the vote summary on the

	on the DRE, including write-ins and undervotes.	paper record, including write-ins and undervotes, although undervotes are not printed in the line-by-line printing following individual selections, deselections or changes..
4.0.10	IV.A.5. The paper record shall be created such that its contents are machine readable.	The contents of the vote summary and timestamp information printed on the paper record are encoded in a group of barcodes which are machine readable.
4.0.14	IV.B.1. The electronic ballot image record and paper records shall be linked by including unique identifiers so that an individual paper record can be identified with its corresponding electronic record. Unique identifiers are tools that will allow LPS to measure the reliability and accuracy of the voting system, as necessary. The electronic ballot image and the paper record shall not reveal the identity of the voter.	• The paper record of each voting session per voter contains a unique Election Identification Number (EIN), which can point to the specific memory address (of the flash memory card and the PEB) at which the corresponding electronic ballot image record is stored. The EIN is printed on the paper record and also contained in the barcodes of the paper record. • The electronic ballot image record that can be displayed and printed using the vendor's proprietary software does not reveal any associated unique identifier number. • By decoding the barcodes of all the paper records and sorting them in ascending order of EIN; each electronic ballot image record can then be matched to the corresponding paper record. • Each electronic ballot image record does have a corresponding paper record provided no paper record is lost. • Information in the paper record and electronic ballot image record does not reveal the voter's identity.
4.0.16	IV.B.2. The DRE should generate and store a digital signature for each electronic record.	The iVotronic does not generate a digital signature for each electronic record (electronic ballot image record).
4.0.17	IV.B.3. The electronic ballot image records shall be able to be exported for auditing or analysis on standards-based and/or COTS (commercial off-the-shelf) information technology computing.	• The electronic ballot image records are digitally recorded in a proprietary file format. • The electronic ballot image records can only be accessed and processed by using the vendor's proprietary software. • Using the vendor's proprietary software, the electronic ballot image records can then be extracted into the text format which can be read by using a COTS software such as Notepad or MS Word for auditing and analysis.

4.0.18	IV.B.3.a. The exported electronic ballot image records shall be in a publicly available, non-proprietary format.	The exported electronic ballot image records can be read by using a COTS software such as MS Word.
4.0.19	IV.B.3.b. The records should be exported with a digital signature which shall be calculated on the entire set of electronic records and their associated digital signatures.	• According to the vendor's communication with NJIT on August 17, 2007 (ES&S Unity 4.0 Compliancy to the New Jersey Criteria for the VVPRS), page 11, "There are no digital signatures used in the creation or export of the electronic record." • The electronic record of the entire election does contain the cumulative electronic ballot image records, but does not have a digital signature. • The electronic ballot image record associated with a paper record does not contain an individual digital signature.
4.0.34	IV.C.5. The paper records shall distinguish between accepted and non-accepted ballots.	• The voting machine prints all vote selections after the voter has cast his or her ballot (the "VOTE" button is pressed). There is no provision of "rejected and non-accepted ballots" per Criteria. • Once the ballot is cast, "Voter Accepted Ballot" and a summary of the cast votes are printed on the paper record along with a group of barcodes.
4.0.35	IV.C.5.a. The voter shall have the opportunity to accept or reject the contents of his or her paper record.	• The voter does have the opportunity to accept or reject the vote selections on the screen before finally casting the ballot during his or her voting session. • When the voter selects (or deselects) a vote on the DRE screen, the voting machine selects (or cancels) the vote and prints the names of the contest office and selected (deselected) candidate on the paper roll in real time. Undervotes are not indicated on the printout at this time. • After the voter presses the "VOTE" button to cast the ballot, the printer prints the selections, write-ins and undervotes of all contests in the vote summary and a group of barcodes on the paper record. At this stage, the voter cannot reject the paper record.
4.0.36	IV.C.5.a.(1) If the voter rejects the contents of the paper record, he or	• The voter has unlimited opportunities to select and deselect the votes on the DRE screen

	she may recast the ballot up to two additional times. This procedure is consistent with current State law, which limits the amount of time a voter has to cast a ballot. (See N.J.S.A. 19:52-3).	during his or her voting session. • The ”VOTE” button is activated for the voter to cast the ballot only after the voter reviews all his or her vote selections on the “paper summary” pages displayed on the DRE screen. • When the voter presses the “VOTE” button, the complete ballot is printed in the vote summary along with a group of barcodes on the paper record. • Once the “VOTE” button is pressed and the vote summary is printed on the paper record, the DRE does not have any mechanisms for the voter to reject and recast the ballot. • The voter cannot recast the ballot up to two additional times per Criteria.
4.0.37	IV.C.5.a.(2) Before the voter causes a third and final paper record to be printed, the voter shall be presented with a warning notice on the machine that the selections on the DRE will be final. The voter will see and verify a printout of the votes, but will not be given additional opportunities to change any vote. The third ballot cast shall constitute the final and official ballot of such a voter.	Not Applicable: this VVPRS does not cause more than one paper record (vote summary) to be printed per voter"
4.0.38	IV.C.5.a.(3) Upon rejecting a paper record, the voter shall be able to modify and verify the selections on the DRE without having to reselect all choices in all contests on the ballot.	There is no provision of the “rejected paper record” per Criteria.
4.0.40	IV.C.5.a.(5) The VVPRS shall be designed to indicate the paper record which the voter has identified and cast as his or her official ballot.	“Voter Accepted Ballot” and “Vote cast by Voter” are printed on the paper record once the voter has completely reviewed his or her vote selections on the DRE screen and pressed the “VOTE” button.

Table 6. Counts of Voting Scenarios for Changing Voter selections

Voting Scenario	No. of Votes Cast During14-hour Test	No. of Votes Recorded Correctly During14-hour Test
2-1/2-2	4	4
8-1/8-2	5	5
4-1/4-2/4-3	4	4
Total	13	13

Note:
Here the final selection is the scenario number shown in Table 1 and the other scenarios are different from the final version. For example, Scenario 2-2 is Scenario Number 2 shown in Table 1, while Scenario 2-1 is somewhat different from Scenario Number 2 (Scenario 2-1 has a vote for the Republican candidate instead of the Democratic candidate for President in Scenario 2-2).

Table 7. Counts of Paper Records, Scanned Records, Electronic Records, and Poll Close for 14-hour Vote

		Count from Paper Records	Count from Scanned Records		Count from Electronic Records	Count from Poll Close
Total Votes		298	298		302	302
Office	**Candidate**					
President	R: Peter	140	140		142	142
	D: Kenneth	141	141		142	142
	BP1: William	4	4		5	5
	BP2:Michael	5	5		5	5
	WI:William	4	4		4	4
	Undervote	4	4		4	4
US Senate	R: John	140	140		142	142
	D: Phlip	141	141		142	142
	BP1: Joanna	0	0		0	0
	BP2:Christian	0	0		0	0
	WI:Ed lynch	8	8		9	9
	Undervote	9	9		9	9
House of Rep	R: David	137	137		139	139
	D: Larry	144	144		145	145
	BP1: Bernada	0	0		0	0
	BP2: Peter	0	0		0	0
	WI:Micheal	9	9		9	9
	Undervote	8	8		9	9
Freeholder 3yrs Vote 2	R: Bill	146	146		146	146
	R: Mike	143	143		143	143
	D: David	136	136		138	138
	D: Ray	138	138		141	141
	BP1:Jeffery	0	0		0	0
	BP1: Michael	0	0		0	0
	BP2: Antonio	0	0		0	0

	BP2: Richard	0	0		0	0
	WI-1:Kelly	8	8		9	9
	WI-2: Bruce	9	9		9	9
	Undervote	16	16		18	18
Freeholder 2yr Vote 1	R: Roy	141	141		141	141
	D: William	140	140		143	143
	BP1: Catherine	0	0		0	0
	BP2: Rebecca	0	0		0	0
	WI: Charles	8	8		9	9
	Undervote	9	9		9	9
Member Township Vote 1	R: Denver	141	141		143	143
	D: Baltimore	140	140		141	141
	BP1: Henry	0	0		0	0
	BP2: Katherine	0	0		0	0
	WI: Michael	8	8		9	9
	Undervote	9	9		9	9
Charter Study Vote 5	BP1: Herald	73	73		75	75
	BP1: Jessica	73	73		75	75
	BP1: Samuel	73	73		75	75
	BP1: Alfred	73	73		74	74
	BP1: Carlton	73	73		74	74
	BP2: Mario T	76	76		76	76
	BP2: Henry	76	76		76	76
	BP2: Mary	79	79		79	79
	BP2: Abraham	78	78		78	78
	BP2: Joel	79	79		79	79
	Write-in Candidates	109	109		109	109
	Undervote	628	628		640	640
Q1	Y	143	143		145	145

	N	138	138		139	139
	Undervote	17	17		18	18
Q2	Y	139	139		142	142
	N	142	142		142	142
	Undervote	17	17		18	18
Q3	Y	137	137		139	139
	N	144	144		145	145
	Undervote	17	17		18	18
Q4	Y	142	142		143	143
	N	139	139		141	141
	Undervote	17	17		18	18
Q5	Y	144	144		144	144
	N	137	137		140	140
	Undervote	17	17		18	18
Q6	Y	142	142		143	143
	N	139	139		141	141
	Undervote	17	17		18	18
Q7	Y	137	137		140	140
	N	144	144		144	144
	Undervote	17	17		18	18

Note: In case of the Charter Study commission, several write-ins have been combined to show the total number of write-ins.

Table 8. Counts of Paper Records, Scanned Records, Electronic Records, and Poll Close for 1200-Vote

		Count from Paper Records	Count from Scanned Records		Count from Electronic Records	Count from Poll Close
Total Votes		1197	1197		1200	1200
Office	**Candidate**					
US Senate	R: John	503	503		505	505
	D: Phlip	502	502		502	502
	BP1: Scott	48	48		48	48
	BP2:Mary	46	46		46	46
	WI-1 USS	49	49		49	49
	Undervote	49	49		50	50
House of Rep	R: David	504	504		505	505
	D: Larry	501	501		502	502
	WI-1 HOR	97	97		98	98
	Undervote	95	95		98	98
Freeholder 3yrs Vote 2	R: Name7	513	513		513	513
	R: Name9	499	499		500	500
	D: Name8	492	492		494	494
	D: Name10	506	506		507	507
	WI-1 FR	98	98		196	196
	WI-2 FR	96	96			
	Undervote	190	190		190	190
SHERIFF	R: Denver	505	505		507	507
	D: Baltimore	500	500		500	500
	WI-1 SHERIFF	143	143		144	144
	Undervote	49	49		49	49
Q1	Y	499	499		500	500
	N	504	504		505	505
	Undervote	194	194		195	195

Q2	Y	496	496		498	498
	N	508	508		508	508
	Undervote	193	193		194	194
Q3	Y	510	510		511	511
	N	494	494		494	494
	Undervote	193	193		195	195
Q4	Y	497	497		498	498
	N	507	507		508	508
	Undervote	193	193		194	194

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c. Single Tests

This following “legend” refers to the New Jersey Criteria for Verified Voter Paper Record for Direct Recording Electronic Voting Machines (the "Criteria"), and indicates the type of testing performed for each requirement:

- Sections marked in Yellow are covered by Volume Tests only.
- Sections marked in Gray are covered by Single Tests only.
- Sections marked in Green are covered by both Volume Test and Single Test.
- Sections marked in Red or not marked are not tested.

No.	Requirement	Test scenario	Test Result
	Marked up for Work Activity May 16th 2007 Markup 6		
	Pursuant to N.J.S.A. 19:48-1 and N.J.S.A. 19:53A-3, no later than January 1, 2008, each voting machine in New Jersey shall produce an individual permanent paper record for each vote cast, which shall be made available for inspection and verification by the voter at the time the vote is cast, and preserved for later use in any manual audit. In the event of a recount, the voter-verified paper records will be the official tally for the election.		
	To effectuate the intent of the statute, and to instill full public confidence in the electoral process, the Attorney General has established the following criteria for the design and use of a Voter-Verified Paper Record System in conjunction with a Direct Recording Electronic Voting Machine.		
1.0.0	**I. Definitions**		
2.0.0	**II. General Description of System**		
2.0.1	**A. Components**		
2.0.7	**B. Operation**		
2.0.8	II.B.1. The VVPRS may be designed in various configurations. In all configurations, prior to casting the	• Inspect the VVPRS to determine whether the voter shall have the ability to verify his or her selections on a paper record in a	• The voter can easily review his or her selections and de-selections printed on the paper roll in a one selection by one selection manner.

No.	Requirement	Test scenario	Test Result
	ballot, the voter shall have the ability to verify his or her selections on a paper record in a private and independent manner.	private and independent manner. • View the votes cast by a voter at a close distance. When the vote is being cast, an observer close by should not be able to view the voter's selection of preferences during the casting and recording of the ballot.	• Two side panels exist, but by themselves do not provide privacy. • An observer may be able to read the screen or Paper Record Display Unit if he or she stands behind or next to the voter.
2.0.9	II.B.2. The VVPRS shall be designed to allow the voter to easily review, accept, or reject his or her paper record.	• Conduct a vote to see if the voter can review, accept, or reject his or her selections.	• The voter can easily review his or her selections and de-selections on paper record in a one selection by one selection manner. • Only one paper record (vote summary) is printed per voter. • The paper record (vote summary) is not reviewable because the vote has been cast and cannot be read by the voter since it advances to the take-up spindle rapidly. Even if the voter were able to read the paper record in the short period of time, there is no mechanism for the voter to reject the paper record and to recast.
2.0.10	II.B.2.a. The DRE shall not record the electronic record until the paper record has been approved by the voter.	• Conduct a vote to see if the record has been electronically recorded before the voter's approval.	• Only one paper record (vote summary) is printed per voter after the voter presses the "VOTE" button. • The DRE does not record the electronic record until the voter has approved his or her ballot on the DRE screen instead of on the paper record.
2.0.11	II.B.3. VVPRS records may be printed and stored by two different methods:		
2.0.12	II.B.3.a. "Cut and Drop" Method: The voter views and verifies the paper record, which the VVPRS cuts and drops into a Storage Unit.	• Check the vendor documentation to determine which method is used in the to-be-tested system. • If it is the case, conduct a vote to see if the operation is consistent with respect to the	This VVPRS adopts the "Continuous Spool" method.

No.	Requirement	Test scenario	Test Result
		"Cut and Drop" method.	
2.0.13	II.B.3.b. "Continuous Spool" Method: The voter views the paper record on a spool-to-spool paper roll. This method shall be used in a manner that fully protects the secrecy of all votes cast.	• Check the vendor documentation to determine which method is used in the to-be-tested system. • If it is the case, conduct a vote to see if the operation is consistent with respect to the "Continuous Spool" method.	• Two side panels exist, but by themselves do not provide privacy. An observer may be able to read the screen or Paper Record Display Unit if he or she stands behind or next to the voter. • The roll of printed paper records is accessible upon unlocking the printer cover.
2.0.14	II.B.4. No electronic or paper record shall indicate the identity of a voter or be maintained in a way that allows a voter to be identified.	• Conduct a vote to check the paper record. • Check the electronic record.	• Neither the electronic record nor the paper record indicates the identity of a voter. • Paper records bear timestamps. If this timestamp information is compared to the Poll Log which records the time when the voter checks in, the cast ballot could be matched to the specific voter, therefore compromising voter privacy.
2.0.15	II.B.5. The electronic and paper records shall be created and stored in ways that preserve the privacy of the record.	• Examine how the electronic record is created and stored. • Examine how the paper record is created and stored.	• Two side panels exist, but by themselves they do not provide privacy for the paper records or the DRE screen. An observer may be able to read the Paper Record Display Unit or the DRE screen by standing behind or next to the voter. • Once the voter presses the “VOTE” button to cast the ballot, the printer prints out the vote summary and a group of barcodes with the exact date and time (YYYY/MM/DD - HH:MM:SS) of the voting session on the paper record. If this timestamp information is used with the Poll Log which records the time when the voter checks in, the cast ballot could be matched to the specific voter, therefore compromising the voter privacy.
2.0.17	II.B.6.a. These requirements shall include, but are not limited to, an audio component that shall accurately relay	• Conduct a mock election to check if the audio information is consistent to the election and its integrity.	This voting machine includes an audio component that accurately relays the information printed on the paper record to the voter.

No.	Requirement	Test scenario	Test Result
	the information printed on the paper ballot to the voter.		
2.0.18	II.B.7. The VVPRS device shall draw its power from the DRE or the same electrical circuit from which the DRE draws its power.	• Inspect the system to ensure that the VVPRS does draw its power either from the DRE or from the same electrical circuit from which the DRE draws its power.	The VVPRS device draws its power from the same electrical circuit from which the DRE draws its power.
2.0.19	II.B.8. The voting machine shall provide a standard, publicly documented printer port, or the equivalent, using a standard communication protocol.	• Inspect the interface between the printer and DRE to determine whether the voting machine provides a standard, publicly documented printer port, or the equivalent, using a standard communication protocol.	The voting machine provides a standard, publicly documented printer port, using a standard communication protocol.
2.0.20	II.B.9. The VVPRS shall mark the paper record precisely as indicated by the voter on the DRE and produce an accurate paper record and corresponding electronic record of all votes cast.	• Setup a mock election. • Open the poll in the official mode. • Conduct a vote. • Review the paper record and verify that the VVPRS marks the paper record precisely as indicated by the voter on the DRE. • Cast the vote. • Close the poll and export electronic data from the electronic storage media with the device/software provided by the vendor. • Verify the electronic ballot image record is accurate as the paper record.	• The VVPRS does print each selection or de-selection on the paper roll as indicated by the voter on the DRE. • After presenting all the pages of the ballot summary on the DRE screen, the “VOTE” button on the top of the DRE screen begins to flash. The voter can press the “VOTE” button on the DRE screen while the button is flashing, a vote summary of the ballot selections and a group of barcodes associated with the ballot are printed on the paper record. • The electronic ballot image record retrieved by using the vendor’s proprietary software is in text format, containing all votes cast as printed in the vote summary on the paper record.
2.0.21	II.B.10. DRE electronic ballot image records shall include all votes cast by the voter, including write-ins and undervotes.	• Conduct a vote including write-ins and undervotes. • Close the poll and export electronic data from the electronic storage media with the device/software provided by the vendor. • Verify the electronic ballot image records include all votes cast by the voter, including	• The electronic ballot image record retrieved by using the vendor’s proprietary software is in text format. • The information recorded in the electronic ballot image matches information printed on the paper record, and does include all votes cast by the voter, including write-ins and undervotes.

No.	Requirement	Test scenario	Test Result
		write-ins and undervotes.	
2.0.24	II.B.11. An electronic ballot image record shall have a corresponding paper record.	• Open the poll in the official mode. • Conduct 10 votes including some voided cast votes. • Close the poll and export electronic data from the electronic storage media with the device/software provided by the vendor. • Match each electronic ballot image record to the corresponding paper record.	• The electronic ballot image records are listed in ascending order of EIN (an index described by the vendor), which is printed on paper records and contained in the barcodes on all cast paper records. • Upon having reviewed all the selections and pressing the "VOTE" button, the vote is electronically recorded. The corresponding paper record is marked "Voter Accepted Ballot" and contains a group of barcodes. • By scanning all the paper records with barcodes and sorting them in ascending order of EIN, each electronic ballot image record can then be matched to the corresponding paper record.
2.0.25	II.B.11.a. The paper record shall be printed and the voter shall have the opportunity to verify the paper record in its totality prior to the final electronic record being recorded.	• Setup a mock election. • Open the poll in the official mode. • Conduct a vote. • Review the paper record and verify that the VVPRS marks the paper record precisely as indicated by the voter on the DRE. • Cast the vote.	• The VVPRS prints precisely as indicated by the voter on the DRE screen for all selections and deselections; however, the paper record does not present a complete ballot until the voter cast the ballot. • The voter has an opportunity to review all the selections in its totality only on the screen before casting the ballot. When the voter presses the "VOTE" button on the top of the DRE screen, a vote summary of the ballot selections is printed; however, the voter does not have enough time to verify the vote summary on the paper record. • The DRE screen shows a message confirming that the vote has been recorded
2.0.26	II.B.11.b. The DRE electronic ballot image record shall correspond to the paper record in a manner that does not reveal the voter's identity.	• Open the poll in the official mode. • Conduct one vote. • Close the poll and export electronic data from the electronic storage media with the device/software provided by the vendor.	• No obvious mark on the paper record reveals the voter's identity. • The electronic ballot image record contains only the corresponding selected information for each candidate, answers, write-ins and undervotes in text format.

No.	Requirement	Test scenario	Test Result
		• Verify that each electronic ballot image record is clearly identifiable on the corresponding printed paper record, but does not reveal the voter's identity.	• The electronic ballot image records are saved in the ascending order of EIN; the EIN is printed on the paper and contained in the barcode of the corresponding paper record. • The EIN is the linkage of electronic ballot image record to the corresponding paper record provided no paper record is lost, in which case the DRE electronic ballot image records correspond to the paper records. • No information in the electronic ballot image record reveals the voter's identity. • The vote summary is printed with the exact date and time (YYYY/MM/DD - HH:MM:SS) of the voting session on the paper record. If this timestamp information is compared to the Poll Log which records the time when the voter checks in, the ballot paper record could be matched to the specific voter, therefore compromising voter privacy.
2.0.27	II.B.11.c. The paper record shall contain all voter selection information stored in the electronic ballot image record.	• Open the poll in the official mode. • Conduct one vote. • Close the poll and export electronic data from the electronic storage media with the device/software provided by the vendor. • Verify that a printed paper record contains all selection information stored on the corresponding electronic ballot image record.	The printed paper record does contain all selection information stored in the corresponding electronic ballot image record.
3.0.0	**III. Design Requirements for a VVPRS**		
3.0.1	**A. Printer**		
3.0.2	III.A.1. The printer shall be designed to have a sufficient amount of paper, ink,	• Inspect the printing unit to determine the capacity of ink and paper supply.	• The only supply needed is the paper roll for paper records.

No.	Requirement	Test scenario	Test Result
	toner, ribbon or like supply for use in an election, taking into account an election district should have at least one voting machine per 750 registered voters.	• Determine if the provided capacity is sufficient for conducting an election. • Set up a mock election. • Cast at least 1200 votes.	• A paper roll provided by the vendor is sufficient for about 120 paper records. • Paper records are legible. • Paper replacement is expected for an election with more than approximately120 voters.
3.0.3	III.A.1.a. If any addition or replacement of paper, ink, toner, ribbon or other like supply is required, it shall be done with minimal disruption to voting and without circumvention of the security features of the Printer and Storage Unit which protect cast ballots and the secrecy of the vote.	• Inspect the process of paper replacement. • Examine the possibility of circumvention of security features. • Repeat the scenario for other printer supplies.	• The VVPRS is protected by a cover which can be locked by a key from behind the VVPRS. • The VVPRS must be unlocked to change the paper. • The printed paper records are rolled around a take-up spindle. • No other protecting mechanism is provided for printed paper records, i.e., the printed paper records are stored in the same enclosure with the printer. The printed paper records are accessible during the paper change process. • No other printer supplies need to be replaced.
3.0.4	III.A.2. The VVPRS shall have a low-paper indicator that will allow for the timely addition of paper so that each voter can fully verify, without disruption, all of his or her ballot selections.	• Conduct a mock election with a low supply of papers and verify that VVPRS alerts.	• If the amount of paper reaches the minimum limit during a voting session, the VVPRS does not give the voter the opportunity to finish voting and the VVPRS automatically voids the vote. • After the printer reaches the low paper supply limit, the VVPRS sounds a beep and displays an error message on the DRE screen. • The VVPRS cannot be activated unless an official worker with a supervisor PEB installs a new paper roll and reactivates the machine.
3.0.5	III.A.3. The printer shall be secured by security seals or locking mechanisms to prevent tampering. The printer shall be accessed only by those election	• Inspect the printer and check its sealing or locking mechanisms. • Examine the accessibility of the printer.	• The printer is enclosed by a removable cover. • The cover of the printer can be locked from the back of the VVPRS with a key. • To access the printer, the cover shall be unlocked

No.	Requirement	Test scenario	Test Result
	officials authorized by the county commissioner of registration.		first. • Upon unlocking the cover, no other protection is provisioned for printed paper records. • The wire connecting the VVPRS to the DRE is exposed to the voter and can be easily disconnected from the printer port on the top of the DRE.
3.0.6	III.A.4. The VVPRS shall be capable of showing the information on the paper record in a font size of at least 3.0 mm and should be capable of showing the information in at least two font ranges, 3.0-4.0 mm and 6.3-9.0 mm, under the control of the voter or poll worker. This criteria can be met by providing a magnification device with the VVPRS.	• Inspect the printed ballot for font size to ensure conformance with the standard. • Inspect the unit for capability of showing the information on at least two font sizes.	• The font size is constant and cannot be changed in this system. • In this observation, the length of the printed characters is in the 2.0-3.0 mm range. • A magnification device provided by the vendor can show the printed paper with a font in the range of 3.0-5.0 mm.
3.0.7	**III.B. Paper Record Display Unit**		
3.0.8	III.B.1. The paper record shall be displayed in a way that allows the voter to privately and independently inspect it.	• Observe how the paper record is displayed. • Observe whether the voters can privately and independently inspect the paper record.	• Two side panels exist, but by themselves do not provide privacy. An observer may be able to read the screen or Paper Record Display Unit if he or she stands behind or next to the voter.
3.0.9	III.B.2. If the paper record cannot be viewed entirely in the Display Unit at one time, the voter shall have the opportunity to verify the entire paper record prior to the electronic or the paper ballot being stored and recorded.	• Conduct a mock election with a sufficient number of contests/positions such that the paper record cannot be viewed entirely in the Display Unit at one time.	• After casting the vote, the vote summary (the final selections) is printed on the paper record but the voter does not have an opportunity to verify the information in the vote summary, since the printed paper record advances to the take-up spindle rapidly.
3.0.10	III.B.3. The Display Unit shall have a protective covering which shall be transparent and shall not obscure the	• Inspect the display unit for protective cover and verify that it does not obscure the voter’s view.	• The Paper Record Display Unit does have a protective covering which is transparent and does not obscure the voter's view of the paper record.

No.	Requirement	Test scenario	Test Result
	voter's view of the paper record. This covering shall be in such condition that it can be made transparent by ordinary cleaning of its exposed surface.		• This covering is in such condition that it can be made transparent by ordinary cleaning of its exposed surface. • The transparent protective cover may appear smeared if it is scratched by sharp objects.
3.0.11	**III.C. Paper**		
3.0.12	III.C.1. Any paper record produced by a VVPRS shall be readable by voters and election officials.	• Inspect the paper records for ink color, type size, type face and readability.	• Printing on paper records viewed through the Paper Record Display Unit is legible. • The officials can read the paper records when the paper records are removed from the VVPRS.
3.0.15	**III.D. Paper Record Storage Unit**		
3.0.16	III.D.1. Security protections including, but not limited to, security seals or locking mechanisms, shall be built into the Storage Unit to prevent tampering at all times, including pre-election, election day, and post-election. The Attorney General, through the Department of Law and Public Safety ("LPS"), will issue chain of custody guidelines regarding the Storage Unit.	• Inspect the security protections of the storage unit.	• The VVPRS is protected by a cover. • A lock is available on the VVPRS cover to secure the printer and printed paper records. • No separate protecting mechanism is available for printed paper records. • The roll of printed paper records is accessible upon unlocking the printer cover.
4.0.0	**IV. Procedural and Usability Requirements**		
4.0.1	**IV.A. Paper Records**		
4.0.2	IV.A.1. The paper record shall include identification of the particular election, the election district, and the voting machine.	• Conduct a mock election. • Check the paper record for identification of the particular election, the election district, and the voting machine. • Verify whether the identification of the mock election, the election district, and the voting machine recorded on the paper record are accurate.	• The paper record does include the identification of the particular election, the election district (i.e., in this test, Precinct ID and Polling Place ID), and the voting machine serial number, along with the date of election and the exact time of voting session.

No.	Requirement	Test scenario	Test Result
4.0.3	IV.A.2. The paper record shall include a barcode that contains the human-readable contents (shorthand is acceptable) of the paper record.	• Conduct a mock election. • Verify whether the paper record contains a barcode. • Verify whether the barcode contains the human-readable contents of the paper record by observing the readable contents. • Verify whether all human-readable contents of the paper record are accurately recorded and in consistent with the contents printed on the paper record.	• The barcode accurately contains all human-readable contents, including the name of contest offices and voted contest candidates, answers for questions, and write-in names, for all voted and undervoted contests. • The barcode can be decoded by any 2D PDF-417 barcode reader; the decoded barcode data can be read by using any text editing COTS or non-proprietary software.
4.0.4	IV.A.2.a. The barcode shall use an industry standard format and shall be able to be read using readily available commercial technology.	• Conduct a mock election. • Verify whether the barcode can be read by using a readily available commercial barcode reader (given by the associated vendor). • Verify whether the barcode's format complies with an industry standard format approved by the Election Commission.	• According to the vendor's communication with NJIT on August 17, 2007 (ES&S Unity 4.0 Compliancy to the New Jersey Criteria for the VVPRS), the ES&S RTAL printer prints the barcode based on the 2D PDF417 barcode standard format. • The barcode correctly complies with the industrial 2D PDF-417 standard format and can be read by a readily available commercial barcode reader.
4.0.5	IV.A.2.b. If the corresponding electronic record contains a digital signature, the digital signature shall be included in the barcode on the paper record.	• Conduct a mock election. • Verify whether the electronic record contains a digital signature as stated in Requirements IV.B.2 and IV.B.3.b. • Verify whether the digital signature calculated and stored in the electronic record is the same signature contained in the barcode on the paper record.	• According to the vendor's communication with NJIT on August 17, 2007 (ES&S Unity 4.0 Compliancy to the New Jersey Criteria for the VVPRS), "The iVotronic with RTAL printer does not employ digital signatures."
4.0.7	IV.A.2.c. The barcode shall not contain any information other than an accurate reflection of the paper record's human-readable content, error correcting codes, and digital signature	• Determine the adopted standard of the barcode. • Conduct a mock election. • Verify that the barcode contains only the paper record's human-readable content,	• The barcode contains all human-readable contents of the paper record, and some internal values (i.e., PGID, PDi, and EIN) defined and used by the vendor's proprietary software. • The error correcting code is implemented as defined

No.	Requirement	Test scenario	Test Result
	information.	error correcting codes, and digital signature information.	by the industrial 2D PDF-417 barcode standard format. • No digital signature is contained in the barcode.
4.0.8	IV.A.3. For the "Cut and Drop" Method, if the paper record cannot be displayed in its entirety on a single page, each page of the record shall be numbered and shall include the total count of pages for that ballot.	• Conduct a mock election with a sufficient number of contests or positions such that the paper record cannot be displayed in its entirety on a single page. • Observe the printed paper records. • Verify whether each page of the paper records shows the page number and the total count of pages for that ballot.	Not Applicable: This voting machine uses the "Continuous Spool" method.
4.0.9	IV.A.4. The image created on the paper record shall include every contest that is displayed to the voter on the DRE, including write-ins and undervotes.	• Conduct a mock election. • Verify whether every contest, write-ins and undervotes that are displayed on the DRE are precisely created and recorded on the paper record.	All selected contests that are displayed to and reviewed by the voter on the DRE screen are accurately printed in the vote summary on the paper record, including write-ins and undervotes, although undervotes are not printed in the line-by-line printing following individual selections, deselections or changes.
4.0.10	IV.A.5. The paper record shall be created such that its contents are machine readable.	• Check the vendor documentation on how the contents of the paper record are made machine readable. • Conduct a mock election. • Observe whether the contents of the paper record can be machine readable by using any specific mechanism that complies with other requirements such as Requirements IV.A.2.a and IV.A.6.	The contents of the vote summary and timestamp information printed on the paper record are encoded in a group of barcodes which are machine readable.
4.0.11	IV.A.6. The paper record shall contain error correcting codes for the purpose of detecting read errors and for preventing other markings on the paper record from being misinterpreted when the paper record is machine read.	• Check the vendor documentation to determine the type of error correcting codes adopted. • Conduct a mock election. • Verify that error correcting codes can help detect read errors when the paper record is	• According to the vendor's communication with NJIT on August 17, 2007 (ES&S Unity 4.0 Compliancy to the New Jersey Criteria for the VVPRS), the error correcting code contained in the barcode is the error correcting code as defined in the 2D PDF-417 specification.

No.	Requirement	Test scenario	Test Result
		read by a machine. • Insert markings on the paper record after an error correcting code is calculated in an attempt to cause misinterpretation and check if the attempt is successful.	• The barcode does contain error correcting codes as defined in the industrial 2D PDf-417 barcode standard (Refer to Information Technology AIDC Techniques Bar code symbology specification PDF-417: ISO/IEC 15438:2006 for the 2D PDF-417 barcode standard): * The barcode can be successfully read, even when there are some markings on the barcode such as marking a line on the top of the barcode, a line at the bottom of the barcode, 21 lines across the barcode (using a black-color 0.7mm pen) with the width of 1 mm between each line, and when the barcode is punched with a small hole (a diameter of 5 mm). * However, the barcode cannot be read when there are other markings: two lines by the left and right sides of the barcode and a cross (/ and X) on the barcode with a black-color permanent marker with a width of 2 mm.
4.0.13	**IV.B. DRE Electronic Records**		
4.0.14	IV.B.1. The electronic ballot image record and paper records shall be linked by including unique identifiers so that an individual paper record can be identified with its corresponding electronic record. Unique identifiers are tools that will allow LP S to measure the reliability and accuracy of the voting system, as necessary. The electronic ballot image and the paper record shall not reveal the identity of the voter.	• Check the vendor documentation on how to generate the identifiers of the electronic ballot image record and the paper record. • Conduct a mock election. • Verify whether the identifiers of the paper record and electronic record for the ballot can be mutually linked.	• According to the vendor's communication with NJIT on August 17, 2007 (ES&S Unity 4.0 Compliancy to the New Jersey Criteria for the VVPRS), page 10, the paper record of each voting session per voter contains an EIN which can point to the specific memory address (of the flash memory card and the PEB) at which the corresponding electronic ballot image record is stored. • However, the electronic ballot image record that can be displayed and printed using the vendor's proprietary software does not reveal any associated unique identifier number. • The only identifier of the accepted paper record that can link to the associated electronic ballot image is the

No.	Requirement	Test scenario	Test Result
			EIN printed on the paper record and contained in the barcode of the paper record. • The following is the procedure to reconcile the paper record with the associated electronic ballot image record: * All the barcodes of the entire set of paper records must be decoded. * Sort the EINs from the decoded barcode data in ascending order. * Match the sorted decoded barcode data with the electronic ballot image records printed in the "Election Summary with Group Detail" report. • Information in the paper record does not reveal the voter's identity. • Information in the electronic ballot image record does not reveal the voter's identity.
4.0.15	IV.B.1.a. Unique identifiers shall not be displayed in a way that can be easily memorized.	• Conduct a mock election with multiple voters. • Ask each voter to memorize the identifiers on the paper record.	• The EIN has 7 digits and is printed after the vote is cast, on the paper record, which is rolled into the take-up spindle very quickly. • None of the five testers could easily memorize the EIN.
4.0.16	IV.B.2. The DRE should generate and store a digital signature for each electronic record.	• Verify if this function is supported. • If this function is supported: * Conduct a mock election. • Verify whether the digital signature is generated for the electronic record.	• According to the vendor's communication with NJIT on August 17, 2007 (ES&S Unity 4.0 Compliancy to the New Jersey Criteria for the VVPRS), page 9, the iVotronic does not generate a digital signature for each electronic record (electronic ballot image record).
4.0.20	IV.B.3.c. The voting system vendor shall provide documentation about the structure of the exported ballot image records and how they shall be read and processed by software.	• Review the vendor documentation about the structure of the electronic ballot image records and how the electronic record can be read and processed.	• The vendor describes how the electronic ballot image records can be read and audited in the vendor documentation (ES&S iVotronic System Operations Procedures, June 14, 2007 (ERM SOP v. 7.4.0.0_6.14.2007.pdf), Chapters 29, Part 6).

No.	Requirement	Test scenario	Test Result
4.0.21	IV.B.3.d. The voting system vendor shall provide a software program that will display the exported ballot image records and that may include other capabilities such as providing vote tallies and indications of undervotes.	• Review the provided software that displays the exported electronic records. • Review the provided software if other capabilities, including providing vote tallies and indications of undervotes, are enabled.	• The exported electronic ballot image records can be printed out to the "Vote Image Log" report by using the vendor's proprietary software (Election Reporting Manager). • The "Election Summary Report with Group Detail" report contains the vote tallies that can be generated by using the vendor's proprietary software (Election Reporting Manager). • The "Write-In" and "Undervote Image Log" reports contain write-in and undervote records that can be generated by using the vendor's proprietary software (Election Reporting Manager).
4.0.22	IV.B.3.e. The voting system vendor shall provide full documentation of procedures for exporting electronic ballot image records and reconciling those records within the paper records.	• Review the vendor documentation of procedures for exporting electronic ballot image records. • Review the vendor documentation of procedures for reconciling these electronic ballot image records within the paper records.	• The vendor documentation (ES&S iVotronic System Operations Procedures, June 14, 2007 (ERM SOP v. 7.4.0.0_6.14.2007 401-480.pdf), Chapter 61) addresses the procedures for exporting the "electronic ballot image records". • The vendor documentation does not provide the procedure to reconcile the electronic ballot image records within the paper records, but we developed the procedure as illustrated in the Test Result of Requirement IV.B.1.
4.0.23	IV.C. Voting with a VVPRS		
4.0.24	IV.C.1. LPS shall promulgate for voters instructions on how to use the VVPRS.		
4.0.25	IV.C.1.a. The VVPRS vendors shall provide, in plain language, any reference material requested by LPS to aid in the preparation of VVPRS instructions. These instructions shall be	• Check that the vendor documentation of procedures for preparing the VVPRS and training the county board of election worker is provided.	• The vendor technical data package, such as system operations procedures, system maintenance manual, personal deployment and training requirements, as well as pre-election and election day operations checklists are provided for board worker training.

No.	Requirement	Test scenario	Test Result
	issued to each county board of election for board worker training.		• The vendor documentation (ES&S iVotronic System Operations Procedures, June 14, 2007 (ERM SOP v. 7.4.0.0_6.14.2007 401-480.pdf), Chapter 3) illustrates the procedures of the election day preparation.
4.0.29	IV.C.2. Voter privacy shall be preserved during the process of recording, verifying, and auditing ballot selections. This includes a voter who uses an audio voting device. Voters using an audio voting device shall also be able to verify votes privately and independently.	• Conduct a mock election. • Verify whether the voting records (both electronic and paper records) can identify or trace back to the voter. • Verify whether the voting records are listed in any specific order and the voter is kept anonymous. • Try to view the votes cast by a voter at a close distance. When the vote is being cast, an observer close by should not be able to view the voter's selection of preferences during the casting and recording the ballot. • Inspect the DRE for the audio voting device and review the manual for the process of voting through the audio voting device. • Conduct an election by using the given audio voting device. • Observe that the voter who uses the audio voting device can cast the vote in a private and independent manner.	• Voter privacy is preserved in several ways: * The machine is expected to be strategically spaced such that no bystanders are allowed to peek into the DRE screen and the Paper Record Display Unit. * No information on the paper record contains any identity-related information that can link to the voter. * No information on the associated electronic record (or the electronic ballot image record) contains any identity-related information that can link to the voter. * The electronic record is stored in the randomized memory blocks of the flash memory card and Master PEB. • Two side panels exist, but by themselves do not provide privacy. An observer may be able to read the screen or Paper Record Display Unit if he or she stands behind or next to the voter. • Audio voters utilize headphones that ensure privacy. • Once the voter presses the "VOTE" button to cast the ballot, the printer prints out the vote summary and a group of barcodes with the exact date and time (YYYY/MM/DD - HH:MM:SS) of the voting session on the paper record. If this timestamp information is used with the Poll Log which records the time when the voter checks in, the cast ballot could be matched to the specific voter, therefore compromising the voter privacy.

No.	Requirement	Test scenario	Test Result
4.0.34	IV.C.5. The paper records shall distinguish between accepted and non-accepted ballots.	• Conduct a mock election, cast and recast the votes up to two additional times, complying with the NJ state law N.J.S.A. 19:52-3 as addressed in Requirement IV.c.5.a.(1). • Check for acceptance information on a paper record. • Check whether the acceptance information items on both accepted and non-accepted paper records are clearly distinguished.	• The voting machine prints all vote selections after the voter has cast his or her ballot (the "VOTE" button is pressed). There is no provision of "rejected and non-accepted ballots" per Criteria. • Once the ballot is cast, "Voter Accepted Ballot" and a summary of the cast votes are printed on the paper record along with a group of barcodes.
4.0.35	IV.C.5.a. The voter shall have the opportunity to accept or reject the contents of his or her paper record.	• Conduct a mock election. • Observe whether the voter can recast the ballot after the ballot is printed and displayed on the DRE, complying with the NJ state law N.J.S.A. 19:52-3 as addressed in Requirement IV.c.5.a.(1).	• The voter does have the opportunity to accept or reject the vote selections on the screen before finally casting the ballot during his or her voting session. • When the voter selects (or deselects) a vote on the DRE screen, the voting machine prints the names of the contest office and selected (deselected) candidate on the paper roll in real time. • Only after the voter presses the "VOTE" button to cast the ballot, the printer prints the selections, write-ins and undervotes of all contests in the vote summary and a group of barcodes on the paper record. However, at this point, the voter cannot reject the paper record.
4.0.36	IV.C.5. a.(1) If the voter rejects the contents of the paper record, he or she may recast the ballot up to two additional times. This procedure is consistent with current State law, which limits the amount of time a voter has to cast a ballot. (See N.J.S.A. 19:52-3).	• Conduct a mock election. • Observe whether if the voter rejects the contents of the paper record, he or she may recast the ballot up to two additional times.	• The voter has unlimited opportunities to select and deselect the votes on the DRE screen during his or her voting session. • The "VOTE" button is activated for the voter to cast the ballot only after the voter reviews all his or her vote selections on the "paper summary" pages displayed on the DRE screen. • When the voter presses the "VOTE" button, the

No.	Requirement	Test scenario	Test Result
			complete ballot is printed in the vote summary along with a group of barcodes on the paper record. • Once the "VOTE" button is pressed and the vote summary is printed on the paper record, the DRE does not have any mechanisms for the voter to reject and recast the ballot. • The voter cannot recast the ballot up to two additional times per Criteria.
4.0.37	IV.C.5. a.(2) Before the voter causes a third and final paper record to be printed, the voter shall be presented with a warning notice on the machine that the selections on the DRE will be final. The voter will see and verify a printout of the votes, but will not be given additional opportunities to change any vote. The third ballot cast shall constitute the final and official ballot of such a voter.	• Conduct a mock election. • Verify that before a voter casts his or her third ballot, a warning notice is displayed informing the voter that this is the last attempt to cast his or her ballot.	Not Applicable: this VVPRS does not cause more than one paper record (vote summary) to be printed per voter.
4.0.38	IV.C.5.a.(3) Upon rejecting a paper record, the voter shall be able to modify and verify the selections on the DRE without having to reselect all choices in all contests on the ballot.	• Conduct a mock election. • Verify that after rejecting a paper record, a voter can modify the selections from the last ballot and verify the new selections for the new ballot on the DRE without having to reselect all selections in all contests on the ballot.	There is no provision of the "rejected paper record" per Criteria.
4.0.39	IV.C.5. a.(4) If a mechanical error in recording or printing a paper record occurs, the record shall be counted as a spoiled paper record. It will not be counted as one of the voter's three	• Conduct a mock election. • Verify that the spoiled ballot is not counted as one of the voter's three attempted votes.	• Some mechanical errors, such as low paper supply, no paper at the print head, or the printer cable disconnected during vote selections, lead to the suspension of the machine that requires the poll worker's intervention. The record is always spoiled,

No.	Requirement	Test scenario	Test Result
	attempted votes.		and the voter is automatically given another chance to vote, that is, to start over. • When the paper jam occurs, the voter can still make or change selections on the DRE and cast the ballot as normal. However, the printer keeps printing over the same area on the paper roll, making it illegible. No barcode is printed. The ballot is electronically recorded. • If the printer cable is disconnected from the printer port on the top of the machine when the vote summary is being printed, the following can occur: * Some vote selections and barcodes are not printed. * The machine displays the error message and requires the supervisor intervention, which automatically results in the voided ballot. * The Event Log shows two corresponding messages: "Printer is not responding" and "Vote Cancelled – Printer Problem". * However, the "Election Summary with Group Detail" report shows that the electronic record is counted. In addition, the "Vote Image Log" report shows the vote selections of the voided ballot.
4.0.40	IV.C.5. a.(5) The VVPRS shall be designed to indicate the paper record which the voter has identified and cast as his or her official ballot.	• Conduct a mock election in which the voter accepts his or her ballot after the cast. That ballot is clearly indicated as an official ballot.	"Voter Accepted Ballot" and "Vote Cast by Voter" are printed on the paper record once the voter completely reviews his or her vote selections on the DRE screen and presses the "VOTE" button.
5.0.0	**V. Security and Reliability**		
5.0.1	V.A. The VVPRS shall not be permitted to externally communicate with any system or machine other than	• Read the vendor documentation of the introduction of the components within the VVPRS.	• The VVPRS consists of a printer and a take-up spindle for storing printed paper records. • Only the printer within the VVPRS has connections

No.	Requirement	Test scenario	Test Result
	the voting system to which it is connected.	• Open the VVPRS. • Inspect all the components in the VVPRS for any external devices and accessible connection interfaces (e.g., serial, USB, or other ports). • Check whether the VVPRS can be connected to other systems other than the voting system.	to the DRE with a power supply cable and a printer cable for data transmitting.
5.0.2	V.B. The VVPRS shall only be able to function as a printer; it shall not contain any other services (e.g., copier or fax functions) or network capability. The printer shall not contain any component with an external communication feature.	• Read the vendor documentation for the functions of all components in the VVPRS. • Open the VVPRS. • Conduct one mock vote. • Inspect all the components in the VVPRS and verify that the VVPRS has a printer and is able to function as a printer. • Verify that the VVPRS does not have any external communication feature/port/interface for other services other than printing • Verify that the printer does not contain any component with an external communication feature other than printing from the voting machine.	• The VVPRS is able to function as a printer to print the paper record, and roll the paper record into the take-up spindle. • The only connections to the external system (the DRE) are one power cable and one printer cable for transmitting printing data. No other services (e.g., copier or fax functions) or network capability is observed. • No component within the printer is observed to have an external communication feature other than printing from the voting machine.
5.0.3	V.C. The paper path between the printing, viewing, and storage of the paper record shall be protected and sealed from access, except by election officials authorized by each county commissioner of registration.	• Conduct one mock vote. • Inspect the paper path of the VVPRS between the printing, viewing, and storage of the paper record. • Attempt to access the paper record along the paper path between the printing and the viewing. • Attempt to access the paper record along	• The VVPRS is locked when the voting machine is under official voting operations. • Every selection or de-selection can be viewed at the bottom of the Paper Record Display Unit. The path of printing is locked and sealed, and the viewing area is behind a clear plexiglass cover. • The printed paper records stored in the take-up spindle is enclosed within the VVPRS which is locked.

No.	Requirement	Test scenario	Test Result
		the paper path between the viewing and the storage.	• The paper path is locked and protected from access between the print head and the take-up spindle.
5.0.7	V.E. The printer shall be connected to the voting machine either by completely concealing the printer connection or via a security tag to prevent tampering.	• Open the VVPRS. • Inspect the connection between the printer and the voting machine. • Observe if the cable connection at the printer interface is protected against tampering. • Observe if the cable between the printer and the voting machine is protected against tampering. • Observe if the cable connection at the voting machine is protected against tampering.	• The cable connectors of the printer are located outside the locked VVPRS without any protection. • The cable connectors at the voting machine are located on the top of the DRE without any protection. • The exposed part of the connection between the VVPRS and the voting machine is not concealed with anything.
5.0.8	V.F. The DRE shall detect and notify the election officials at the polling place of any errors and malfunctions, such as paper jams or low supplies of consumables (e.g. paper) that may prevent paper records from being correctly displayed, printed, or stored.	• Conduct one mock vote. • Open the VVPRS. • Create a paper jam at the VVPRS. • Check and verify if the DRE can detect the error and can send a warning signal.	• The DRE does not detect the paper jam. The voting process continues on the DRE. • The voter can make selections or changes, and cast the vote. The printer is printing over the same area on the paper roll. • No legible information is printed out on the paper roll. • No warning signal has been observed.
5.0.9	V.G. If a mechanical error or malfunction occurs (such as, but not limited to, a paper jam or running out of paper), the DRE and VVPRS shall suspend voting operations, not record votes, and present a clear indication of the malfunction to the voter and election officials.	• Conduct one mock vote. • Open the VVPRS. • Create a situation with low paper supply to the printer. • Check and verify if the DRE and VVPRS can detect the error and can send a warning signal.	• The DRE does detect the low paper supply and display an error message on the DRE screen to the voter. • The system emits a beeping sound until poll workers intervene. • The voting process was suspended at the DRE and VVPRS. • A message is displayed on the DRE screen indicating to the voter that the ballot will be cancelled, and the

No.	Requirement	Test scenario	Test Result
			voter is requested to contact the poll worker for assistance.
5.0.10	V.H. If the connection between the voting machine and the printer has been broken, the voting machine shall detect and provide notice of this event and record it in the DRE's internal audit log. Voting operations shall be suspended and no votes shall be recorded.	• Conduct one mock vote. • Open the VVPRS and disconnect the cable between the voting machine and the printer. • Check and verify if the DRE and VVPRS react properly to this error. • Close the poll. • Check the DRE's internal audit log.	• If the printer cable is disconnected, which is easy to achieve by pulling it off from the printer port on the top of the DRE, the VVPRS is suspended and the DRE does detect the error and display an error message on the DRE screen to the voter. The audio sound lasts until the poll worker intervenes. The DRE screen displays a message stating that the ballot will be cancelled. • However, if the printer cable is disconnected after the voter presses the "VOTE" button, the ballot is electronically recorded and counted in the close-poll report. Yet, no barcode is printed on the paper record, and it is indicated on the DRE screen and in the Event Log report that the ballot is cancelled.
5.0.13	V.J. The vendor shall provide to LPS documentation for the DRE and the VVPRS that includes procedures for the recovery of votes in case of a malfunction. LPS shall be responsible for disseminating this information to the county commissioners of registration.	• Verify that the vendor documentation includes procedures for the recovery of votes in case of a malfunction.	The vendor has provided electronic documentation that includes procedures for the recovery of votes in case of a malfunction on the DRE and the VVPRS.
5.0.14	V.K. The vendor shall provide to LPS documentation for the DRE and the VVPRS that includes recommended procedures to enable the election officials to return a voting machine to workable status after the machine has malfunctioned, the printer needs to be	• Verify that the vendor documentation includes recommended procedures to enable the election officials to return a voting machine to workable status after the machine has malfunctioned, the printer needs to be replaced, or a voter has used it incompletely or incorrectly.	The vendor has provided electronic documentation that includes recommended procedures to enable the election officials to return a voting machine to workable status after the machine has malfunctioned, the printer needs to be replaced, or a voter has used it incompletely or incorrectly.

No.	Requirement	Test scenario	Test Result
	replaced, or a voter has used it incompletely or incorrectly.		
5.0.15	V.K.1. These procedures shall not cause discrepancies between the tallies of the electronic and paper records.	• Conduct one mock vote. • Open the VVPRS and disconnect the cable between the voting machine and the printer. • Check how the DRE and VVPRS react. • Follow the procedures recommended by the vendor to return the voting machine to workable status. • Close the poll and export electronic data from the electronic storage media with the device/software provided by the vendor. • Examine and compare the tallies of the electronic and paper records.	• Following the recommended procedures does not cause discrepancies between the tallies of the electronic and paper records.
5.0.17	V.L. Vendor documentation shall include procedures for investigating and resolving printer malfunctions including, but not limited to, printer operations, misreporting of votes, unreadable paper records, and process failures.	• Verify that the vendor documentation includes procedures for investigating and resolving printer malfunctions including, but not limited to, printer operations, misreporting of votes, unreadable paper records, and process failures.	The vendor has provided electronic documentation that includes procedures for investigating and resolving printer malfunctions.
6.0.0	**VI. Certification**		
6.0.3	VI.C. Whether conducted by the Examination Committee, technical advisors, or a combination of both, the examination of the VVPRS shall include, but not be limited to, the functionality, security, durability, and accessibility of the system. This examination shall also include volume		

No.	Requirement	Test scenario	Test Result
	testing, which is the investigation of the system's response to processing more than the expected number of ballots and/or voters or to any other similar conditions that tend to overload the system's capacity to process, store, and report data.		
6.0.4	VI.C.1. The vendor shall provide to the State, electronically and in hard copy, all use and technical specifications and documentation relating to the function of the VVPRS.	• Verify that the vendor has provided the state with both electronic and hard copy technical specifications and documentations relating to the function of the VVPRS.	The vendor has provided electronic documentation that includes technical specifications and documentation relating to the function of the VVPRS.
6.0.9	VI.G. Vendor documentation shall include printer reliability specifications including Mean Time Between Failure estimates, and shall include recommendations for appropriate quantities of backup printers and supplies.	• Verify that the vendor documentation includes printer reliability specifications including Mean time between failure estimates and recommendations for appropriate quantities of backup printers and supplies.	• The vendor has included the information about printer reliability and specifications including MTBF in the "Part 3 - System Hardware Specification" document. • The vendor has provided information about the quantity of the paper supply in the "ESS RTAL - New Jersey Criteria" document.

IV. Appendices

a. Test Ballot Scenarios

Long Ballots: Scenarios 1-8

Scenario 1

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 2

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 3

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question7	YES	NO			

Scenario 4

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 5

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	TERRANCE JOHNSON
			JESSICA M. FORD	HENRY H. HOOLIGAN	MARIO JOHNSON
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 6

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 7

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	MILDRED WHITE
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 8

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Long Ballots: Scenarios 9-12

Scenario 9

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	EDWARD A LYNCH
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	MICHAEL WEIS
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	KELLY SMALL
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	CHARLES SCHULTZ
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	MICAEL McDONALD
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 10

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	BRUCE SPRINGSTEEN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 11

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	EDWARD A LYNCH
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	MICHAEL WEIS
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	KELLY SMALL
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	BRUCE SPRINGSTEEN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	CHARLES SCHULTZ
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	MICHAEL McDONALD
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 12

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J. DONALDSON	WILLIAM P. MORROW
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Long Ballot Special Scenarios

Scenario 2-1

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 2-2

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 4-1

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 4-2

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 4-3

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Scenario 8-1

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question7	YES	NO			

Scenario 8-2

OFFICIAL GENERAL ELECTION TEST-1

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
PRESIDENT (VOTE FOR ONE)	PETER B. RANDALL	KENNETH P. ROBINSON	WILLIAM D. FITZGERALD	MICHAEL J DONALDSON	WRITE-IN
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	JOANNA G. SCOTT	CHRISTIAN B. CHRISTANSEN	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL	BERNAD A. JONES	PETER GENOVA	WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	BILL ANDERSEN	DAVID PROWN	JEFFERY H. JOHNSON	ANTONIO B. GUTTENBERG	WRITE-IN
	MIKE DELL	RAY HAYES	MICHAEL B. SMITH	RICHARD D. DeLEON	WRITE-IN
FREEHOLDERS (2-YEAR TERM) (VOTE FOR ONE)	ROY K. GOODMAN	WILLIAM K. WILLIAMS	CATHERINE A. PETERSON	REBECCA M. CHARLESTON	WRITE-IN
Member of TOWNSHIP COMMITTEE (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND	HENRY P. LINCOLN	KATHERINE P. ROSS	WRITE-IN
CHARTER STUDY COMMISSION (VOTE FOR FIVE)			HERALD D. MICHAELS	MARIO S. TREEBORO	WRITE-IN
			JESSICA M. FORD	HENRY H. HOOLIGAN	WRITE-IN
			SAMUEL T. JACKSON	MARY K. LINCOLN	WRITE-IN
			ALFREDA A. JONES	ABRAHAM B. LINCOLN	WRITE-IN
			CARLTON D. THOMPSON	JOEL C. CARSON	WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO
Local Question 5	YES	NO	Local Question 6	YES	NO	Local Question 7	YES	NO			

Short Ballot Scenarios 1-12

Scenario 1

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 2

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 3

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 4

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 5

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 6

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 7

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 8

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 9

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WI-1 HOR
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WI-1 FR
	NAME9	NAME10			WI-2 FR
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WI-1-SHERIFF

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 10

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WI-1 SHERIFF

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 11

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WRITE-IN
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WI-1 HOR
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WI-1 FR
	NAME9	NAME10			WI-2 FR
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WI-1 SHERIFF

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

Scenario 12

OFFICIAL GENERAL ELECTION TEST-2

OFFICE TITLE	REPUBLICAN COLUMN A	DEMOCRATIC COLUMN B	BY PETITION COLUMN C	BY PETITION COLUMN D	WRITE-IN (USE KEYBOARD)
U. S. SENATE (VOTE FOR ONE)	JOHN P. DENVER	PHILIP B. OHIO–AND–GOLD –AND–TEXAS–MICHIGAN-AND-SILVER	SCOTT E. FITZGERNALD	MARY S. DAVID	WI-1 USS
HOUSE OF REP (VOTE FOR ONE)	DAVID K. ROSS	LARRY P. HALL			WRITE-IN
FREEHOLDERS (3-YR TERM) (VOTE FOR TWO)	NAME7	NAME8			WRITE-IN
	NAME9	NAME10			WRITE-IN
SHERIFF (VOTE FOR ONE)	DENVER P. COLORADO	BALTIMORE K. MARYLAND			WRITE-IN

Local Question 1	YES	NO	Local Question 2	YES	NO	Local Question 3	YES	NO	Local Question 4	YES	NO

b. Mock Voter Questionnaires

Questionnaire 1

Dear "Mock Voter":

Please answer the following questions about the vote you just cast (scenario_____):

1. Did you get an opportunity to review the complete ballot on the screen for each corresponding vote and verify your vote selection for each position or question before casting your vote?
Yes___No__If no, please describe your observation…….

2. Have you observed any discrepancy between your vote selections for each position or question and the information on the complete ballot **on the screen**?
Yes___No__If yes, please describe your observation…….

"Mock Voter" Name:

"Mock Voter" Signature: Date

Questionnaire 2

Dear "Mock Voter":

Please answer the following questions about the vote you just cast (scenario_____):

3. Did you have an opportunity to accept or reject the contents of your complete ballot **on the screen**?
Yes___No__If no, please describe your observation…….

4. Once you accepted the contents of your complete ballot **on the screen**, were you able to see any indication on the machine that it is your final vote?
Yes___No__If yes, please describe your observation…….

"Mock Voter" Name:

"Mock Voter" Signature: Date

Questionnaire 3

Dear "Mock Voter":

Please answer the following questions about the vote you just cast (scenario_____):

5. Upon rejecting a complete ballot **on the screen**, were you able to change ONE item in your set of vote selections and verify this change **on the paper record**?

Yes___No__If no, please describe your observation…….

"Mock Voter" Name:

"Mock Voter" Signature: Date

Questionnaire 4

Dear "Mock Voter":

Please answer the following questions about the vote you just cast (scenario_____):

6. Upon rejecting a complete ballot **on the screen**, were you able to change TWO items in your set of vote selections and verify these changes **on the paper record**?

Yes___No__If no, please describe your observation…….

.

"Mock Voter" Name:

"Mock Voter" Signature: Date

c. "Criteria"
State of New Jersey: Criteria for Voter-Verified Paper Records for Direct Recording Electronic Voting Machines

State of New Jersey
Criteria for Voter-Verified Paper Record for Direct Recording Electronic Voting Machines

Pursuant to N.J.S.A. 19:48-1 and N.J.S.A. 19:53A-3, no later than January 1, 2008, each voting machine in New Jersey shall produce an individual permanent paper record for each vote cast, which shall be made available for inspection and verification by the voter at the time the vote is cast, and preserved for later use in any manual audit. In the event of a recount, the voter-verified paper records will be the official tally for the election.

To effectuate the intent of the statute, and to instill full public confidence in the electoral process, the Attorney General has established the following criteria for the design and use of a Voter-Verified Paper Record System in conjunction with a Direct Recording Electronic Voting Machine.

I. Definitions

Direct Recording Electronic Voting Machine ("DRE"):

> A voting machine that records votes by means of a ballot display provided with mechanical or electro-optical components that can be activated by the voter and processes data by means of a computer program. Voting data and ballot images are recorded in internal and external memory components. A DRE produces a tabulation of the voting data stored in a removable memory component and a printed paper ballot.

Voter-Verified Paper Record ("VVPR" or "paper record"):

> Physical piece of paper on which the voter's ballot choices are recorded, cast, and preserved for later use in any recount or manual audit.

Voter-Verified Paper Record System ("VVPRS"):

> A system that includes a printer and storage unit attached to, built into, and/or used in conjunction with a DRE. This system produces, stores, and secures voter-verified paper records.

II. General Description of System[1]

A. Components

A DRE with VVPR capability shall consist of the following components:

1 This Criteria is for the use of a VVPRS with a DRE. The issuance of the Criteria does not preclude the use of any other voting system permitted under Title 19 and certified by the Attorney General.

1. Printer: a device that prints the voter's DRE selection on a paper record;

2. Paper Record Display Unit: a unit that allows a voter to view his or her paper record while preventing the voter from directly handling the paper record;

3. Paper: the paper used to produce the voter-verified paper record shall be sturdy, clean, and resistant to degradation; and

4. Storage Unit: a device that securely stores all paper records (including accepted and rejected ballots) during the course of the election and thereafter as required or necessary.

B. Operation

1. The VVPRS may be designed in various configurations. In all configurations, prior to casting the ballot, the voter shall have the ability to verify his or her selections on a paper record in a private and independent manner.

2. The VVPRS shall be designed to allow the voter to easily review, accept, or reject his or her paper record.

   a. The DRE shall not record the electronic record until the paper record has been approved by the voter.

3. VVPRS records may be printed and stored by two different methods:

   a. "Cut and Drop" Method: The voter views and verifies the paper record, which the VVPRS cuts and drops into a Storage Unit.

   b. "Continuous Spool" Method: The voter views the paper record on a spool-to-spool paper roll. This method shall be used in a manner that fully protects the secrecy of all votes cast.

4. No electronic or paper record shall indicate the identity of a voter or be maintained in a way that allows a voter to be identified.

5. The electronic and paper records shall be created and stored in ways that preserve the privacy of the record.

6. The VVPRS components shall conform to federal and state accessibility requirements.

    a. These requirements shall include, but are not limited to, an audio component that shall accurately relay the information printed on the paper ballot to the voter.

7. The VVPRS device shall draw its power from the DRE or the same electrical circuit from which the DRE draws its power.

8. The voting machine shall provide a standard, publicly documented printer port, or the equivalent, using a standard communication protocol.

9. The VVPRS shall mark the paper record precisely as indicated by the voter on the DRE and produce an accurate paper record and corresponding electronic record of all votes cast.

10. DRE electronic ballot image records shall include all votes cast by the voter, including write-ins and undervotes.

    a. Write-in votes are votes cast by a voter for an individual not listed on the ballot as a formal candidate.

    b. Undervotes are elective office and/or public questions on the ballot for which the voter has not cast a vote.

11. An electronic ballot image record shall have a corresponding paper record.

    a. The paper record shall be printed and the voter shall have the opportunity to verify the paper record in its totality prior to the final electronic record being recorded.

    b. The DRE electronic ballot image record shall correspond to the paper record in a manner that does not reveal the voter's identity.

    c. The paper record shall contain all voter selection information stored in the electronic ballot image record.

III. Design Requirements for a VVPRS

A. Printer

1. The printer shall be designed to have a sufficient amount of paper, ink, toner, ribbon or like supply for use in an election, taking into account an election district should have at least one voting machine per 750 registered voters.

    a. If any addition or replacement of paper, ink, toner, ribbon or other like supply is required, it shall be done with minimal disruption to voting and without circumvention of the security features of the Printer and Storage Unit which protect cast ballots and the secrecy of the vote.

2. The VVPRS shall have a low-paper indicator that will allow for the timely addition of paper so that each voter can fully verify, without disruption, all of his or her ballot selections.

3. The printer shall be secured by security seals or locking mechanisms to prevent tampering. The printer shall be accessed only by those election officials authorized by the county commissioner of registration.

4. The VVPRS shall be capable of showing the information on the paper record in a font size of at least 3.0 mm and should be capable of showing the information in at least two font ranges, 3.0-4.0 mm and 6.3-9.0 mm, under the control of the voter or poll worker. This criteria can be met by providing a magnification device with the VVPRS.

B. Paper Record Display Unit

1. The paper record shall be displayed in a way that allows the voter to privately and independently inspect it.

2. If the paper record cannot be viewed entirely in the Display Unit at one time, the voter shall have the opportunity to verify the entire paper record prior to the electronic or the paper ballot being stored and recorded.

3. The Display Unit shall have a protective covering which shall be transparent and shall not obscure the voter's view of the paper record. This covering shall be in such condition that it can be made transparent by ordinary cleaning of its exposed surface.

C. **Paper**

1. Any paper record produced by a VVPRS shall be readable by voters and election officials.

2. All paper records shall be stored in accordance with vendor specifications.

3. If stored in accordance with vendor specifications, the paper used to produce a paper record shall be readable for a period of at least two years after the election in which it is used.

D. Paper Record Storage Unit

1. Security protections including, but not limited to, security seals or locking mechanisms, shall be built into the Storage Unit to prevent tampering at all times, including pre-election, election day, and post-election. The Attorney General, through the Department of Law and Public Safety ("LPS"), will issue chain of custody guidelines regarding the Storage Unit.

IV. Procedural and Usability Requirements

A. Paper Records

1. The paper record shall include identification of the particular election, the election district, and the voting machine.

2. The paper record shall include a barcode that contains the human-readable contents (shorthand is acceptable) of the paper record.

   a. The barcode shall use an industry standard format and shall be able to be read using readily available commercial technology.

   b. If the corresponding electronic record contains a digital signature, the digital signature shall be included in the barcode on the paper record.

      (1) A digital signature is extra data appended to an electronic document which identifies and authenticates the sender and message data using public key encryption, or other means approved by LPS.

c. The barcode shall not contain any information other than an accurate reflection of the paper record's human-readable content, error correcting codes, and digital signature information.

3. For the "Cut and Drop" Method, if the paper record cannot be displayed in its entirety on a single page, each page of the record shall be numbered and shall include the total count of pages for that ballot.

4. The image created on the paper record shall include every contest that is displayed to the voter on the DRE, including write-ins and undervotes.

5. The paper record shall be created such that its contents are machine readable.

6. The paper record shall contain error correcting codes for the purpose of detecting read errors and for preventing other markings on the paper record from being misinterpreted when the paper record is machine read.

a. A read error is a separate code or piece of data that can be used to indicate whether the data printed on the paper record is different from the data created on the electronic record.

B. DRE Electronic Records

1. The electronic ballot image record and paper records shall be linked by including unique identifiers so that an individual paper record can be identified with its corresponding electronic record. Unique identifiers are tools that will allow LP S to measure the reliability and accuracy of the voting system, as necessary. The electronic ballot image and the paper record shall not reveal the identity of the voter.

a. Unique identifiers shall not be displayed in a way that can be easily memorized.

2. The DRE should generate and store a digital signature for each electronic record.

3. The electronic ballot image records shall be able to be exported for auditing or analysis on standards-based and/or COTS (commercial off-the-shelf) information technology computing.

a. The exported electronic ballot image records shall be in a publicly available, non-proprietary format.

b. The records should be exported with a digital signature which shall be calculated on the entire set of electronic records and their associated digital signatures.

c. The voting system vendor shall provide documentation about the structure of the exported ballot image records and how they shall be read and processed by software.

d. The voting system vendor shall provide a software program that will display the exported ballot image records and that may include other capabilities such as providing vote tallies and indications of undervotes.

e. The voting system vendor shall provide full documentation of procedures for exporting electronic ballot image records and reconciling those records within the paper records.

C. Voting with a VVPRS

1. LPS shall promulgate for voters instructions on how to use the VVPRS.

   a. The VVPRS vendors shall provide, in plain language, any reference material requested by LPS to aid in the preparation of VVPRS instructions. These instructions shall be issued to each county board of election for board worker training.

   b. Instructions for use of a VVPRS shall be made available prior to an election on the Division of Elections' website and shall be available to the voter at the polling place on an election day.

   c. Prior to an election, the county commissioners of registration will provide demonstration machines at convenient locations throughout the county for voter education purposes.

   d. The instructions for performing the verification process shall be made available to the voter on a location inside the voting machine. Where feasible, the instructions shall also be on the machine ballot face.

2. Voter privacy shall be preserved during the process of recording, verifying, and auditing ballot selections. This includes a voter who uses an audio voting device. Voters using an audio voting device shall also be able to verify votes privately and independently.

3. In any election where the ballot contains a language in addition to English, the paper record shall be produced in all such languages.

   a. To assist with manual auditing, candidate names on the paper record shall be presented in the same language as used on the DRE summary screen.

   b. Information on the paper record not needed by the voter to perform verification shall be in English.

4. The privacy of voters whose paper records contain an alternative language shall be maintained.

5. The paper records shall distinguish between accepted and non-accepted ballots.

   a. The voter shall have the opportunity to accept or reject the contents of his or her paper record.

      (1) If the voter rejects the contents of the paper record, he or she may recast the ballot up to two additional times. This procedure is consistent with current State law, which limits the amount of time a voter has to cast a ballot. (See N.J.S.A. 19:52-3).

      (2) Before the voter causes a third and final paper record to be printed, the voter shall be presented with a warning notice on the machine that the selections on the DRE will be final. The voter will see and verify a printout of the votes, but will not be given additional opportunities to change any vote. The third ballot cast shall constitute the final and official ballot of such a voter.

      (3) Upon rejecting a paper record, the voter shall be able to modify and verify the selections on the DRE without having to reselect all choices in all contests on the ballot.

      (4) If a mechanical error in recording or printing a paper record occurs, the record shall be counted as a spoiled paper record. It will not be counted as one of the voter's three attempted votes.

(5) The VVPRS shall be designed to indicate the paper record which the voter has identified and cast as his or her official ballot.

V. Security and Reliability

A. The VVPRS shall not be permitted to externally communicate with any system or machine other than the voting system to which it is connected.

B. The VVPRS shall only be able to function as a printer; it shall not contain any other services (e.g., copier or fax functions) or network capability. The printer shall not contain any component with an external communication feature.

C. The paper path between the printing, viewing, and storage of the paper record shall be protected and sealed from access, except by election officials authorized by each county commissioner of registration.

D. All cryptographic software in the voting system shall be approved by the U.S. Government's Cryptographic Module Validation Program, if applicable, prior to being certified in New Jersey.

1. As stated in the discussion portion of Section 7.9.3 of the United States Election Assistance Commission draft criteria for "Voter Verifiable Paper Audit Trail Requirement, "There may be cryptographic voting schemes where the cryptographic algorithms used are necessarily different from any algorithms that have approved CMVP (Cryptographic Module Validation Program) implementations, thus CMVP approved software should be used when feasible but is not required. The CMVP website is http://csrc.govicryptual."

2. The vendor shall provide a certification of CMVP approval, if applicable. If not applicable, the vendor shall provide a certification setting forth the reasons why CMVP approval does not apply.

E. The printer shall be connected to the voting machine either by completely concealing the printer connection or via a security tag to prevent tampering.

F. The DRE shall detect and notify the election officials at the polling place of any errors and malfunctions, such as paper jams or low supplies of consumables (e.g. paper) that may prevent paper records from being correctly displayed, printed, or stored.

G. If a mechanical error or malfunction occurs (such as, but not limited to, a paper jam or running out of paper), the DRE and VVPRS shall suspend voting operations, not record votes, and present a clear indication of the malfunction to the voter and election officials.

H. If the connection between the voting machine and the printer has been broken, the voting machine shall detect and provide notice of this event and record it in the DRE's internal audit log. Voting operations shall be suspended and no votes shall be recorded.

I. If the voter's selections on the DRE do not match the paper record, then the DRE shall immediately be withdrawn from service.

1. The affected voter shall be able to vote on another voting machine, if available, or by emergency ballot.

J. The vendor shall provide to LPS documentation for the DRE and the VVPRS that includes procedures for the recovery of votes in case of a malfunction. LPS shall be responsible for disseminating this information to the county commissioners of registration.

K. The vendor shall provide to LPS documentation for the DRE and the VVPRS that includes recommended procedures to enable the election officials to return a voting machine to workable status after the machine has malfunctioned, the printer needs to be replaced, or a voter has used it incompletely or incorrectly.

1. These procedures shall not cause discrepancies between the tallies of the electronic and paper records.

2. LPS shall be responsible for disseminating this information to the county commissioners of registration.

L. Vendor documentation shall include procedures for investigating and resolving printer malfunctions including, but not limited to, printer operations, misreporting of votes, unreadable paper records, and process failures.

M. If a machine malfunctions or becomes inoperable, voters will be entitled to vote by emergency ballots.

VI. Certification

A. A VVPRS shall conform to State requirements. These requirements shall include, but are not limited to, the submission to LPS of any and all reports concerning the VVPRS issued by a federally-certified Independent Testing Authority ("ITA").

B. The VVPRS shall be subject to examination by the State Voting Machine Examination Committee ("Examination Committee"). LPS, in its discretion, may also appoint or retain a technical advisor or a panel of technical advisors ("technical advisors") to evaluate and test the VVPRS or assist the Examination Committee in its examination.

C. Whether conducted by the Examination Committee, technical advisors, or a combination of both, the examination of the VVPRS shall include, but not be limited to, the functionality, security, durability, and accessibility of the system. This examination shall also include volume testing, which is the investigation of the system's response to processing more than the expected number of ballots and/or voters or to any other similar conditions that tend to overload the system's capacity to process, store, and report data.

1. The vendor shall provide to the State, electronically and in hard copy, all use and technical specifications and documentation relating to the function of the VVPRS.

2. The vendor shall submit a certification that the VVPRS satisfies the State's criteria.

D. VVPRS shall not, at any time, contain or use undisclosed hardware or software. The only components that may be used in the system are components that have been tested and certified for use in the State.

E. The vendor will be required to provide the source code for the DRE and the VVPRS to the State, and/or to place such source code in escrow, to allow for independent testing by the State, at its discretion. Upon request, the State will enter into a non-disclosure agreement with the vendor.

F. The vendor will be responsible for the cost of any testing of the VVPRS that the State deems necessary to achieve certification.

G. Vendor documentation shall include printer reliability specifications including Mean Time Between Failure estimates, and shall include recommendations for appropriate quantities of backup printers and supplies.

1. Mean Time Between Failures, which measures the reliability of a voting system device, is the average time that a component works without failure. It is the value of the ratio of operating time to the number of failures which have occurred in the specific time interval.

VII. Pre-Election Procedures

A. A VVPRS's components shall be integrated into the existing local logic testing procedures performed by county election officials, which are performed in preparation for an election.

VIII. Post-Election Procedures

A. The county commissioner of registration will be required to perform a full and complete examination of any machine that malfunctioned or became inoperable on an election day.

B. Unless there is an amendment to the current statutory law, LPS will issue procedures for mandatory, post-election, random manual audits of election results. These procedures will be published for public comment prior to their effective date.

1. These procedures will be consistent with the statutory impoundment period for voting machines following an election.

2. The audit process shall be open for public observation.

C. In the case of a recount, the votes cast on the paper records shall serve as the official ballot, pursuant to N.J.S.A. 19:48-1 and N.J.S.A. 19:53A-3.

D. In case the machine cartridge becomes unreadable or is damaged for an audit or recount, the county commissioner of registration shall produce the ballot image audit log from the machine. The vendor shall provide to LPS documentation regarding the production of such audit log.

E. The paper record shall be created such that its contents are machine readable for purposes of any recount, audit, or initial tallying of an election in the event that the machine cartridge containing the electronic record is not usable.

1. The paper record shall contain error correcting codes for the purpose of detecting read errors. This may be done by barcode.

F. If a county employs a "Continuous Spool" VVPRS, it shall conduct any audit or recount in accordance with the procedures established by LPS to fully protect the

secrecy of all votes cast. Such procedures may include, but not be limited to, cutting the spool-to-spool paper roll into individual paper records, and restricting public access to the uncut paper roll.

G. The vendor shall provide to LPS written procedures to identify and resolve any discrepancy between an electronic record and its corresponding paper record. LPS shall be responsible for disseminating this information to the county commissioners of registration.

H. The vendor shall provide written procedures for determining what constitutes clear evidence that a paper record is inaccurate, incomplete, or unreadable. LPS shall be responsible for disseminating this information to the county commissioners of registration.

LPS may, in its discretion, revise, amend, or otherwise modify any of the criteria set forth in this document.

d. Resumes of Team Leaders

NIRWAN ANSARI
Summary

Nirwan Ansari received the B.S.E.E. (summa cum laude) from the New Jersey Institute of Technology (NJIT), Newark, in 1982, the M.S.E.E. degree from University of Michigan, Ann Arbor, in 1983, and the Ph.D. degree from Purdue University, West Lafayette, IN, in 1988.

He joined NJIT's Department of Electrical and Computer Engineering as Assistant Professor in 1988, and has been Full Professor since 1997. He has also assumed various administrative positions.

He authored Computational Intelligence for Optimization (Springer, 1997, translated into Chinese in 2000) with E.S.H. Hou, and edited Neural Networks in Telecommunications (Springer, 1994) with B. Yuhas. His current research focuses on various aspects of broadband networks and multimedia communications including network security, traffic modeling, QoS routing, switch architecture and scheduling, congestion control, and buffer management. He has also contributed approximately 300 technical papers including over 100 refereed journal/magazine articles.

He is a Senior Technical Editor of the IEEE Communications Magazine, and also serves on the editorial board of Computer Communications, the ETRI Journal, and the Journal of Computing and Information Technology.

He was the founding general chair of the First IEEE International Conference on Information Technology: Research and Education (ITRE2003), and was instrumental, while serving as its Chapter Chair, in rejuvenating the North Jersey Chapter of the IEEE Communications Society. This chapter received the 1996 Chapter of the Year Award and a 2003 Chapter Achievement Award, served as Chair of the IEEE North Jersey Section and in the IEEE Region 1 Board of Governors during 2001-2002, and has been serving in various IEEE committees such as Vice-Chair of IEEE COMSOC Technical Committee on Ad Hoc and Sensor Networks, and Chair/Vice-chair and TPC Chair/Vice-chair of several conferences/symposia.

He has been frequently invited to deliver keynote addresses, distinguished lectures, tutorials, and talks. His awards and recognitions include the NJIT Excellence Teaching Award in Graduate Instruction (1998), IEEE Region 1 Award (1999), IEEE Leadership Award (2007, from IEEE Princeton and Central Jersey Section), and designation as an IEEE Communications Society Distinguished Lecturer.

PATENTS

N. Ansari, A. Arulambalam and X. Chen, "Method For Providing A Fair-Rate Allocation For Available Bit Rate Services," U.S. Patent Number 6052361, issued 04/18/2000.

Eleven US Non-provisional Patents have been filed to US Patent Office (in review).

SELECTED PUBLICATIONS

Published Books

- Nirwan Ansari and Edwin S. H. Hou, *Computational Intelligence for Optimization*, Kluwer Academic Publishers, ISBN-0-7923-9838-6, 1997, (225 pages). Chinese Version published by Tsinghua University Press, PRC, ISDN 7-302-03635-7/TP.2019, 2000.
- Ben Yuhas and Nirwan Ansari (eds.), *Neural Networks in Telecommunications*, Kluwer Academic Publishers, ISBN-0-7923-9417-8, 1994. (369 pages)

Published Conference Proceedings

- N. Ansari, F. Deek, C. Lin, and H. Yu, *Proceedings of 2003 IEEE International Conference on Information Technology: Research and Education*, IEEE.

Published Book Chapters (2000-2007)

- C. Zhang, N. Ansari, and E.S.H. Hou, "Chapter 8: Node Clustering in Wireless Sensor Networks," *Wireless Sensor Networks: A Networking Perspective* (J. Zheng and A. Jamalipour, ed.), Wiley/IEEE Press, to appear in 2008.
- N. Ansari, C. Zhang, Y. Luo, and E.S.H. Hou, "Chapter 12: WiMAX Security: Privacy Key Management," *WiMAX Standards and Security* (Syed Ahson and Mohammad Ilyas, ed.), CRC Press, 2007.
- J. Liu and N. Ansari, "Public Switched Telephone Network," *The Handbook Of Computer Networks* (Hossein Bidgoli, ed.), John Wiley & Son, to appear in 2007.
- N. Ansari and Si Yin, "Storage Area Networks Architectures and Protocols," *The Handbook Of Computer Networks* (Hossein Bidgoli, ed.), John Wiley & Son, to appear in 2007.
- N. Ansari and Y. Luo, "Passive Optical Networks for Broadband Access," *The Handbook Of Computer Networks* (Hossein Bidgoli, ed.), John Wiley & Son, to appear in 2007.
- Z. Guo, R. Rojas-cessa, and N. Ansari, "Packet Switch with Internally-Buffered Crossbars," *High-Performance Packet Switching Architectures* (I. Elhanany, M. Hamdi, eds.), Springer-Verlag, ISBN: 1-84628-273-X, 2007.
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- D. Wei and N. Ansari, "Chapter 6: On IP Traffic Monitoring," in *Intelligent Virtual World: Technologies and Applications in Distributed Virtual Environments* (T.K. Shih and P.P. Wang, ed.), pp. 113-124, World Scientific Publishing Co., ISBN 981-238-618-1, July 2004.
- S. Li and N. Ansari, "Chapter 1.3: Switch Architectures and Scheduling Algorithms," in *ATM Handbook* (F. Golshani and F. Groom, ed.), pp. 37-54, *International Engineering Consortium*, Chicago, IL., 2000.

Refereed Journal Articles (2000-2007)

- Y. Luo, S. Yin, N. Ansari, and T. Wang, "Resource Management for Broadband Access over TDM PONs," *IEEE Network*, accepted.
- N. Ansari, C. Zhang, R. Rojas-Cessa, S. De, P. Sakarindr, and E.S.H. Hou, "Networking for Critical Conditions," *IEEE Wireless Communications*, accepted.
- H. Nakayama, N. Ansari, A. Jamilipour, and N. Kato, "Fault-resilient Sensing in Wireless Sensor Networks," *Computer Communications*, accepted.
- P. Sakarindr and N. Ansari, "Security Services in Group Communications over Wireless Infrastructure, Mobile Ad-Hoc, and Wireless Sensor Networks," *IEEE Wireless Communications,* accepted.
- Z. Wang, L. Liu, M. Zhou, and N. Ansari, "A Position-Based Clustering Technique for Ad-hoc Inter-vehicle Communication," *IEEE Transactions Systems, Man and Cybernetics*, accepted.
- S. Yin, Y. Luo, N. Ansari, and T. Wang, "Stability of Predictor-Based Dynamic Bandwidth Allocation over EPONs," *IEEE Communications Letters*, to appear.
- A. Belenky and N. Ansari, "On Deterministic Packet Marking," *Computer Networks*, Vol. 51, No. 10, pp. 2677-2700, July 11, 2007.
- T.N. Chang and N. Ansari, "Passband Control of Lightly Damped Systems with Mode Separation," *IEEE Transactions on Industrial Electronics*, accepted.
- Z. Gao and N. Ansari, "A Practical and Robust Inter-domain Marking Scheme for IP Traceback," *Computer Networks*, Vol. 51, No. 3, pp. 732-750, Feb. 21, 2007.
- P. Sakarindr and N. Ansari, "Adaptive Trust-based Anonymous Network," *International Journal of Security and Networks* (*IJSN*), Special Issue on Computer & Network Security, Vol. 2, No. 1/2, pp. 11-26, 2007.
- G. Cheng and N. Ansari, "Rate-distortion Based Link State Update," *Computer Networks*, Vol. 50, No. 17, pp. 3300-3314, Dec. 5, 2006.
- R. Rojas-cessa, Z. Guo, and N. Ansari, "On the Maximum Throughput of a Combined Input-Crosspoint Queued Packet Switch," *IEICE Trans. on Communications*, Vol. E89-B, No. 11, pp. 3120-3123, Nov. 2006.
- Z. Gao and N. Ansari, "Differentiating Malicious DDoS Attack Traffic from Normal TCP Flows with Proactive Tests," *IEEE Communications Letters*, Vol. 10, No. 11, pp. 793-795, Nov. 2006.
- D. Gozupek, S. Papavassiliou, and N. Ansari, "Enhancing Quality of Service Provisioning in Wireless Ad Hoc Networking Using Service Vector Paradigm," *Journal of Wireless Communications and Mobile Computing*, Special Issue on Wireless Ad hoc Networks: Technologies and Challenges, Vol. 6, No. 7, pp. 1003-1015, Nov. 2006.
- G. Cheng and N. Ansari, "On Selecting the Cost Function for Source Routing," *Computer Communications*, Vol. 29, No. 17, pp. 3602-3608, 2006.
- W. Yan, E.S.H. Hou, and N. Ansari, "Description Logics for an Autonomic IDS Event Analysis System," *Computer Communications*, Vol. 29, No. 15, pp 2841-2852, Sep. 5, 2006.
- G. Cheng, N. Ansari, and L. Zhu, "Enhancing ε approximation Algorithms with the Optimal Linear Scaling Factor," *IEEE Transactions on Communications*, Vol. 54, No. 9, pp. 1624 – 1632, September 2006.

- H. Zhao, N. Ansari, and Y.Q. Shi, "Network Traffic Prediction Using Least Mean Kurtosis," *IEICE Trans. Communications*, *IEICE Transactions on* Communications, Vol.E89-B, No.5, pp.1672-1674, May 2006.
- F. Alharbi and N. Ansari, "SSA: Simple Scheduling Algorithm for Resilient Packet Ring Networks," *IEE Proc. Communications*, Vol. 153, No. 2, pp. 183-188, April 2006.
- G. Cheng, L. Zhu, and N. Ansari, "A New Deterministic Traffic Model for Core-stateless Scheduling," *IEEE Transactions on Communications*, Vol. 54, No. 4, pp. 704-713, April 2006.
- J. Zeng, L. Zakrevski, and N. Ansari, "Computing the Loss Differentiation Parameters of the Proportional Differentiation Service Model," *IEE Proc. Communications*, Vol. 153, No. 2, pp. 177-182, April 2006.
- Z. Ni, Y.Q. Shi, N. Ansari, and W. Su, "Reversible Data Hiding," *IEEE Transactions on Circuits and Systems for Video Technology*, Vol. 16, No. 3, pp. 354-362, March 2006.
- L. Zhu, N. Ansari, G. Cheng, and K. Xu, "Edge-based Active Queue Management (EAQM)," *IEE Proc. Communications*, Vol. 153, No. 1, pp. 55-60, February 2006.
- G. Cheng and N. Ansari, "Finding a Least Hop(s) Path Subject to Multiple Additive Constraints," *Computer Communications*, Vol. 29, No. 3, pp. 392-401, Feb. 1, 2006.
- F. Alharbi and N. Ansari, "Distributed Bandwidth Allocation for Resilient Packet Ring Networks," *Computer Networks*, Vol. 49, No. 2, pp. 161-171, October 5, 2005.
- D. Wei and N. Ansari, "A Novel Modified Secant Method for Computing the Fair Share Rate," *Journal of Computing and Information Technology*, Vol. 13, No. 3, pp. 247–254, September 2005.
- Y. Luo and N. Ansari, "Survivable GMPLS Networks with QoS Guarantees," *IEE Proc. Communications*, Vol. 152, No. 4, pp. 427-431, August 2005.
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- L. Zhu, N. Ansari, and J. Liu, "Throughput of HighSpeed TCP in Optical Burst Switching Networks," *IEE Proc. Communications*, Vol. 152, No. 3, pp. 349-352, June 2005.
- Z. Gao and N. Ansari, "IP Traceback from the Practical Perspective," *IEEE Communications Magazine*, Vol.43, No. 5, pp. 123-131, May 2005.
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- K. Xu and N. Ansari, "Stability and Fairness of Rate Estimation Based AIAD Congestion Control in TCP," *IEEE Communications Letters*, Vol. 9, No. 4, pp. 378-380, April 2005.
- Y. Tian, K. Xu, and N. Ansari, "TCP in Wireless Environment: Problems and Solutions," *IEEE Communications Magazine*, Vol.43, No. 3, pp. S27-S32, March 2005.
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- Y. Luo and N. Ansari, "Bandwidth Allocation for Multi-service Access on EPONs," *IEEE Communications Magazine*, Vol. 43, No. 2, pp. S16-S21, February 2005.

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- H. Zhao, N. Ansari, and Y.Q. Shi, "Delay Guaranteed Bandwidth Allocation for Real Time Video Delivery," *IEE Proc. Communications*, Vol. 151, No. 6, pp. 553-558, December 2004.
- D. Wei and N. Ansari, "Implementing Fair Bandwidth Allocation Schemes in Hose-modeled VPS," *IEE Proc. Communications*, Vol. 151, No. 6, pp. 521-528, December 2004.
- G. Cheng and N. Ansari, "An Information Theory Based Framework for Optimal Link State Update," *IEEE Communications Letters*, Vol. 8, No. 11, pp. 692-694, November 2004.
- J. Liu and N. Ansari, "A New Control Architecture with Enhanced ARP, Burst-based Transmission, and Hop-based Wavelength Allocation for Ethernet-supported IP-over-WDM MANs," *IEEE Journal on Selected Areas in Communications*, Vol. 22, No. 8, pp. 1419-1431, October, 2004.
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- N. Ansari, G. Cheng, and Ram N. Krishnan, "Efficient and Reliable Link State Information Dissemination," *IEEE Communications Letters*, Vol. 8, No. 5, pp. 317-319, May 2004.
- K. Xu, Y. Tian, and N. Ansari, "TCP-Jersey for Wireless IP Communications," *IEEE Journal on Selected Areas in Communications*, Vol. 22, No. 4, pp. 747-756, May 2004.
- X. Zhang, Y.Q. Chen, N. Ansari, and Y.Q. Shi, "Mini-Max Initialization for Function Approximation," *Neurocomputing*, Vol. 57, pp. 389-409, March 2004.
- G. Cheng and N. Ansari, "Finding All Hop(s) Shortest Path," *IEEE Communications Letters*, Vol. 8, No. 2, pp. 122-124, February 2004.
- Y.Q. Shi, X.M. Zhang, Z. Ni and N. Ansari, "Interleaving for Combating Bursts of Errors," *IEEE Circuits and Systems Magazine*, Vol. 4, No.1, pp. 29-42, 1st quarter, 2004.
- Y. Luo and N. Ansari, "A Computational Model for Estimating Blocking Probabilities of Multifiber WDM Optical Networks," *IEEE Communications Letters*, Vol. 8, No. 1, pp. 60-62, January 2004.
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- L. Zhu, G. Cheng and N. Ansari, "Local stable condition for random exponential marking," *IEE Proc. Communications*, Vol. 150, No. 5, pp. 367-370, October 2003.
- J. Liu, N. Ansari and T. Ott, "FRR for Latency Reduction and QoS Provisioning in OBS Networks," *IEEE Journal on Selected Areas in Communications*, Vol. 21, No. 7, pp. 1210-1219, September 2003.
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- J. Liu and N. Ansari, "On Aggressive Resource Reservation for OBS systems," *IEE Proc. Communications*, Vol. 150, No. 4, pp. 233-238, August 2003.
- A. Belenky and N. Ansari, "On IP Traceback," *IEEE Communications Magazine*, Vol. 41, No. 5, pp. 142-153, July 2003, rated "Award Quality".
- A. Belenky and N. Ansari, "IP Traceback with Deterministic Packet Marking," *IEEE Communications Letters*, Vol. 7, No. 4, pp. 162-164, April 2003.
- J. Zeng and N. Ansari, "Towards IP Virtual Private Network (VPN) Quality of Service: A Service Provider Perspective," *IEEE Communications Magazine*, Vol. 41, No. 4, pp. 113-119, April 2003.
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- G. Cheng, Y. Tian and N. Ansari, "A New QoS Routing Framework for Solving MCP," Special Issue on Internet Technology, *IEICE Trans. on Communications*, Vol. E86-B, No. 2, pp. 534-541, Feb. 2003.
- D. Wei, Y. Jie, N. Ansari and S. Papavassiliou, "Cell-based Schedulers with Dual-rate Grouping," Special Issue on Internet Technology, *IEICE Trans. on Communications*, Vol. E86-B, No. 2, pp. 637-645, Feb. 2003.
- L. Zhu, G. Cheng and N. Ansari, "Delay Bound of Youngest Serve First Aggregated Packet Scheduling," *IEE Proc. Communications*, Vol. 150, No. 1, pp. 6-10, Feb 2003.
- H. Zhao, N. Ansari and Y.Q. Shi, "Efficient Predictive Bandwidth Allocation for Real Time Videos," *IEICE Trans. on Communications*, Vol. E86-B, No. 1, pp. 443-450, Jan. 2003.
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- G. Cheng and N. Ansari, "On Multiple Additively Constrained Path Selection," *IEE Proc. Communications*, Vol. 149, No. 5, pp.237-241, Oct. 2002.
- J. Li and N. Ansari, "Credit-Based Scheduling Algorithms for Input Queued Switches," *IEICE Trans. Communications*, Vol. E85-B, No. 9, pp. 1698-1705, Sep. 2002.
- J. Zeng and N. Ansari, "Virtual Queue Occupancy and Its Applications on Periodic Bandwidth On Demand Schemes for IP/SONET," *IEICE Trans. Communications*, Vol. E85-B, No. 9, pp. 1749-1755, Sep. 2002.
- H. Zhao, N. Ansari, and Y.Q. Shi, "Transmission of Real-time Videos over IP Differentiated Services," *IEE Electronics Letters*, Vol. 38, No. 19, pp. 1151-1153, September 2002.
- Y. Luo and N. Ansari, "Restoration with Wavelength Conversion in WDM Networks," *IEE Electronics Letters*, Vol. 38, No.16, pp. 900-901, August 2002.
- J. Bang, N. Ansari and S. Tekinay, "Performance Analysis of an ATM MUX with a New Space Priority Mechanism under ON-OFF Processes," *Journal of Communications and Networks* (technically co-sponsored by IEEE COMSOC), Vol. 4, No. 2, pp. 128-135, June 2002.
- J. Li and N. Ansari, "Enhanced Birkhoff-von Neumann Decomposition Algorithm for Input Queued Switches," *IEE Proc. Communications*, Vol. 148, No. 6, pp. 339-342, December 2001.

- D. Liu, N. Ansari, and E.S.H. Hou, "A Novel Fairness Criterion for Allocating Resources in Input Queued Switches," *IEE Electronics Letters*, Vol. 37, No. 19, pp. 1205-1206, September 2001.
- H. Liu, N. Ansari and Y.Q. Shi, "Modeling MPEG Coded Video Traffic by Markov-Modulated Self-Similar Processes," *Journal of VLSI Signal Processing Systems* (special issue on Multimedia Signal Processing), Vol. 29, No. 1/2, pp. 101-113, August/September 2001.
- L.C. Zhong, Z. Siveski, R.E. Kamel and N. Ansari, "Adaptive Multiuser CDMA Detector for Asynchronous AWGN Channels — Steady State and Transient Analysis," *IEEE Transactions on Communications*, Vol. 8, No. 9, pp. 1541-1549, September 2000.

INVITED TALKS (2000-2007)

- "On Tracing and Mitigating Distributed Denial of Service Attacks," **Distinguished Invited Talk**, *2007 IEEE International Conference on Computer Communications (ICCN 2007)*, August 13-16, 2007.
- "On TCP-Jersey," Invited Talk, *2007 Wireless and Optical Communications Conference (WOCC 2007)*, April 27-28, Newark, NJ.
- "On Tracing and Mitigating Distributed Denial of Service Attacks," delivered at Hong Kong, Macao, and Tokyo, as an **IEEE COMSOC Distinguished Lecture Tour**, during March 8-16, 2007. (3 talks)
- "WiMAX: Privacy Key Management," **Distinguished Lecture**, 2007 *Sendai International Workshop on Network Security and Wireless Communications*, Sendai, Japan, January 24, 2007.
- "Congestion Control in Heterogeneous Network Environment," **tutorial**, *6th Annual VI Winter Workshop Series,* Warren, MI, January 8-11, 2007.
- "On Tracing and Mitigating Distributed Denial of Service Attacks," *IEICE Joint Technical Meetings,* Sendai, Japan, September 14, 2006. (Presentation slides were produced in three IEICE Technical Reports, Vol. 106, No. 236-238, NS2006-76, IN2006-56, CS2006-22(2006-9))
- "Tracing Cyber Attacks by Deterministic Packet Marking," University of Texas at San Antonio, May 8, 2006.
- "TU-02 - Tracing Cyber Attacks," **tutorial**, *2005 IEEE Global Telecommunications Conference Globecom2005,* St. Louis, MO, USA, Nov. 28, 2005.
- "TCP-Jersey for the Emerging Hybrid Network," Hong Kong Applied Science and Technology Research Institute (ASTRI) Company Limited, Hong Kong, July 8, 2005.
- "TCP-Jersey for the Emerging Hybrid Network," Shangdong University, Jinan, Shangdong, PRC, July 5, 2005.
- "Dynamic Upstream Bandwidth Allocation over Ethernet Passive Optical Networks," Shangdong University, Jinan, Shangdong, PRC, July 4, 2005.
- "TCP-Jersey: A Reliable Transmission Protocol for Next Generation Networks," **Keynote Speech**, 2005 IEEE International Conference on Information Technology: Research and Education, Hsinchu, Taiwan, June 28, 2005.
- "TCP in Heterogeneous Environment," **tutorial**, 2005 IEEE International Conference on Information Technology: Research and Education, Hsinchu, Taiwan, June 27, 2005.

- "TU19: Enterprise Network Security: Managing And Tracing Cyberattacks," (with Pradeep Ray) **tutorial**, *2004 IEEE Global Telecommunications Conference Globecom2004,* Dallas, Texas, USA, Nov. 29-Dec. 3, 2004.
- "Toward Identifying the Sources of IP Packets," Electrical and Computer Engineering Lecture Series, Polytechnic University, Brooklyn, NY, November 11, 2004.
- **"**Toward Identifying the Attack Source by Deterministic Packet Marking," **Keynote Speech**, *IEEE/ACM International Conference on e-Business and Telecommunication Networks ICETE2004*, Setúbal, Portugal, August 25-28, 2004.
- "TU09: QoS in Multimedia Networks," **tutorial**, *IEEE International Conference on Communications ICC2004,* Paris, France, June 20-24, 2004.
- "On Traffic Assembly and Transport Mechanisms for IP over WDM Burst-switched Networks," University of Zagreb, Croatia, June 16, 2004.
- "On IP Traceback," **tutorial**, *IEEE International Workshop on High Performance Switching and Routing*, April 18, 2004.
- "IP Traceback by DPM," Overseas **Distinguished** Speech, *2nd Sendai International Workshop on Internet Security and Management*, Sendai, Japan, January 29, 2004.
- "QoS in Multimedia Communications," **tutoria**l, *3rd Annual VI Winter Workshop Series,* Warren, MI, January 12-16, 2004.
- "On Deterministic Packet Marking," ISS Seminar, DIMACS Series-Joint Rutgers and Princeton, Princeton University, December 11, 2004.
- "On IP Traceback," in the Security in Wireless Systems and Networks Panel, in conjunction with the 12th Annual Wireless and Optical Communications Conference (WOCC'2003), Newark, NJ, USA, April 25-26, 2003. (panelist & speaker)
- "Research in Advanced Networking," IT Industry Forum and Tours, sponsored by NJ Technology Council and NJIT, September 27, 2002.
- "Traffic Scheduling," a **tutorial** given at the Seventh International Conference on Distributed Multimedia Systems DMS'2001, Taipei, Taiwan, September 26-28, 2001.
- "Emerging Issues in Broadband Networks," an 8-hour invited **short course** conducted at Tamkang University, Taipei, Taiwan, ROC, September 24-25, 2001. (Over 50 attendees)
- "On Traffic Scheduling for High Speed Switches," presented at Industrial Technology Research Institute, Hsinchu, Taiwan, ROC, September 28, 2001.
- "On Modeling MPEG Videos," presented at National Tsing Hua University, Hsinchu, Taiwan, ROC, September 28, 2001.
- "Emerging Topics on Broadband Networks," a 4 half-day short course, as part of the Telecommunications Engineering Management Program for UTStarcom, Oct. 2-13, 2000.

ARIDAMAN K. JAIN

Summary

Teacher, consultant, and researcher in a wide variety of statistical fields, including Reliability Analysis, Applied Statistics, Design of Experiments, Statistical Modeling, and Sampling Surveys, as well as Network Security, and Cost Modeling

Professional Experience

New Jersey Institute of Technology (NJIT), Newark, NJ 2003 -
Senior University Lecturer

- Currently teaching 3 courses - undergraduate and graduate - in Statistics.
- Coordinator of Probability & Statistics Course.
- Coordinator of the Statistics Consulting Lab.

Lucent Technologies - Bell Laboratories, Holmdel, NJ 1997 – 2001
Member of Technical Staff

Represented Lucent in the Measurements Working Group of the Telecom Industry specific TL 9000 Forum on quality and reliability standards and IEEE Reliability Prediction Working Group; conducted reliability studies of several Lucent products.

- Led the development of the "Product Performance Indicator". Played a key role in the development of the "Return Rate" and "System Outage" measurements in TL 9000.
- Convinced the TL 9000 Measurements Group to reduce the number of metrics from 30 to 10 most critical, which resulted in a multi-million dollar savings for Lucent.
- Led the development of a security profile of Lucent computer network that resulted in the filing of two patent applications.
- Developed a sampling plan for Factory EST of DDM-2000 system that reduced the manufacturing test interval and the testing costs by 50% - 70%.
- Teamed with a cross-functional group to develop the new balanced scorecard that is a key tool being used by the Executive Committee to manage the Lucent turn around.
- Coauthored several sections of the "Reliability Prediction Guide", being developed by the IEEE Reliability Prediction Working Group.
- Developed and presented a tutorial on reliability prediction during1995-2001 Annual Reliability and Maintainability Symposiums, each attended by more than 100 people.

Bellcore (now Telcordia Technologies), Red Bank, NJ 1984 - 1996

Distinguished Member of Staff /District Manager

Provided industry consulting on reliability of electronic equipment and conducted Reliability Review Forums (RRFs) for tracking the reliability performance of Telecom products.

- Conducted RRFs for tracking the reliability performance of large transmission systems deployed by the Regional Bell Operating Companies and developed corrective action programs with several large telecommunications suppliers.

- Coordinated and conducted the first telecommunications industry study of the Cost of Poor Quality that provided a quantitative measure of the potential cost savings.
- Prepared Issues 4 & 5 of the Bellcore Reliability Prediction Procedure that is used by the Telecommunications industry for estimating the reliability of products.
- Authored three issues of the Bellcore Field Reliability Performance Study Handbook, which was the first telecommunications industry document on the subject.
- Developed and presented a tutorial on reliability prediction at the 1995-1997 RAMS, each of these was attended by more than 100 people.

Bell Laboratories, Holmdel, NJ **1967 - 1983**

Member of Technical Staff

Made a broad range of technical contributions: modeled computer performance, developed sampling plans for measurement of billing accuracy, designed experiments for optimum phrasing of telephone-intercept messages, and estimated telecom demand in the health-care segment. These contributions had a major impact on the design of telecommunications systems and provided estimates of potential demand for making important decisions on offerings of new telecommunications services.

Course Development & Teaching Experience

- Taught at NJIT: Probability, Applied Statistics, and Sampling Theory 2003 -
- Developed and presented a tutorial: "Reliability Prediction" at the Reliability and Maintainability Symposium (sponsored by IEEE, ASQ, IIE, SRE, and 8 other professional societies) for 7 consecutive years during 1995 – 2001.
- Developed and taught: "Advanced Statistics" at Stevens Institute of Technology, 1995-1996; "Statistical Process Control" at Monmouth Univ., 1994; "Business Statistics" at Monmouth Univ., 1993 - 1994; "Engineering Reliability" at NJIT, 1993; "Design and Analysis of Sampling Surveys" at Bell Laboratories, 1978 & 1979.
- Taught at Bell Laboratories: two-semester order of "Data Analysis", 1975-1976 & 1976-1977; two-semester order of "Design of Experiments", 1971-1972 & 1973-1974; and "Linear Statistical Models", 1968.

Professional Activities

- NJ Chapter of American Statistical Association, Past President, 1996-1997; Continuing Education Committee Chairman , 1986-1987 & 1994-1996; Chairman of the Election Committee, 1998-2001; and Science Fair Judge, 2004 & 2005.
- Senior Member of both the American Society for Quality and the Institute of Electrical and Electronics Engineers (IEEE).
- American Society for Quality (ASQ), Chair of two Writing Committees, "An Attribute Skip-Lot Sampling Program: ANSI/ASQ S1-2003" and "Chain Sampling Procedures for Inspection by Attributes: ANSI/ASQ S3-2004".

Education

- Ph.D., Statistics and Industrial Engineering, Purdue Univ., Lafayette, IN, 1968.
- M.S., Statistics, Indian Statistical Institute, Calcutta, India, 1960.
- B.Sc. with Honors, Mathematics, Delhi University, Delhi, India, 1957.

Major Awards/Patents

- Lucent Technologies Standards Excellence Award (2001)
- Reliability and Maintainability Symp., Best Continuing Tutorial Award (2000)
- Co-author of two patent applications on Cyber Security (1998)
- Distinguished Member of Staff Award, Bellcore, 1984.
- Outstanding Presentation Award at the Annual meetings of the American Statistical Association, 1980.

Journal Articles and Papers in Proceedings

1. "Sampling and Short Period Usage in the Purdue Library," *College and Research Libraries,* Vol. 27, p. 211 -218, May 1966.

2. "A Statistical Study of Book Use," *PhD Thesis,* Purdue University, Distributed by U.S. Clearinghouse (PB-176525), 1967.

3. "Sampling and Data Collection Methods for a Book-Use Study," *The Library Quarterly,* Vol. 39, p. 245-252, July 1969.

4. "A Statistical Model of Book Use and its Application to the Book Storage Problem," *Journal of the American Statistical Association,* Vol. 64, p. 1211-1224, December 1969 (Co-authors: V. L. Anderson and F. F. Leimkuhler).

5. "Sampling In-Library Book Use," *Journal of the American Society for Information Science,* Vol. 23, p. l50-155, May-June 1972.

6. "Monte-Carlo Simulation of Cross-talk in Communication Cables," *Proceedings of 1973 Winter Simulation Conference, p.* 844-857, January 1973.

7. "Statistical Modeling of Computer Performance," *Proceedings of the Ninth, Tenth and Eleventh Meetings of the Computer Performance Evaluation Users Group, p.* 19-29, 1974-1975 (Co-author: T. W. Potter).

8. "Statistical Modeling of Computer Performance (A Cost Benefit Approach)," *Proceedings of the Twelfth Meeting of the Computer Performance Evaluation Users Group, p.* 171-178, November 1976 (Co-author: T. W. Potter).

9. "Estimation from a Stratified Random Sample Under Changes in Strata Composition," *Proceedings of the Section on Survey Research Methods,* American Statistical Association, Washington, D.C., p. 642-646, August 1978.

10. "A Guideline to Statistical Approaches in Computer Performance Evaluation Studies," *Performance Evaluation Review,* Vol. 8, No. 1-2, p 63-77, 1979.

11. "Quantitative Methods in Computer Performance Evaluation," *Proceedings of the 15th Meeting of the Computer Performance Evaluation Users Group,* October 1979.

12. "Computer System Migration Planning Through Benchmark Performance Evaluation," *Proceedings of the 15th Meeting of the Computer Performance Evaluation Users Group,* p. 89-104, October 1979 (Co-authors: A. Mukherjee and B. A. Ketchledge).

13. "Design of a Rotation Scheme for a Stratified Multi-Stage Sample," *Journal of Statistical Planning and Inference,* Vol. 5, No. 1, p. 57-69, 1981.

14. "Estimation in Stratified Sampling: Adjustment for Changes in Strata Composition," *Annals of the Institute of Statistical Mathematics,* Vol. 34, No. 1, Part A, p. 91-103, 1982.

15. "A Multivariate Methodology for Analyzing Data from Stratified Multi-Stage Sampling Surveys," *Proceedings of the Section on Survey Research Methods,* American Statistical Association, Washington, D.C., p. 111- 116, August 1982 (Co-author: R. E. Hausman).

16. "Stratified Multi-Stage Sampling," *Encyclopedia of Statistical Sciences,* Vol. 9, p. 8-12, John Wiley and Sons, Inc., 1985 (Co-author: R. E. Hausman).

17. "Quantification of the Cost of Poor Quality for Selected Telecommunications Products," *Proceedings of the Business and Economic Statistics Section,* American Statistical Association, Washington, D.C., p. 289-293, August 1985 (Co-author: B. S. Liebesman).

18. "The Cost of Poor Quality for Selected Operating Telephone Company Products," *Proceedings of the IEEE Global Telecommunications Conference,* IEEE Communications Society, p. 1393-1397, December 1985 (Co-author: B. S. Liebesman).

19. "What is the Cost of Poor Quality?", *Bell Communications Research EXCHANGE,* Vol. 2, Issue 6, p. 18-22, November/December 1986 (Co-author: B. S. Liebesman).

20. "Conducting Quality and Reliability Field Performance Studies," *Bell Communications Research EXCHANGE,* Vol. 3, Issue 3, p. 19-23, May/June 1987.

21. "Improved Quality of Protocol Testing Through Techniques of Experimental Design," *Proceedings of the IEEE International Conference on Communications, p.* 745-752, May 1994 (Co-authors: K. Burroughs and R.L. Erickson).

22. "Quality Assurance Cost Effectiveness as a Measure of Customer Satisfaction", *Annual Review of Communications,* Volume XLVIII, p. l013-l018, 1994-95 (Coauthor: R. N. Brigham).

23. "Reliability Prediction", A Best Continuing-Excellence-Award-Winning Tutorial at Seven Consecutive *Reliability and Maintainability Symposiums - Tutorial Notes,* During 1995-2001 (Coauthors: John Healy and Jay Bennett).

24. "The Realism of FAA Reliability-Safety Requirements and Alternatives", IEEE AES Systems Magazine, February 1998 (Coauthors: Michael Pecht, et al).

25. "Improving the Manufacturing Test-Interval and Costs for Telecommunications Equipment", *Proceedings of the Reliability and Maintainability Symposium,* January 1999 (Coauthor: Harry Saraidaridis).

26. "Managing Cyber Security Vulnerabilities in Large Networks", Bell Labs Technical Journal, Volume 4, Number 4, October-December 1999 (Co-authors: Edward S. Chang, David M. Slade, and S. Lee Tsao).

27. "Development of Quality Index for TL 9000 Measurements", *Proceedings of the Reliability and Maintainability Symposium,* January 2002.

28. "Reliability Predictions Based on Criticality-Associated Similarity Analysis", *Proceedings of the Reliability and Maintainability Symposium,* January 2002 (Coauthors: Alazel Jackson and Tyrone Jackson).

29. "Development and Use of Quality Index for Reliability Improvement", *Reliability, Maintainability, and Supportability (RMS) Newsletter*, Volume 6, Number 2, April 2002.

30. "Quality Index for Feedback and Reliability Improvement", *Proceedings of the Annual Quality Congress,* May 2003.

31. "Small-sample Non-parametric Tests for the Effectiveness of Liposuction Breast-Reduction Surgery in African American Women" (Coauthors: Martin J. Moskovitz, Sherwood A. Baxt, and Robert E. Hausman), Journal of Plastic Reconstruction Surgery, January – February, 2007.

Selected Reports at Bell Labs, Bellcore, and Lucent Technologies

1. Effect of Twist Lengths and Distances between Pairs on Cross-talk, Bell Laboratories Report, October 29, 1968.
2. Sampling and Data Collection Methods for Book Use Studies, Bell Laboratories Report, February 6, 1969.
3. Optimum Twist Length Selection, Bell Laboratories Report, May 12, 1969.
4. An Experiment to Investigate the Phrasing of Automatic Intercept Messages, Bell Laboratories Report, July 31, 1969.
5. Analysis of a Completely Balanced Lattice Square Experiment for Investigating the Phrasing of Automatic Intercept Messages, Bell Laboratories Report, July 15, 1970.
6. A Likelihood Analysis of Time Dependent Models for Customer Revenue Lifetime, Bell Laboratories Report, September 3, 1971 (Coauthor: J. A. Tischendorf).
7. Investigation of Possible Sources of Bias in MDF Activity Study, Bell Laboratories Report, July 23, 1973 (Coauthors: P. S. Miller and J. A. Tischendorf).
8. Application of Asymptotic Normality of Power Sums to Communication Crosstalk Studies, Bell Laboratories Report, November 13, 1974 (Coauthor: B. Saperstein).
9. Analysis of Possible observer Bias in the Final NAP - Installation Data Base for Bell of Pennsylvania, Bell Laboratories Report, December 23, 1974 (Coauthor: P. A. Groll).
10. Formulas for Estimates of Billing Error Probabilities for operator Handled Calls, Bell Laboratories Report, March 4, 1977.
11. Revenue Impact of Billing Errors in Direct-Distance-Dialed Calls, Bell Laboratories Report, November 11, 1977.

12. Estimation of Potential Demand for Advanced Mobile Phone Service, Bell Laboratories Report, October 26, 1979.
13. The Nationwide Credit - Classification Study: Study overview and Sampling Plan, Bell Laboratories Report, December 20, 1979 (Coauthor: W. H. Elliott).
14. Estimation of Potential Demand in the Health Care Segment, Bell Laboratories Report, July 24, 1981 (Coauthor: P. Agarwala).
15. Integrity of Special Services Forecast Data Base, Bell Laboratories Report, October 21, 1981.
16. Special Services Forecasting Reports: Survey Results, Bell Laboratories Report, November 23, 1982
17. Specifications for a Field Quality Data Base, Bellcore Report, May 17, 1984.
18. Cost of Poor Quality: Fiber optic Regenerators, Bellcore Report, December 31, 1984.
19. Field Performance Study Handbook, Issue 1, Bellcore Report, December 1988.
20. Field Reliability Performance Study Handbook, Issue 2, Bellcore Report, September 1989.
21. An Economic Model of the Life Cycle Cost of Repairing Defective Plug-ins vs Buying. New Plug-ins, Bellcore Report, July 30, l990 (Coauthor: R. G. Wingerter).
22. Reliability Prediction Procedure for Electronic eqiupment, Issue 4, Bellcore Technical Reference, September 1992.
23. A new Procedure for Supplier Data Validation for the case of Small Number of Defectives, Bellcore Report, May 1993.
24. Quality Cost Management Using QuACE, Issue 2, Bellcore Report, February 1994.
25. Economic Impact of Increasing the operating Temperature Range Within Telecommunications Central offices: The Wide-Band Study, Bellcore Report, November 1994 (Coauthors: G. G. Neuburger, et al).
26. Reliability Prediction Procedure for Electronic Equipment, Issue 5, Bellcore Technical Reference, December 1995.
27. Statistical Analysis of DDM-2000 Factory and Field Data During 1996-1997, Lucent Technologies Report, April 1998 (Coathors: F. R. Forgit, J.P. Maceachern, and C. I. Saraidaridis).
28. WNG Production Sampling EST – Proposed Production Sampling Plan and Analysis of Factory and Field Data, Lucent Technologies Report, December 1998 (Coathor: C. I. Saraidaridis).
29. Reliability Information Notebook, Edition 7, Revision 1, Lucent Technologies Report, October 1999.
30. Reliability Information Notebook, Edition 8, Lucent Technologies Report, October 2001 (Coauthor: Lou Dechiaro).

Dr. Yun Qing Shi

Summary

Dr. Yun Qing Shi has joined the Department of Electrical and Computer Engineering at the New Jersey Institute of Technology (NJIT), Newark, NJ since 1987, and is currently a professor there. He obtained his B.S. degree and M.S. degree from the Shanghai Jiao Tong University, Shanghai, China; his M.S. and Ph.D. degrees from the University of Pittsburgh, PA. His research interests include visual signal processing and communications (motion analysis, video compression and transmission), multimedia data hiding and security (robust watermarking, fragile- and semi-fragile lossless data hiding, authentication, steganalysis, and data forensics), applications of digital image processing, computer vision and pattern recognition to industrial automation and biomedical engineering, theory of multidimensional systems and signal processing (robust stability of linear systems, 2-D spectral factorization, 2-D/3-D interleaving). Prior to entering graduate school, he had industrial experience in a radio factory as a principal design and test engineer in numerical control manufacturing and electronic broadcasting devices. Some of his research projects have been supported by several federal and New Jersey State funding agencies.

He is an author/coauthor of 200 papers in his research areas, a book on Image and Video Compression, three book chapters on Image Data Hiding, and one book chapter on Digital Image Processing. He holds two US patents and has 20 US patents pending (among which 11 have been licensed to another party by NJIT). He is the chairman of Signal Processing Chapter of IEEE North Jersey Section, the founding editor-in-chief of *LNCS Transactions on Data Hiding and Multimedia Security* (Springer), an editorial board member of *International Journal of Image and Graphics* (World Scientific) and Journal on *Multidimensional Systems and Signal Processing* (Springer), a member of IEEE Circuits and Systems Society (CASS)'s Technical Committee of Visual Signal Processing and Communications, Technical Committee of Multimedia Systems and Applications, and Technical Committee of Life Science, Systems and Applications, the chair of Technical Program Committee of IEEE International Conference on Multimedia and Expo 2007 (ICME07), the chair of Technical Program Committee of International Workshop on Digital Watermarking 2007 (IWDW07), a fellow of IEEE since 2005.

He was an Associate Editor of IEEE Transactions on Signal Processing, IEEE Transactions on Circuits and Systems Part II, the guest editor of special issue on Image Data Hiding for *International Journal of Image and Graphics*, the guest editor of special issue on Multimedia Signal Processing for *Journal of VLSI Signal Processing Systems*, the guest editor of special issue on Image Order Processing for *International Journal of Imaging Systems and Technology,* a formal reviewer of the *Mathematical Reviews*, a contributing author in the area of Signal and Image Processing for the *Comprehensive Dictionary of Electrical Engineering* (CRC), an IEEE CASS Distinguished Lecturer, a member of IEEE Signal Processing Society's Technical Committee of Multimedia Signal Processing, a co-general chair of IEEE 2002 International Workshop on Multimedia Signal Processing (MMSP02), a co-technical chair of IEEE 2005 International Workshop on Multimedia Signal Processing (MMSP05), a co-chair of Technical Program Committee of International Workshop on Digital Watermarking 2006 (IWDW06).

Three Pieces of Related Works:
Barcodes, Digital Signature and Error Correction Codes

Yun Q. Shi

(I) My team has worked with a barcode company for Postnet Barcode in our past work.
One patent resulting from one-month intensive work in 1994 for ACCU-SORT Systems, Inc. Allenton, PA (a barcode company) by my team under my leadership.

> Y. Q. Shi, C. Chang, S. Lin, and W. Su
> US 6,708,884 B1, awarded on March 23, 2004
> "Method and Apparatus for Rapid and Precision Detection of Omnidirectional Postnet Barcode Location"

(II) My team has used Digital Signature in our past work.
A joint proposal by Institute of Infocomm Research, Singapore and NJIT, entitled "A Unified Authentication System for JPEG2000 Images", has been included into the Security Part of JPEG2000 (JPSEC), Final FDIS (Final Draft, International Standard), ISO/IEC JTC 1/SC 29/WG 1 N3853, February 2006.

At NJIT side, it was my team. The following two patents and one paper are the base of the Authentication Framework adopted by JPEG2000 for lossless compression mode. In this proposal to JPEG2000, we have used digital signature technology.

1. One patent NJIT #03-019
   Y. Q. Shi, Z. C. Ni and N. Ansari
   "Systems and Methods for Robust Reversible Data Hiding and Data Recovery in the Spatial Domain"
   US Non-Provisional Patent was filed on December 3, 2004, serial no: 11/004,041
   PCT/US2004/040528 (December 2004)

2. Another patent NJIT #03-030
   Y. Q. Shi, D. K. Zou and Z. C. Ni
   "System and Method for Robust Lossless Data Hiding and Recovery From The Integer Wavelet Representation"
   US Non-Provisional Patent was filed on December 3, 2004, serial no: 11/004,040
   PCT/US2004/040442 (December 2004)

3. Z. Zhang, Q. Sun, X. Lin, Y. Q. Shi and Z. Ni, "A unified authentication framework for JPEG2000 images," *IEEE International Conference and Expo (ICME04)*, Taipei, Taiwan, June 2004.

(III) My team has used Error Correction Codes in our past work.
In the works reported in the following papers, BCH error correction codes have been used intensively.

1. Y. Q. Shi, X. M. Zhang, Z. Ni and N. Ansari, "Interleaving for combating bursts of errors," *IEEE Circuits and Systems Magazine*, vol. 4, no. 1, pp.29-42, First Quarter, 2004.

2. Y. Q. Shi and X. M. Zhang, "A new two-dimensional interleaving technique using successive packing," *IEEE Transactions on Circuits and Systems*, *Part I: Fundamental Theory and Application,* Special Issue on Multidimensional Signals and Systems, vol. 49, no. 6, pp. 779-789, June 2002.

3. F. Elmasry and Y. Q. Shi, "2-D interleaving for enhancing the robustness of watermarking signals embedded in still images," *Proceedings of IEEE International Conference on Multimedia & Expo*, New York, July 31 to August 2, 2000.

4. F. Elmasry and Y. Q. Shi, "3-D interleaving for enhancing the robustness of watermarking signals embedded in video orders," *Proceedings of IEEE International Conference on Multimedia & Expo*, New York, July 31 to August 2, 2000.