**FINAL REPORT OF THE
JOINT SUBCOMMITTEE TO STUDY**

The Certification, Performance, and Deployment of Voting Equipment

**TO THE GOVERNOR AND
THE GENERAL ASSEMBLY OF VIRGINIA**

HOUSE DOCUMENT NO. 34

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MEMBERS OF THE JOINT SUBCOMMITTEE TO STUDY CERTIFICATION, PERFORMANCE, AND DEPLOYMENT OF VOTING EQUIPMENT

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EXECUTIVE SUMMARY

House Joint Resolution 174, agreed to during the 2004 Session of the General Assembly, established a joint subcommittee to study the certification, performance, and deployment of voting equipment. Senate Joint Resolution 371, agreed to during the 2005 Session, continued the joint subcommittee with the addition of two members with computer expertise.

2004 Interim

The resolutions charged the joint subcommittee to "(i) review the procedures and processes for the certification of voting equipment, (ii) consider the comparative merits of alternative voting systems, (iii) examine procedures for the storage, set-up, deployment, handling and decertification of voting equipment, (iv) review processes for dealing with election day problems with voting equipment, and (v) study the proper procedure for handling voting equipment pending election recounts and contests." The joint subcommittee was required to complete its work in time for the 2006 Session of the General Assembly.

The joint subcommittee organized and met on August 16, 2004, and elected Delegate Timothy D. Hugo, Chair. Senator William C. Mims and then Senator Jeannemarie Devolites Davis served as Vice-Chair.

At its August 2004 meeting, members heard two presentations. The first covered the special study for the State Board of Elections on the Development of Security Policies, Standards, and Guidelines for Direct Recording Electronic (DRE) Voting Systems.

The second outlined the debate over the pros and cons of DRE voting systems and voter verified paper ballots or trails. This report uses the acronym VVPR (voter-verified paper record) to cover various forms of a paper trail associated with DREs. Michael I. Shamos, Institute for Software Research International, School of Computer Science, Carnegie Mellon University, emphasized that DRE systems have been in use for 25 years without a verified incident of tampering.

However, he noted that there is a public perception that DRE systems are subject to tampering as a result of well-publicized studies pointing to security problems with the equipment. He reviewed the pros and cons of the most frequently proposed cure for DRE security problems -- a VVPR or paper record of each vote that the voter can review and verify. The advantages are that the paper trail will demonstrate to the voter that the machine has captured his votes correctly and will create a sense of security among voters. He described the disadvantages of a VVPR: no guarantee the vote was counted or that the paper will be secured for a recount; major problems in handling and securing the paper ballots; delays in the election process; accessibility issues; possible voter confusion; and an increased demand for recounts. His advice was to await the outcome of the November

2004 election when VVPRs for DRE equipment will be used in California, Missouri, and Nevada.

The joint subcommittee reached the consensus that it would await the outcome of the November 2004 election for further evaluation of proposals to improve the present procedures in the Commonwealth that govern the certification, performance, and deployment of voting equipment and related issues.

A full report of the subcommittee's 2004 activities has been published as House Document 23 (2005).

2005 Interim

During its four meetings held in 2005, the joint subcommittee sought the opinions and advice of the technology community, elections experts and officials, and the public. The joint subcommittee received information in many forms from numerous parties:

➤ Background from the State Board of Elections and its staff on the current status of voting equipment purchases in Virginia, HAVA (the Help America Vote Act) compliance, and the fact that no VVPR has requested certification yet in Virginia. Two VVPRs have been certified nationally. These two systems are compatible with some but not all of the DREs in use in Virginia at this time. Of the 90 localities prompted by HAVA to replace punch card and lever equipment, 87 have purchased DREs and three have bought optical scan equipment that uses a paper ballot and scanning equipment to read and count the ballots.

➤ Testimony from a panel of computer experts and individual computer experts that pointed to vulnerabilities in DRE systems and, in some instances, to potential problems with VVPR equipment. The predominant view from computer experts was that DREs could be vulnerable to hacking or inadvertent programming error.

➤ Testimony from a number of local election officials expressing satisfaction with DRE equipment on the part of their staffs and voters in their localities and enumerating concerns about the costs and practical effects of mandating VVPR equipment at this time.

➤ Testimony from Chesterfield and Hanover that these localities chose optical scan equipment, in part, to avoid the VVPR controversy.

➤ Demonstrations of DRE equipment, optical scan equipment, and VVPR equipment.

➤ Testimony from representatives of the disabled with emphasis on the importance of accessibility for the various facets of the disabled community.

➢ Testimony from the Maryland Elections Administrator on that state's experience with DREs, the challenges by computer experts and in court to the state's decision to use DREs without any VVPR, the ultimate court decision to allow use of the DREs, and the state's current contract with the University of Maryland for a study of VVPR and various verification methods to determine the best technology.

➢ Presentations and statements by organized groups such as Virginia Verified Voting and numerous individuals questioning the security of DRE and other electronic voting equipment. The joint subcommittee heard a wide spectrum of opinions ranging from a detailed proposal for the immediate implementation of a VVPR requirement for DREs to more general expressions of concern about the vulnerability of DRE equipment and the need for some type of audit or paper trail.

.   At its final meeting, the joint subcommittee reviewed various specific proposals for possible approval and to present as recommendations to the General Assembly.

➢ The subcommittee approved a specific recommendation that the State Board of Elections design and implement a pilot program to test the use of DRE equipment with VVPR equipment, to take into account the concerns of the subcommittee as shown in its final report, and to report its progress and findings to the Committees on Privileges and Elections. Introduced as SB 272 and continued to 2007 by the House Committee on Appropriations for study by the Subcommittee on General Government and Technology. Also introduced in HB 1243 with additional provisions for a VVPR requirement to be effective on January 1, 2009, and continued to 2007 by the House Committee on Appropriations.

➢ The subcommittee reviewed a compromise paper presented by Cameron Quinn that would take a variety of steps to test and audit DRE and VVPR equipment prior to any mandate to provide VVPR capabilities with DREs. It approved the paper for consideration by the State Board of Elections in its design of the pilot program.

➢ The subcommittee reviewed the Chairman's Suggested List of Items which he presented to reflect the public's, computer community's, and many legislators' concerns with the safety and security of DRE equipment absent a VVPR. It approved the List for consideration by the State Board of Elections in its design of the pilot program.

➢ It was noted that individual legislators would introduce legislation in the 2006 Session to reflect these recommendations and concerns. HB 1243 and SB 424 mandating security features for electronic pollbooks and DRE's were introduced and continued to 2007. SB 424 was continued to 2007 by the Senate Committee on Privileges and Elections. HB 1243 was reported by the House Committee on Privileges and Elections by a vote of 17 to 5. However, because it also contained provision for a pilot program like SB 272, it was continued to 2007 by the House

Committee on Appropriations for study by the Subcommittee on General Government and Technology.

I. INTRODUCTION

Authority

House Joint Resolution 174 (HJR 174), agreed to during the 2004 Session of the General Assembly, established a joint subcommittee to study the certification, performance, and deployment of voting equipment. The subcommittee consisted of six legislators (four Delegates and two Senators) and five citizen members (three appointed by the Speaker of the House of Delegates and two appointed by the Senate Committee on Rules). The subcommittee elected Delegate Timothy D. Hugo and Senator William C. Mims as chairman and vice-chairman, respectively. HJR 174 gave the subcommittee the following responsibilities:

- ➢ review the procedures and processes for the certification of voting equipment;
- ➢ consider the comparative merits of alternative voting systems;
- ➢ examine procedures for the storage, set-up, deployment, handling and decertification of voting equipment;
- ➢ review processes for dealing with election day problems with voting equipment; and
- ➢ study the proper procedure for handling voting equipment pending election recounts and contests.

In accordance with HJR 174, the Chairman submitted to the Division of Legislative Automated Systems an executive summary and report of its findings and recommendations for publication as House Document 23 (2005). Information on the HJR 174 subcommittee, including meeting materials, the executive summary, and report can be found on the Internet (http://dls.state.va.us/votingequipment.htm).

Senate Joint Resolution 371 (SJR 371), agreed to during the 2005 Session, continued the joint subcommittee with the addition of two nonvoting citizen members with computer security expertise appointed by the Senate Committee on Rules and the Speaker of the House of Delegates upon the recommendation, if any, of the Chief Information Officer of the Virginia Information Technologies Agency. A copy of SJR 371 is attached as Appendix A.

Information on the SJR 371 subcommittee, including meeting materials, the executive summary, and this report can be found on the Internet (http://dls.state.va.us/votingequipment.htm).

Study Scope

The subcommittee focused its attention on analyzing the issues central to the debate about the ability of electronic voting machines to provide reliable and secure elections: the capacity for direct record electronic ("DRE") voting machines to produce voter verified paper records (VVPRs); electronic pollbooks; and security risks presented by telecommunications features of voting equipment. The subcommittee met four times during the 2005 interim and received testimony from the public and private sectors.

The subcommittee developed recommended legislation establishing a pilot program to test the capacity for DRE's to provide VVPR's in Virginia elections and to address security concerns presented by electronic pollbooks and wireless electronic communications capabilities on DRE voting machines.

II.   SUBCOMMITTEE MEETINGS AND ACTIVITIES

May 18, 2005

State Board of Elections Report on Virginia Voting Equipment

The joint subcommittee resumed its work by considering a presentation by State Board of Elections staff on the following topics:

• Use of electronic voting equipment in the 2004 election:
    40 million of 121 million voters in the November 2, 2004, election
        voted on electronic equipment;
    the State Board did not receive any report of a problem with DRE
        (direct recording electronic) equipment in the election; and
    problems were reported in three Pennsylvania counties (leading to
        decertification of a Unilect Patriot machine (different than
        the Patriot used in some Virginia localities) and in one
        county in North Carolina and in Ohio. There may be other
        instances not widely reported.

• The current certification process:
    19 voting systems are currently certified for use by Virginia localities,
        including eight DRE systems;
    no applications for certification are in process; and
    the current certification process was described to the subcommittee.

• Security measures:
    the State Board has prepared its final voting systems security policy, standards,
    and guidelines for circulation to localities July 1 with follow-up training

and workshop sessions around the Commonwealth.

• HAVA requirements and distributions of HAVA funds:
  > 81 of 90 Virginia localities required by HAVA to replace punch card and lever equipment have done so involving $17,608,930 in HAVA funds;
  > 16 of 44 localities required by HAVA to provide one accessible voting unit (DRE) per precinct have done so involving $1,734,279 in HAVA funds;
  > total HAVA funds for voting equipment allocated to Virginia equals $29,941,318, and 64.5% (the $19,343,208 cited above) has been allocated to localities to date; and
  > the final date to meet HAVA requirements is January 1, 2006.

VVPR Presentation

The subcommittee viewed a tape on the use of a DRE (Sequoia Edge) system equipped with a printer to provide a voter verified paper audit trail or VVPR capacity in Nevada in the 2004 presidential election. Members requested more information on reactions to the VVPR experience in Nevada and information from other states that have passed legislation mandating use of VVPR.

Work Plan

The subcommittee reviewed and suggested revisions in a draft work plan for three additional meetings during the 2005 interim. After review by the chair and vice chair, a revised work plan will be circulated to the subcommittee.

Meeting July 19, 2005

DRE Demonstration

Kirk Showalter, General Registrar, City of Richmond, provided a demonstration of the City's Winvote (Advanced Voting Solutions) touch screen voting system showing how the equipment is programmed and then used. This is a direct recording electronic (DRE) system. The system does not produce a voter-verified paper ballot or audit trail (VVPR) but can produce a paper print-out of each ballot image. Subcommittee members used the equipment in a test election and asked questions on security issues. She later demonstrated the optical scan equipment used for absentee ballots.

Report from Maryland Elections Administrator

Linda Lamone, Maryland Elections Administrator, reported on the Maryland decision to use a DRE system, the Diebold AccuVote TS Electronic Voting System, on a statewide basis with optical scan equipment for absentee ballots. She outlined their treatment of security issues. While they were in the procurement process, on July 23,

2003, the Hopkins report was released that pointed out security weaknesses in another Diebold DRE system.

The Hopkins study was followed by executive and legislative branch studies and a series of steps taken to address the security concerns raised by the studies: a state security action plan; a disaster recovery and incident management plan; an independent verification and validation expert to review any program or software change in certified equipment; three security personnel on the elections staff; background checks on elections equipment personnel; training on security for local officials; changes required to be made by Diebold to Maryland equipment; use of Maresware software to verify server software; physical security for equipment; parallel monitoring; and other steps. They are contracting with the University of Maryland for a study of VVPR and various verification methods, including usability, to be completed in the first part of December. In response to questions whether Maryland would consider a paper or other ballot audit feature, Lamone said no because of the complexity of the paper ballot feature -- at least at this time and absent future testing and improvements.

State Board of Elections Report on Candidate Filing Deadlines

Jean Jensen, Secretary of the State Board of Elections, spoke in response to the Chairman's request for background on candidate filing deadlines and on the State Board's authority to extend the deadline for filing statements of qualification and economic interests under Code § 24.2-503. She outlined the legislative history dating back to 1980 and the Board's practice on granting limited extensions under that section. Members expressed an interest in limiting the extension possibilities and working with the Board and staff on suggested revisions to be reviewed at a later meeting.

Voluntary Voting System Guidelines

Staff reviewed background materials on the proposed Voluntary Voting System Guidelines (VVSG) that the Election Assistance Commission released for public comment in June. The comment period will end September 30, 2005, and there will be a period for reviewing comments and revising the VVSG before they become final. States are free to follow or reject the guidelines and to adopt more stringent standards for equipment.

Public Comments

A public comment period followed with 15 speakers representing a variety of opinions:

➢ Eight speakers (including four representatives of Virginia Verified Voting) were critical of DRE equipment. There were various viewpoints expressed: (i) a preference for optical scan equipment because it is less expensive and provides a paper ballot for recount purposes; (ii) advocacy for VVPR for DRE equipment to

assure voters that their vote is properly recorded and to provide an audit trail; and (iii) assertions that VVPR equipment can be made to be accessible.

➢ Three local elections officials opposed a VVPR requirement for the certified DRE equipment already in use in their localities. They cited the proven track record of their equipment, the costs of VVPR equipment, the added time and complexity that a VVPR requirement would bring to the election process, and the lack of any proven instance of tampering with DRE equipment.

➢ Two speakers addressed concerns of the disabled community and the need to assure that any requirement for a VVPR be proven to be accessible for visually and physically disabled voters. One speaker cautioned that if there is only one voting station for the disabled, it should be used by multiple voters to assure that ballot secrecy is preserved for disabled voters.

➢ A voting equipment (Elections Systems and Software) spokesman cautioned that the HAVA deadline for replacing punch card and lever equipment is firm -- January 1, 2006. Any new requirement such as a VVPR must allow time for development, manufacture, and certification. The reel-to-reel VVPR equipment developed to date may not meet final federal standards now out for comment and not expected to be final before the end of this year.

➢ Robert Ostergren, General Registrar of Hanover County, reported that the county expects to purchase optical scan equipment with AutoMark equipment to meet HAVA accessibility requirements. AutoMark equipment is now in process for state certification.

The Chairman thanked all the participants, and the meeting adjourned.

August 22, 2005

Public Comments

The meeting opened with a public hearing that produced comments from 19 speakers covering a number of topics and conflicting points of view:

➢ Larry Haake, Chesterfield County General Registrar, summarized the process by which the County decided to purchase optical scan equipment to replace their punch card voting equipment. He cited the similarities of their old punch card and new optical scan equipment as pluses for voters and election officers, cost savings, and the desire to avoid the DRE and paper trail controversy. He demonstrated their optical scan equipment and described the AutoMark equipment now submitted for certification which is an accessible touch screen device for marking an optical scan ballot.

➢ Twelve speakers advocated changes to meet problems perceived with DRE equipment and other voting equipment with a majority of the speakers advocating a voter verified paper audit trail (VVPR) requirement. There were various recommendations brought forward:

• Create an independent task force of computer experts to test DRE equipment because the manufacturers and current certification process have not performed satisfactorily to assure that only well-designed DREs are approved. Move cautiously on any VVPR or printer requirement.
• Follow the recent North Carolina example and require a paper ballot in some form, a state RFP procedure, and random post election equipment and ballot audits to determine the accuracy of the equipment.
• Require an accessible VVPR for use with DRE equipment or require VVPR for DREs and other accessible alternatives for the disabled community in each precinct.
• Utilize redundant testing procedures for DREs and voting equipment in an open process, provide adequate training for election workers and voters, and provide more stringent security for all equipment as possible alternatives to a VVPR requirement.
• Require paper ballots for recount purposes.

➢ Two local elections officials cautioned that there were significant costs in enacting a VVPR requirement for the certified DRE equipment already in use in many localities. One suggested that any VVPR requirement should be (i) preceded by a pilot program run in actual precincts to document the costs and logistics of VVPR, (ii) enacted to provide for random testing and require VVPR printers for only a percentage of DREs, and (iii) delayed until manufacturers develop better VVPR equipment and the Election Assistance Commission develops standards for such equipment.

➢ Two speakers addressed concerns of the disabled community and the need to continue to improve the accessibility of voting equipment and to assure that any requirement for a VVPR be proven to be accessible for visually and physically disabled voters. Voting equipment should meet Election Assistance Commission standards and be subject to continuing quality assurance review.

➢ A representative of Ferey International, Inc., demonstrated their voter verified ballot printer which they offer as compatible with any certified DRE equipment. This printer is relatively small, costs between $800 and $1,000 per unit, and produces a paper ballot (shown behind a window in the printer) that the voter reviews before casting his ballot. The voter can cancel that ballot and it is marked void. The voter can then cast a corrected ballot. The paper ballot is then cut and dropped into a secure ballot box so that the ballots are mixed and not retained in the order in which voted.

Presentation on Electronic Pollbooks

Dave Andrews, General Registrar, Williamsburg, gave a presentation on the use of electronic pollbooks (EPBs) that they tested in two precincts in the June 14 primary elections. He cited the benefits to voters in the shorter time needed to find a voter's name, the avoidance of split pollbooks with long lines for some voters (A to M) and not others (N to Z), and the ability to find a voter's proper precinct on the EPB database. He also cited paper and storage cost savings and the advantage of producing almost immediate reports on voter participation for media, parties, and candidates compared to the months now required for the reports to be produced from the current paper pollbook system.

Expert Panel Discussion on Security

The Chairman thanked all the participants, and the meeting continued with expert panel discussion.

Dr. Dan Wallach, Associate Professor, Rice University Department of Computer Sciences, and manager, Rice University computer security lab, spoke first and noted that computer-driven voting equipment can fail just as any computer can fail, so a back-up paper ballot is essential as a check. On the issue of paperless versus paper, he views the paper as a valid back-up for computers and as a check against tampering. He recommended more stringent and independent testing for DRE and other voting equipment including any product that produces a paper record. There should be "penetration" and full "simulation" testing so that the equipment is tested against possible failures and hackers. There is a culture problem that relies on manufacturers and routine testing. Any cost analysis should take into account the costs of machine failure and new elections required as a result of failures. He cautioned against both internet voting and transfers of machine vote totals by internet. At this point he would recommend precinct based optical scan equipment.

Justin Moore, sixth-year Ph.D. student, Duke University, and member of Duke Internet Systems and Storage Group, addressed three issues. First, on costs, in North Carolina a voter group reported that the cost per voter for optical scan equipment is $3.50 and for DRE equipment is $5.50. Second, the standards now in place for voting equipment are too lax in permitting failures of certifiable equipment and we should be more stringent in testing equipment software. Third, we need to audit elections and a paper trail to facilitate audits. There is a need to detect failures. He recommended that Virginia use optical scan equipment with the AutoMark touch screen and paper ballot for accessibility.

Paco Hope, senior software security consultant, Cigital, Inc. described the security issues and procedures involved in the gaming industry as a point of comparison for computer-driven voting equipment. Casino slot machines are touch screens that print a verifiable paper receipt and are designed to be easily used. Casino regulators in the states have the source codes for the machine software and conduct simulation tests to assure that the machines pay off at the stated percentage. The gaming equipment is subject to

continuous physical protection and observation. This is not possible for voting equipment that must be operated to guarantee voter privacy. Gambling is a billion dollar business that can afford extensive testing and verification of computer software, but this is not the case for election equipment.

Hugh Gallagher, managing director, Election Systems Acquisition & Management Services, questioned assertions that current systems can be tampered with and cited lack of proof of any incidents of tampering. He described Virginia's security policies that have been updated and are being applied at the local level. There is no internet connection to the voting equipment that would permit hacking into the voting process. Regarding the transmission of voting data, current encryption procedures are adequate. If a VVPR is considered, go slowly to assure that it is workable and cost effective. He stressed the need for adequate training for elections officials to prevent human errors and reinforce security procedures.

Dr. Hratch Semerjian, Deputy Director of the National Institute for Standards and Technology (NIST), described NIST's role in the development of the Voluntary Voting System Guidelines (VVSG) with the Technical Guidelines Development Committee (TGDC) to assist the Election Assistance Commission (EAC) meet its responsibilities under HAVA. The TGDC submitted its draft VVSG to the EAC which has reviewed and modified them and published them for public comment on June 29. The public comment period ends September 30, 2005, and then the EAC will review and revise the VVSG and release them later in the fall. This first phase addresses the most pressing issues, but the NIST and TGDC work continues. They have another committee meeting at the end of September to begin the next phase. They will be looking at other issues such as security and dual verification and will set priorities at their September meeting. Their initial effort was designed to make critically needed changes to the existing 2002 federal standards, and the next phase will take a look the standards as a whole.[1]

Draft Recommendations

Members were given a staff outline for the subcommittee's report and a proposal for consideration provided by Cameron Quinn. The Chairman asked members and the public to send proposals for review to staff for circulation to the subcommittee as a means to prepare for the subcommittee's next meeting on November 21, 2005, at 1:00 p.m. in House Room C of the General Assembly Building. The Chairman thanked the panel participants and Dr. Semerjian for their time and contributions, and the meeting adjourned.

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[1] The EAC adopted the VVSG on December 13, 2005, to be effective December 2007, and has made them available online at http://www.eac.gov/vvsg_intro.htm EAC also provides the guidelines in paper or on CD by faxing a request to (202) 566-3127 or email to HAVAinfo@eac.gov

November 21, 2005

<u>Presentation on Universal Verification Technology</u>

The Chairman called the meeting to order and introduced Bryan Finney of VoteHere Inc. to describe their company's Sentinal product, a universal verification product. Sentinal is an independent elections validation device that sits by a voting system and creates a record of how votes are recorded. He noted that the device has not been certified and that NIST is now drafting standards. The cost of this device will be approximately $500 in comparison to the $800 to $1200 cost of other VVPR units now available. He recommended that the subcommittee call for accuracy tests of "paper trail" counts and of universal verification technology before mandating a particular voter verified paper solution.

<u>State Board of Elections Report on HAVA Compliance</u>

Jean Jensen, Secretary of the State Board of Elections, distributed information listing the voting systems certified for use in Virginia and showing the status of voting equipment purchases and distribution of HAVA funding with $25,597,686 of $29,941,318 spent to date. Of the 90 localities that were required to replace punch card or lever voting systems, 87 purchased DRE equipment and 3 (Chesterfield, Gloucester, and Hanover) purchased optical scan equipment. Forty of the 44 localities required to purchase one DRE per precinct to meet HAVA accessibility requirements have made those purchases.

She noted that only two VVPR systems (Diebold and Sequoia) have been certified nationally and that no applications for certification of such equipment have been filed in Virginia to date. She cautioned that a balanced approach involves improved security, training, and recruitment of elections personnel and that equipment technology is evolving, making it inadvisable to mandate the use of VVPR equipment at this time.

<u>Possible Recommendations</u>

The Chairman distributed a list of possible recommendations to serve as an outline for subcommittee discussion and guide for the subcommittee's use in reviewing possible recommendations. Subcommittee members agreed to exchange e-mails to add to the outline and provide information in preparation for their next meeting when they will take action on their recommendations.

January 5, 2006

At its fourth and final meeting, the subcommittee concluded its work, and finalized its recommendations to the 2006 session.

<u>Submissions from the Public</u>

Chairman Hugo opened the meeting by thanking the members of the public who had made written submissions following the subcommittee's November 21, 2005, meeting. The following statements were submitted and are attached as Appendix C to this report:

1.   Model Legislation
        Virginia Verified Voting
        Submitted by Alex Blakemore 11/23/05

2.   Counting Mark-Sense Ballots
        Douglas W. Jones
        Submitted by Maggie Luca 11/23/05

3.   Statement of Views
        Submitted by Joyce Braithwaite, Committee Member, 12/02/05

4.   Statement of Views
        Libertarian Party
        Submitted by Steve Damerell 12/28/05

5.   Statement of Views
        Virginia Electoral Board Association
        Submitted by Arelia S. Langhorne, President, 1/3/06

6.   Statement of Views
        Edward A. O'Neal, Chairman, Norfolk Electoral Board
        Submitted 1/4/06

<u>Recount of Election for Attorney General</u>

The subcommittee heard a presentation from Jean Jensen, Secretary of the State Board of Elections about the pending recount proceedings. She reported that the process had gone smoothly under the direction of Chief Judge Markow of the City of Richmond Circuit Court. She stated that the process had disclosed human errors and a difference in votes of about 360. She also noted that the Court had declined to order rerunning of optical scan ballots. She agreed to work with counsel to assure that the House and Senate Privileges and Elections Committees would have the benefit of this experience in considering legislation dealing with recount procedures. Chairman Hugo expressed appreciation to the Secretary and the State Board of Elections for its help in connection with the subcommittee's deliberations.

Consideration of Proposed Recommendations

Before inviting the subcommittee members to present their views, Chairman Hugo asked counsel to review the subcommittee voting procedures and the votes required to approve or defeat the proposals set forth in the Chairman's Suggested List of Items for Subcommittee Review and Action included in Appendix C to this report. Counsel noted that the Subcommittee's report would reflect actions agreed to by a majority.

Cameron Quinn, Subcommittee Member, elaborated on written remarks presented to the subcommittee that are included in Appendix C. She noted that the addition of capacity to direct response electronic ("DRE") voting equipment to create a voter-verified permanent records ("VVPR") is new and controversial. She recommended making this capacity optional. The subcommittee agreed to incorporate her recommendations into the Chairman's list.

Senator Whipple observed that Virginia has a secure voting system staffed by competent people. She acknowledged people are accustomed to receipts, but recommended a pilot project to allow Virginia time to test VVPR capacity.

Secretary Jensen reported that of the six vendors providing DRE equipment, only two have VVPR capacity. She stated that there are not yet final standards on certifying equipment nationally and that adding VVPR requirements at the state level is premature and likely could not be done in time for the November 2006 elections.

Maggie Lucca, Subcommittee member, elaborated on a written statement submitted to the subcommittee included in Appendix C. She stated that Fairfax County has experienced problems with recounts and that election officials have been legally unable to count paper ballots under rulings by a judge and the Attorney General. She expressed support for a pilot project and her willingness to continue providing input.

Jeremy Epstein, Subcommittee member, suggested that the subcommittee consider combining all three of the ballot reliability measures set forth in the Chairman's list: VVPR, random audits and mandatory audits of selected precincts using optical scan ballots.

Members of the subcommittee debated whether a problem of voter confidence supports consideration of VVPR technology. Michael Brown stated that he has seen no problem with voter confidence or problems with Virginia voting equipment. Judith A. Stokes concurred that in the recent recount proceedings only one person questioned the DRE's and were satisfied with the response. In contrast, Jeremy Epstein and David Evans both saw a problem with voter confidence based on their experience. Maggie Luca agreed there was no problem of voter confidence but suggested contacting local electoral board and governing bodies. Secretary Jensen recommended further study, particularly to continue receiving updates on new technologies. She noted that standards for the VVPR technology will not be available until January 2007 for November 2007. She stated that two vendors offer this addition to DRE's that could optimally be tested in

localities using DRE equipment to evaluate the six different voting methods currently being used.

Ms. Luca recommended a pilot project on electronic pollbooks rather than prohibiting them. Mr. Brown recommended against eliminating wireless capacity on voting equipment because its use is limited to setting up equipment and the communication capacity is disabled and not used during elections. Ms. Quinn concurred she was aware of no security risk. She suggested allowing the State Board to design the equipment to be tested in the pilot.

The joint subcommittee reviewed various specific proposals for possible approval and to present as recommendations to the General Assembly.

➢ The subcommittee approved a specific recommendation that the State Board of Elections design and implement a pilot program to test the use of DRE equipment with VVPR equipment, to take into account the concerns of the subcommittee as shown in its final report, and to report its progress and findings to the Committees on Privileges and Elections.

➢ The subcommittee reviewed a compromise paper presented by Cameron Quinn that would take a variety of steps to test and audit DRE and VVPR equipment prior to any mandate to provide VVPR capabilities with DREs. It approved the paper for consideration by the State Board of Elections in its design of the pilot program.

➢ The subcommittee reviewed the Chairman's Suggested List of Items which he presented to reflect the public's, computer community's, and many legislators' concerns with the safety and security of DRE equipment absent a VVPR. It approved the List for consideration by the State Board of Elections in its design of the pilot program.

The subcommittee agreed that a central feature of its recommendations to the General Assembly should be a pilot project to test the VVPR technology with a supporting budget amendment. The subcommittee recommended that any legislation to implement proposals requiring a VVPR should take effect 1/1/09. The subcommittee also agreed that the legislator members could also propose legislation.

III. ACTIONS TAKEN ON SUBCOMMITTEE'S RECOMMENDATIONS AT 2006 SESSION

Companion bills, HB 1243 and SB 272, were introduced to immediately enable the State Board of Elections to design and implement a pilot program to test the use of DRE equipment with the addition of VVPR capacity and to begin audits of DREs and electronic counting devices for optical scan ballots, taking into account the subcommittee's concerns about voter confidence and the security of wireless

communications features. These bills were continued to 2007 by the House Committee on Appropriations for study by the Subcommittee on General Government and Technology. Pursuant to Va. Code § 30-85, the General Assembly has requested that the Joint Commission on Technology and Science consider the proposed pilot in order that a recommendation about funding can be made to the 2007 Session. The estimated cost of adding the VVPR capacity is $1,200 per DRE machine. Most Virginia localities use DRE machines and about 9,400 units are in operation statewide according to the information available on the State Board's official website on the Internet (http://www.sbe.virginia.gov/cms/Election_Information/Voting_Systems_Ballots/Index.asp) as of May 15, 2006.

HB 1243 and another companion bill, SB 424, were introduced to effect broader, more permanent changes relating to electronic pollbooks, voting machine security, audits and recount procedures. HB 1243 provided that these broader changes would not take effect until January 1, 2009. SB 424 was continued to 2007 by the Senate Committee on Privileges and Elections.

IV. CONCLUSION

The subcommittee heard extensive testimony and received numerous reports about recent developments in voting machine technology and security. Some of these reports are included in Appendix C to this Report. Because of the developing nature of the computer technology involved and the lack of any national certification standards for equipment producing voter verified paper records, the subcommittee's chief recommendation was to enable the State Board of Elections to design a pilot project to test the feasibility of adding voter verified paper record (VVPR) capacity to existing direct electronic recording (DRE) voting machines. This legislation in turn was continued to 2007 to allow study by the General Government and Technology Subcommittee of the House Committee on Appropriations. Pursuant to Va. Code § 30-85, the General Assembly has requested the Joint Commission on Technology and Science to consider the proposed pilot in order that a recommendation about funding can be made to the 2007 Session.

**MEMBERS OF THE JOINT SUBCOMMITTEE TO STUDY
CERTIFICATION, PERFORMANCE, AND DEPLOYMENT OF VOTING
EQUIPMENT**

Delegate Timothy D. Hugo, Chairman

Senator Jeannemarie Devolites Davis, Vice-Chair

Delegate John A. Cosgrove

Delegate Clarence E. Phillips

Delegate Melanie L. Rapp

Senator Mary Margaret Whipple

Joyce S. Braithwaite

Michael G. Brown

Jeremy Epstein

David Evans

Margaret K. Luca

Cameron P. Quinn

Judith A. Stokes

Appendix A

SENATE JOINT RESOLUTION NO. 371

Increasing the membership of the Joint Subcommittee to Study the Certification Process for Voting Equipment and Matters Related to the Performance and Proper Deployment of Voting Equipment to include two members with computer security expertise.

WHEREAS, House Joint Resolution No. 174 (2004) established the Joint Subcommittee to Study the Certification Process for Voting Equipment and Matters Related to the Performance and Proper Deployment of Voting Equipment; and

WHEREAS, the current membership of the joint subcommittee consists of 11 members as follows: four members of the House of Delegates to be appointed by the Speaker of the House of Delegates in accordance with the principles of proportional representation contained in the Rules of the House of Delegates; two members of the Senate to be appointed by the Senate Committee on Rules; three nonlegislative members to be appointed by the Speaker of the House of Delegates upon consideration of the recommendation, if any, of each of the following: the state Republican Party, the state Democratic Party and the Virginia Association of Electoral Boards; and two nonlegislative members with computer expertise to be appointed by the Senate Committee on Rules upon consideration of the recommendation, if any, of the Chief Information Officer of the Virginia Information Technologies Agency; and

WHEREAS, the current composition of the joint subcommittee does not include any members with expertise in software engineering and computer security; and

WHEREAS, an understanding of software engineering and computer security is critical for analyzing the issues central to the debate about the ability of electronic voting machines to provide reliable and secure elections; now, therefore, be it

RESOLVED by the Senate, the House of Delegates concurring, That the membership of the Joint Subcommittee to Study the Certification Process for Voting Equipment and Matters Related to the Performance and Proper Deployment of Voting Equipment be increased to include two members with computer security expertise. The current membership shall be increased by adding two additional nonlegislative citizen members as follows: one nonlegislative citizen member with computer security expertise as defined by this resolution to be appointed by the Senate Committee on Rules upon consideration of the recommendation, if any, of the Chief Information Officer of the Virginia Information Technologies Agency; and one nonlegislative citizen member with computer security expertise as defined by this resolution to be appointed by the Speaker of the House of Delegates upon the recommendation, if any, of the Chief Information Officer of the Virginia Information Technologies Agency. The additional nonlegislative citizen members shall be nonvoting members of the joint subcommittee.

For purposes of this resolution, "computer security expertise" means having (i) an undergraduate degree in computer science or a closely related engineering discipline, but preferably a graduate degree in computer science or a closely related engineering discipline, and (ii) 15 years or more of professional experience either developing software or specializing in computer security, or at least five years academic experience as a faculty member specializing in computer science, software engineering, or computer security at an institution of higher learning in the Commonwealth.

The additional direct costs of this study shall not exceed $800.

Recommended Legislation to the 2006 Session

HOUSE BILL NO. 1243

A BILL to amend and reenact §§ 24.2-611, 24.2-629, and 24.2-802 of the Code of Virginia and to amend the Code of Virginia by adding sections numbered 24.2-625.2, 24.2-625.3, 24.2-631.1, and 24.2-671.1, relating to election procedures; pollbooks, voting equipment requirements and audits, and recount procedures; and pilot program.

Be it enacted by the General Assembly of Virginia:

1. That §§ 24.2-611, 24.2-629, and 24.2-802 of the Code of Virginia are amended and reenacted and that the Code of Virginia is amended by adding sections numbered 24.2-625.2, 24.2-625.3, 24.2-631.1, and 24.2-671.1, as follows:

§ 24.2-611. Form and signing of pollbooks; records of persons voting; electronic pollbooks.

A. The following oath shall be on a form prescribed by the State Board, administered to all officers of election, and kept by the officers of election with the pollbook:

"I do solemnly swear (or affirm) that I will perform the duties for this election according to law and the best of my ability, and that I will studiously endeavor to prevent fraud, deceit, and abuse in conducting this election."

The oath shall be administered to each officer of election by the general registrar, a member of the electoral board, or an officer of election designated by the general registrar and secretary of the electoral board, who shall be so identified on the form. The oath shall be signed by each officer of election and the person administering the oath. The pollbook shall be marked to identify the election for which it is used.

B. The State Board shall provide the pollbook pursuant to subdivision A 7 of § 24.2-404. The pollbook shall (i) provide a space for the officer of election to record the name and consecutive number of the voter at the time he offers to vote and (ii) be retained in accordance with the provisions governing pollbooks in this title. If the pollbook is provided in printed form, the State Board shall provide a numerical check sheet to be used to determine the consecutive number to be recorded with the name of the voter by the officer of election. If the pollbook is provided in electronic form, the consecutive number shall be entered automatically when the officer of election records that the voter has voted. *If the pollbook is provided in electronic form, it shall provide a paper copy record of the names of the voters and their associated identifying information on a contemporaneous and continuous basis as the voters are recorded. The election officers*

shall verify that the name printed on the paper copy record matches the voter's name on the electronic pollbook. When the name and number of the last qualified voter have been entered on the pollbook, the officer of election responsible for that pollbook shall sign a statement on the check sheet, or on a separate form if an electronic pollbook is used, certifying the number of qualified registrants who have voted. The State Board shall provide instructions to the local electoral boards, general registrars, and officers of election for the conduct of the election and for procedures for entering a voting record for each voter and recording each voter's name, including voters unable to enter the polling place, and for verifying the accurate entry of the voting record for each registrant on the Virginia Voter Registration System.

C. The State Board shall incorporate safeguards to assure that the records of the election, including the pollbook, voter count sheets, or other alternative records, will provide promptly an accurate and secure record of those who have voted. The State Board may provide for the pollbook to be in a paper format or in an electronic format if funds are appropriated to cover the costs associated with the provision of a pollbook in an electronic format. The State Board shall be authorized to conduct pilot programs in one or more localities, with the consent of the electoral board of the locality, to test the use of an electronic pollbook in one or more precincts, notwithstanding any other provision of law to the contrary.

D. *Within 10 days after the election, the local electoral board shall meet publicly to initiate an audit of at least 5% of the precincts that used electronic pollbooks and shall select the precincts by a drawing or other random method. The local electoral board shall compare the paper record produced by the electronic pollbook in the audited precincts with the official list of qualified voters for the selected precinct. Audits shall be conducted in public, and candidates and political parties shall be invited to provide observers.*

§ *24.2-625.2. Voting equipment; prohibition on wireless communications.*

No direct recorded electronic voting machine, optical ballot tabulator, or other equipment used to enter or count votes shall have any form of wireless or power cable based electronic communication capability. Any device that is manufactured with a wireless or power cable based communication capability shall have that feature permanently and physically disabled before it may be used in any election. It shall not be sufficient to temporarily disable a wireless communication capability by a software configuration whether or not a cardkey is used to effect the disabling.

Wireless communications features include, but are not limited to, radio frequency and infrared ports. Power cable based communication includes, but is not limited to, devices that allow electronic communications to be made over power cables. Permanent physical disabling can be accomplished by cutting the wires that support the feature or by removing the hardware circuits or ports.

§ *24.2-625.3. Review of source code for software used in voting equipment.*

No direct recorded electronic voting machine, optical ballot tabulator, or other equipment used to enter or count votes shall be certified for use in elections unless the vendor supplies in escrow with the State Board the source code for any software used to program the particular equipment for which certification is requested. The Board shall appoint technical experts with software engineering and computer security credentials and expertise to examine the source code and report to the Board prior to certification whether the software is likely to perform correctly and has appropriate security safeguards. The Board shall ensure that the technical experts have at least 30 days for the source code review and to report their findings. The Board shall consider the software review reports before certifying all voting systems and shall have authority to deny certification of systems that receive negative reviews. The Board shall make such reports available to the public. The Board shall also make the source code available, if requested by any state political party chairman, for review by a committee of no more than three technical experts selected by the political party.

The Board may require that any technical experts that review vendor source codes agree to refrain from making the source code available to third parties, but such agreements shall not prohibit the technical experts from making a public report describing the engineering quality, accuracy, and security aspects of the software reviewed.

The Board shall use the best technical means possible to ensure that the software provided by a vendor is exactly the same as the software that is installed upon the voting equipment being certified. Such means may include comparing checksums or digital signatures of the software installed on all voting machines with those produced by the binary image of the version of the software that was reviewed.

§ 24.2-629. Authorized use of electronic systems and ballots.

A. Any person, firm, or corporation hereinafter referred to as the "vendor," manufacturing, owning, or offering for sale any electronic voting or counting system and ballots designed to be used with such equipment may apply to the State Board, in the manner prescribed by the Board, to have examined a production model of such equipment and the ballots used with it. The Board may require the vendor to pay a reasonable application fee when he files his request for testing or certification of new or upgraded voting equipment. Receipts from such fees shall be credited to the Board for reimbursement of testing and certification expenses. In addition to any other materials that may be required, a current statement of the financial status of the vendor, including any assets and liabilities, shall be filed with the Board; if the vendor is not the manufacturer of the equipment for which application is made, such a statement shall also be filed for the manufacturer. These statements shall be exempt from the provisions of the Virginia Freedom of Information Act (§ 2.2-3700 et seq.). The Board shall also require, at a site of its choosing, a demonstration of such system and ballots and may require that a production model of the system and a supply of ballots be provided to the Board for testing purposes.

B. The provisions of this title pertaining to mechanical voting devices and ballots shall be deemed applicable to such equipment and ballots provided that (i) the counting equipment used with punchcard or mark sense ballots shall not be required to prevent a voter from voting for a greater number of candidates than he is lawfully entitled to; (ii) the provisions of this title pertaining to ballot squares shall not be applicable to punchcard or mark sense ballots; and (iii) any system approved pursuant to this title shall segregate ballots containing write-in votes from all others*; and (iv) any direct recorded electronic (DRE) voting device shall be equipped to provide a paper copy record of the votes cast on a contemporaneous and continuous basis as the votes are cast and accumulated on the device.*

Any direct electronic voting device shall generate a complete paper record showing all votes cast by each voter that is visually verifiable by the voter before his vote is cast and he leaves the device. The paper record shall be in a format that protects voter privacy and is practical for supporting audits and recounts.

In the case of a discrepancy between the paper and electronic totals, the paper record shall take precedence in a recount unless the court finds clear and convincing evidence that there is reason to do otherwise.

Every electronic voting system shall ensure voting in absolute secrecy, and systems requiring the voter to vote a ballot that is inserted in an electronic counting device shall provide for secrecy of the ballot and a method to conceal the voted ballot. Systems requiring the voter to vote a ballot that is inserted in an electronic counting device shall report, if possible, the number of ballots on which a voter voted for a lesser number of candidates for an office than the number he was lawfully entitled to vote and the number of ballots on which a voter voted for a greater number of candidates than the number he was lawfully entitled to vote. Electronic voting devices shall be programmable, if possible, to allow such undervoted and overvoted ballots to be separated when necessary.

B1. The system shall provide the voter with an opportunity to correct any error before a permanent record is preserved.

C. After its examination of the equipment, ballots, and other materials submitted by the vendors, the Board shall prepare and file in its office a report of its finding as to (i) the apparent capability of such equipment to accurately count, register, and report votes; (ii) whether the system can be conveniently used without undue confusion to the voter; (iii) its accessibility to voters with disabilities; (iv) whether the system can be safely used without undue potential for fraud; (v) the ease of its operation and transportation by voting equipment custodians and officers of election; (vi) the financial stability of the vendor and manufacturer; (vii) whether the system meets the requirements of this title; (viii) whether the system meets federal requirements; and (ix) whether, in the opinion of the Board, the potential for approval of such system is such as to justify further examination and testing.

D. If the Board determines that there is such potential and prior to its final determination as to approval or disapproval of such system, the Board shall obtain a report by an independent electronics or engineering consultant as to (i) whether the system accurately counts, registers, and reports votes; (ii) whether it is capable of storing and retaining existing votes in a permanent memory in the event of power failure during and after the election; (iii) the number of separate memory capabilities for the storage of recorded votes; (iv) its mechanical and electronic perfections and imperfections; (v) the audit trail provided by the system; (vi) the anticipated frequency of repair; (vii) the ease of repair; (viii) the anticipated life of the equipment; (ix) its potential for fraudulent use; (x) its accessibility to voters with disabilities; (xi) the ease of its programming, transportation, and operation by voting equipment custodians and officers of election; and (xii) any other matters deemed necessary by the Board. Failure by an applicant to cooperate with the consultant by furnishing information and production equipment and ballots requested shall be deemed a withdrawal of the application, but nothing in this section shall require the disclosure of trade secrets by the applicant. If such trade secrets are essential to the proper analysis of the system and are provided for that reason, the consultant shall subscribe to an oath subject to the penalty for perjury that he will neither disclose nor make use of such information except as necessary for the system analysis. The report of the consultant shall be filed in the office of the Board.

E. If the Board determines that there is potential for approval of the system and prior to its final determination, the Board shall also require that the system be tested in an actual election in one or more counties or cities. Its use at such election shall be as valid for all purposes as if it had been legally approved by the Board and adopted by the counties or cities.

F. If, following testing, the Board approves any electronic system and its ballots for use, the Board shall so notify the electoral boards of each county and city. Systems so approved may be adopted for use at elections as herein provided. No form of electronic system and ballots not so approved shall be adopted by any county or city. Any electronic system and ballots approved for use by the Board shall be deemed to meet the requirements of this title and any applicable federal laws, and their use in any election shall be valid.

§ 24.2-631.1. Pilot program to test electronic voting equipment and paper record requirements; audits of voting equipment.

A. The State Board of Elections shall conduct a pilot program to test the use of voter-verified records of votes on direct recording electronic voting devices (DREs) beginning with the November 2006 general election, or as soon thereafter as practicable, and to provide for audits of DREs and electronic counting devices for optical scan ballots.

B. The Board shall determine the scope and design of the pilot program to accomplish the following goals: (i) testing in a reasonable number of precincts throughout the Commonwealth that represent a variety of regions and localities, including large and small localities and counties and cities; (ii) testing of devices that produce a voter-

verified record of the votes cast on each type of DRE certified for use in the Commonwealth including devices provided by the manufacturer of the certified DREs and devices manufactured by other manufacturers that are designed for use with multiple types of DREs; (iii) testing of the devices for their accuracy, reliability, practicality, and potential for certification under federal and Commonwealth standards; and (iv) testing of the ability and potential of the devices to provide audit and recount capabilities.

C. In designing the pilot program, the Board shall consider the report of the Joint Subcommittee Studying Voting Equipment established pursuant to House Joint Resolution 174 (2004) and Senate Joint Resolution 371 (2005) and the Subcommittee's concerns with regard to the improvement of voter confidence in the use of DREs and electronic counting devices, the security of wireless communications features and electronic counting devices, and the desirability of a reliable audit trail for voting equipment.

D. As part of the pilot program, the Board shall incorporate an audit process to compare the results of the DRE-produced vote total and the voter-verified record of votes and other appropriate audit features to test the DREs and electronic counting devices.

E. The Board shall report to the Chairmen of the House and Senate Committees on Privileges and Elections by September 1, 2006, on its design for the pilot program.

F. In designing the pilot program, the Board is authorized to include the testing of devices on an experimental basis prior to certification of the device.

§ 24.2-671.1. Random audits of voter-verified paper records.

Each electoral board shall publicly conduct a random drawing to select at least five percent of the precincts for a postelection manual audit of the voter-verified paper records. The audit shall be performed using the same procedures established by the Board for conducting hand counts of voter-verified paper records during recounts. The audited precincts shall include all years and models of the election devices producing voter-verified paper records, including, but not limited to, DREs and optical scan tabulators. The drawing shall not occur until such time as all results have been certified and announced publicly, but shall be completed with 48 hours of such certification. Any candidate, qualified voter, or political party may petition the electoral board to include additional precincts in the audit. Immediately following the random drawing, the local Board shall publicly announce the time and location of the audits. Candidates and political parties may have representatives observe the audits.

No election results shall be certified until all audits have been completed.

If the local board finds that any of the hand counts conducted under this section show a discrepancy between the hand count and the initial device tally that totals more than 0.1% of the vote in the audited precincts, the local board shall conduct audits at such additional precincts as it considers appropriate to ensure the accuracy of the results.

With respect to votes cast other than at the precinct on the date of the election or votes cast by provisional ballot on the date of the election that are certified and counted by the electoral board on or after the date of the election, including votes cast by absent uniformed services voters and overseas voters under the Uniformed and Overseas Citizens Absentee Voting Act, the electoral board shall count by hand the applicable voter-verified paper records and compare its count with the machine tally of those votes.

If an error is detected with a voting device during the course of an audit, the results obtained from hand counting the voter-verified paper records shall form the official election results.

At the conclusion of each audit, the local board shall announce and publish the results of the audit, and shall include in the announcement a comparison of the results of the election in the precinct as determined by the local board under the audit and the initial tally in the precinct as previously announced by the local board.

§ 24.2-802. Procedure for recount.

A. The State Board of Elections shall promulgate standards for (i) the proper handling and security of voting and counting devices, ballots, and other materials required for a recount, (ii) accurate determination of votes based upon objective evidence and taking into account the counting device and form of ballots approved for use in the Commonwealth, and (iii) any other matters that will promote a timely and accurate resolution of the recount. The chief judge of the circuit court or the full recount court may, consistent with State Board of Elections standards, resolve disputes over the application of the standards and direct all other appropriate measures to ensure the proper conduct of the recount.

The recount procedures to be followed throughout the election district shall be as uniform as practicable, taking into account the types of ballots and voting devices in use in the election district.

B. Within seven calendar days of the filing of the petition for a recount of any election other than an election for presidential electors, or within five calendar days of the filing of a petition for a recount of an election for presidential electors, the chief judge of the circuit court shall call a preliminary hearing at which (i) motions may be disposed of and (ii) the rules of procedure may be fixed, both subject to review by the full court. As part of the preliminary hearing, the chief judge may permit the petitioner and his counsel, together with each other party and his counsel and at least two members of the electoral board and the custodians, to examine any mechanical or direct electronic voting device of the type that prints returns when the print-out sheets are not clearly legible. The petitioner and his counsel and each other party and their counsel under supervision of the electoral board and its agents shall also have access to pollbooks and other materials used in the election for examination purposes, provided that individual ballots cast in the election shall not be examined at the preliminary hearing. The chief judge during the preliminary hearing shall review all security measures taken for all ballots and voting devices and

direct, as he deems necessary, all appropriate measures to ensure proper security to conduct the recount.

The chief judge, subject to review by the full court, may set the place or places for the recount and may order the delivery of election materials to a central location and the transportation of voting devices to a central location in each county or city under appropriate safeguards.

After the full court is appointed under § 24.2-801 or § 24.2-801.1, it shall call a hearing at which all motions shall be disposed of and the rules of procedure shall be fixed finally. The court shall call for the advice and cooperation of the State Board or any local electoral board, as appropriate, and such boards shall have the duty and authority to assist the court. The court shall fix procedures that shall provide for the accurate determination of votes in the election.

The determination of the votes in a recount shall be based on votes cast in the election and shall not take into account (i) any absentee ballots or provisional ballots sought to be cast but ruled invalid and not cast in the election, (ii) ballots cast only for administrative or test purposes and voided by the officers of election, or (iii) ballots spoiled by a voter and replaced with a new ballot.

The eligibility of any voter to have voted shall not be an issue in a recount. Commencing upon the filing of the recount, nothing shall prevent the discovery or disclosure of any evidence that could be used pursuant to § 24.2-803 in contesting the results of an election.

C. The court shall permit each candidate, or petitioner and governing body or chief executive officer, to select an equal number of the officers of election to be recount officials and to count ballots, or in the case of mechanical or direct electronic voting devices to redetermine the vote. The number shall be fixed by the court and be sufficient to conduct the recount within a reasonable period. The court may permit each party to the recount to submit a list of alternate officials in the number the court directs. There shall be at least one team of recount officials to recount paper ballots and to redetermine the vote cast on mechanical or direct electronic devices of the type that prints returns for the election district at large in which the recount is being held. There shall be at least one team from each locality in the election district to redetermine the vote on other types of mechanical voting devices. There shall be at least one team from each locality using electronic counting devices to insert the ballots into one or more counting devices. The counting devices shall be programmed to count only votes cast for parties to the recount or for or against the question in a referendum recount. Each team shall be composed of one representative of each party.

The court may provide that if, at the time of the recount, any recount official fails to appear, the remaining recount officials present shall appoint substitute recount officials who shall possess the same qualifications as the recount officials for whom they substitute. The court may select pairs of recount coordinators to serve for each county or city in the election district who shall be members of the county or city electoral board and

represent different political parties. The court shall have authority to summon such officials and coordinators. On request of a party to the recount, the court shall allow each party to appoint one representative observer for each team of recount officials. The expenses of its representatives shall be borne by each party.

D. The court (i) shall supervise the recount and (ii) may require delivery of any or all pollbooks used and any or all ballots cast at the election, or may assume supervision thereof through the recount coordinators and officials.

The redetermination of the vote in a recount shall be conducted as follows:

1. For paper ballots, the recount officials shall hand count the ballots using the standards promulgated by the State Board pursuant to subsection A.

2. For mechanical lever machines without printouts, the recount officials shall open the machines and read the counters.

3. For mechanical lever machines with printouts and *any* direct recording electronic machines (DREs) *that did not produce a voter-verified paper record*, the recount officials shall open the envelopes with the printouts and read the results from the printouts. If the printout is not clear, or on the request of the court, the recount officials shall rerun the printout from the machine or examine the counters as appropriate.

4. For optical scan tabulators *and DREs designed to produce a voter-verified paper record*, the recount officials shall ~~first examine the printout to redetermine the vote. Only~~ *randomly select at least five percent of the precincts, beyond any precincts audited during the normal certification process, for a manual audit to determine the accuracy of the voting equipment. (i) For the audited precincts, the recount officials shall count the votes for the office or issue in question in the recount by hand using the standards promulgated by the State Board pursuant to subsection A. (ii) If the totals found in the hand recount do not match the totals reported by the tabulators or DREs in the audited precincts within the more stringent tolerance of either 0.1% of the totals reported in the hand recount or the margin of victory in the audited precincts reported prior to the recount, then the recount officials shall count the votes by hand in the remaining precincts using the same standards promulgated by the State Board. In that case, the State Board shall also conduct an investigation into the reasons for the discrepancies and prepare a report for the public. (iii) If the totals found in the hand recount of the audited precincts match the totals reported by the tabulators or DREs within the tolerances specified in clause (ii), then the recount officials shall rely upon the tabulator or DRE results for the remaining precincts. In those remaining precincts, only* if the printout is not clear, or on the request of the court, the recount officials shall rerun all the ballots through a tabulator programmed to count only the votes for the office or issue in question in the recount and to set aside all ballots containing write-in votes, overvotes, and undervotes. The ballots that are set aside and any ballots not accepted by the tabulator shall be hand counted using the standards promulgated by the State Board pursuant to subsection A.

5. For punchcard tabulators, the recount officials shall first examine the printout to redetermine the vote. Only if the printout is not clear, or on the request of the court, the recount officials shall rerun all the ballots through a tabulator programmed to count only the votes for the office or issue in question in the recount and to set aside all ballots containing write-in votes and, if possible, overvotes and undervotes. The ballots that are set aside and any ballots not accepted by the tabulator shall be hand counted using the standards promulgated by the State Board pursuant to subsection A and the standards set forth in this subdivision. The following standards shall apply in determining whether a ballot has been properly voted and should be counted. A chad is the small piece of a punch card ballot that, when removed by the voter in the voting process, leaves a hole that is recognizable by a ballot tabulator. A ballot on which the chad indicating the selection of a candidate or position on an issue is broken or separated from the card at two or more corners shall be deemed a vote and counted; a chad on which only one corner is broken or separated from the card shall not be considered a vote. No other depression, dimple, or other mark on the ballot shall be counted as a vote. On any ballot on which two or more corners of the chad indicating the selection of a candidate or position have been broken or separated from the card and the voter has also cast a vote for another candidate for the same office or position on the same issue, the partially punched chad also shall be deemed a vote and, if the voter has cast more votes than the number for which he was lawfully entitled to vote, the ballot shall be deemed an overvote and shall not be counted with respect to that office or issue.

There shall be only one redetermination of the vote in each precinct.

At the conclusion of the recount of each precinct, the recount officials shall write down the number of valid ballots cast, this number being obtained from the ballots cast in the precinct, or from the ballots cast as shown on the statement of results if the ballots cannot be found, for each of the two candidates or for and against the question. They shall submit the ballots or the statement of results used, as to the validity of which questions exist, to the court. The written statement of any one recount official challenging a ballot shall be sufficient to require its submission to the court. If, on all mechanical or direct electronic voting devices, the number of persons voting in the election, or the number of votes cast for the office or on the question, totals more than the number of names on the pollbooks of persons voting on the devices, the figures recorded by the devices shall be accepted as correct.

At the conclusion of the recount of all precincts, after allowing the parties to inspect the questioned ballots, and after hearing arguments, the court shall rule on the validity of all questioned ballots and votes. After determining all matters pertaining to the recount and redetermination of the vote as raised by the parties, the court shall certify to the State Board and the electoral board or boards (a) the vote for each party to the recount and declare the person who received the higher number of votes to be nominated or elected, as appropriate, or (b) the votes for and against the question and declare the outcome of the referendum.

E. Costs of the recount shall be assessed against the counties and cities comprising the election district when (i) the candidate petitioning for the recount is declared the winner; (ii) the petitioners in a recount of a referendum win the recount; or (iii) there was between the candidate apparently nominated or elected and the candidate petitioning for the recount a difference of not more than one-half of one percent of the total vote cast for the two such candidates as determined by the State Board or electoral board prior to the recount. Otherwise the costs of the recount shall be assessed against the candidate petitioning for the recount or the petitioners in a recount of a referendum. If more than one candidate petitions for a recount, the court may assess costs in an equitable manner between the counties and cities and any such candidate if both are liable for costs under this subsection. Costs incurred to date shall be assessed against any candidate or petitioner who defaults or withdraws his petition.

F. The court shall determine the costs of the recount subject to the following limitations: (i) no per diem payment shall be assessed for salaried election officials; (ii) no per diem payment to officers of election serving as recount officials shall exceed two-thirds of the per diem paid such officers by the county or city for service on election day; and (iii) per diem payments to alternates shall be allowed only if they serve.

G. Any petitioner who may be assessed with costs under subsection E shall post a bond with surety with the court in the amount of $10 per precinct in the area subject to recount. If the petitioner wins the recount, the bond shall not be forfeit. If the petitioner loses the recount, the bond shall be forfeit only to the extent of the assessed costs. If the assessed costs exceed the bond, he shall be liable for such excess.

H. The recount proceeding shall be final and not subject to appeal.

I. For the purposes of this section:

"Overvote" means a ballot on which a voter casts a vote for a greater number of candidates or positions than the number for which he was lawfully entitled to vote and no vote shall be counted with respect to that office or issue.

"Undervote" means a ballot on which a voter casts a vote for a lesser number of candidates or positions than the number for which he was lawfully entitled to vote.

2. That the provisions § 24.2-631.1 of this act shall become effective in due course on July 1, 2006.

3. That the remaining amendments and provisions of this act shall become effective on January 1, 2009.

A BILL to amend the Code of Virginia by adding a section numbered 24.2-631.1, relating to elections; a pilot program to test electronic voting equipment and paper record requirements; audits of voting equipment.

Be it enacted by the General Assembly of Virginia:

1. That the Code of Virginia is amended by adding a section numbered 24.2-631.1 as follows:

§ 24.2-631.1. Pilot program to test electronic voting equipment and paper record requirements; audits of voting equipment.

A. The State Board of Elections shall conduct a pilot program to test the use of voter-verified records of votes on direct recording electronic voting devices (DREs) beginning with the November 2006 general election, or as soon thereafter as practicable, and to provide for audits of DREs and electronic counting devices for optical scan ballots.

B. The Board shall determine the scope and design of the pilot program to accomplish the following goals: (i) testing in a reasonable number of precincts throughout the Commonwealth that represent a variety of regions and localities, including large and small localities and counties and cities; (ii) testing of devices that produce a voter-verified record of the votes cast on each type of DRE certified for use in the Commonwealth including devices provided by the manufacturer of the certified DREs and devices manufactured by other manufacturers that are designed for use with multiple types of DREs; (iii) testing of the devices for their accuracy, reliability, practicality, and potential for certification under federal and Commonwealth standards; and (iv) testing of the ability and potential of the devices to provide audit and recount capabilities.

C. In designing the pilot program, the Board shall consider the report of the Joint Subcommittee Studying Voting Equipment established pursuant to House Joint Resolution 174 (2004) and Senate Joint Resolution 371 (2005) and the Subcommittee's concerns with regard to the improvement of voter confidence in the use of DREs and electronic counting devices, the security of wireless communications features and electronic counting devices, and the desirability of a reliable audit trail for voting equipment. [The State Board shall consult independent experts with technical and computer expertise in designing the pilot program and in evaluating the results of the program.]

D. As part of the pilot program, the Board shall incorporate an audit process to compare the results of the DRE-produced vote total and the voter-verified record of votes and other appropriate audit features to test the DREs and electronic counting devices.

E. The Board shall report to the Chairmen of the House and Senate Committees on Privileges and Elections by September 1, 2006, on its design for the pilot program.

F. In designing the pilot program, the Board is authorized to include the testing of devices on an experimental basis prior to certification of the device.

[G. The provisions of this section shall be implemented only to the extent funded by the Commonwealth through the general appropriation act.]

[2. That the provisions of this act shall not become effective unless an appropriation of general funds effectuating the purposes of this act is included in the general appropriations act passed by the 2006 Session of the General Assembly, which becomes law.]

SENATE BILL NO. 424

A BILL to amend and reenact §§ 24.2-611, 24.2-629, and 24.2-802 of the Code of Virginia and to amend the Code of Virginia by adding sections numbered 24.2-625.2, 24.2-625.3, and 24.2-671.1, relating to election procedures; pollbooks, voting equipment requirements and audits, and recount procedures.

Be it enacted by the General Assembly of Virginia:

1. That §§ 24.2-611, 24.2-629, and 24.2-802 of the Code of Virginia are amended and reenacted and that the Code of Virginia is amended by adding sections numbered 24.2-625.2, 24.2-625.3, and 24.2-671.1, as follows:

§ 24.2-611. Form and signing of pollbooks; records of persons voting; electronic pollbooks.

A. The following oath shall be on a form prescribed by the State Board, administered to all officers of election, and kept by the officers of election with the pollbook:

"I do solemnly swear (or affirm) that I will perform the duties for this election according to law and the best of my ability, and that I will studiously endeavor to prevent fraud, deceit, and abuse in conducting this election."

The oath shall be administered to each officer of election by the general registrar, a member of the electoral board, or an officer of election designated by the general registrar and secretary of the electoral board, who shall be so identified on the form. The oath shall be signed by each officer of election and the person administering the oath. The pollbook shall be marked to identify the election for which it is used.

B. The State Board shall provide the pollbook pursuant to subdivision A 7 of § 24.2-404. The pollbook shall (i) provide a space for the officer of election to record the name and consecutive number of the voter at the time he offers to vote and (ii) be retained in accordance with the provisions governing pollbooks in this title. If the pollbook is provided in printed form, the State Board shall provide a numerical check sheet to be used to determine the consecutive number to be recorded with the name of the voter by the officer of election. If the pollbook is provided in electronic form, the consecutive number shall be entered automatically when the officer of election records that the voter has voted. *If the pollbook is provided in electronic form, it shall provide a paper copy record of the names of the voters and their associated identifying information on a contemporaneous and continuous basis as the voters are recorded. The election officers shall verify that the name printed on the paper copy record matches the voter's name on the electronic pollbook.* When the name and number of the last qualified voter have been entered on the pollbook, the officer of election responsible for that pollbook shall sign a statement on the check sheet, or on a separate form if an electronic pollbook is used, certifying the number of qualified registrants who have voted. The State Board shall provide instructions to the local electoral boards, general registrars, and officers of election for the conduct of the election and for procedures for entering a voting record for each voter and recording each voter's name, including voters unable to enter the polling place, and for verifying the accurate entry of the voting record for each registrant on the Virginia Voter Registration System.

C. The State Board shall incorporate safeguards to assure that the records of the election, including the pollbook, voter count sheets, or other alternative records, will provide promptly an accurate and secure record of those who have voted. The State Board may provide for the pollbook to be in a paper format or in an electronic format if funds are appropriated to cover the costs associated with the provision of a pollbook in an electronic format. The State Board shall be authorized to conduct pilot programs in one or more localities, with the consent of the electoral board of the locality, to test the use of an electronic pollbook in one or more precincts, notwithstanding any other provision of law to the contrary.

D. *Within 10 days after the election, the local electoral board shall meet publicly to initiate an audit of at least 5% of the precincts that used electronic pollbooks and shall select the precincts by a drawing or other random method. The local electoral board shall compare the paper record produced by the electronic pollbook in the audited precincts with the information on the electronic pollbook. Audits shall be conducted in public, and candidates and political parties shall be invited to provide observers.*

§ 24.2-625.2. *Voting equipment; prohibition on wireless communications.*

No direct recorded electronic voting machine, optical ballot tabulator, or other equipment used to enter or count votes shall have any form of wireless or power cable based electronic communication capability. Any device that is manufactured with a wireless or power cable based communication capability shall have that feature permanently and physically disabled before it may be used in any election. It shall not be

sufficient to temporarily disable a wireless communication capability by a software configuration whether or not a cardkey is used to effect the disabling.

Wireless communications features include, but are not limited to, radio frequency and infrared ports. Permanent physical disabling can be accomplished by cutting the wires that support the feature or by removing the hardware circuits or ports. Power cable based communication refers to the capability to communicate electronically using power cables as a transmission medium.

§ 24.2-625.3. Review of source code for software used in voting equipment.

No direct recorded electronic voting machine, optical ballot tabulator, or other equipment used to enter or count votes shall be certified for use in elections unless the vendor supplies in escrow with the State Board the source code for any software used to program the particular equipment for which certification is requested. The Board shall appoint technical experts with software engineering and computer security credentials and expertise to examine the source code and report to the Board prior to certification whether the software is likely to perform correctly and has appropriate security safeguards. The Board shall ensure that the technical experts have at least 30 days for the source code review and to report their findings. The Board shall make such reports available to the public. The Board shall consider the software review reports before certifying all voting systems and shall have the authority to deny certification of systems that receive negative reviews. The Board shall also make the source code available, if requested by any state political party chairman, for review by a committee of no more than three technical experts selected by the political party.

The Board may require that any technical experts that review vendor source codes agree to refrain from making the source code available to third parties, but such agreements shall not prohibit the technical experts from making a public report on the engineering quality, accuracy, and security aspects of the software reviewed.

The Board shall use the best technical means possible to ensure that the software provided by a vendor is exactly the same as the software that is installed upon the voting equipment being certified. Such means may include comparing checksums or digital signatures of the software installed on all voting machines with those produced by the binary image of the version of the software that was reviewed. Voting systems that were certified prior to the enactment of this requirement must meet the review and escrow requirements of this section by June 1, 2007, to retain certification.

§ 24.2-629. Authorized use of electronic systems and ballots.

A. Any person, firm, or corporation hereinafter referred to as the "vendor," manufacturing, owning, or offering for sale any electronic voting or counting system and ballots designed to be used with such equipment may apply to the State Board, in the manner prescribed by the Board, to have examined a production model of such equipment and the ballots used with it. The Board may require the vendor to pay a

reasonable application fee when he files his request for testing or certification of new or upgraded voting equipment. Receipts from such fees shall be credited to the Board for reimbursement of testing and certification expenses. In addition to any other materials that may be required, a current statement of the financial status of the vendor, including any assets and liabilities, shall be filed with the Board; if the vendor is not the manufacturer of the equipment for which application is made, such a statement shall also be filed for the manufacturer. These statements shall be exempt from the provisions of the Virginia Freedom of Information Act (§ 2.2-3700 et seq.). The Board shall also require, at a site of its choosing, a demonstration of such system and ballots and may require that a production model of the system and a supply of ballots be provided to the Board for testing purposes.

B. The provisions of this title pertaining to mechanical voting devices and ballots shall be deemed applicable to such equipment and ballots provided that (i) the counting equipment used with punchcard or mark sense ballots shall not be required to prevent a voter from voting for a greater number of candidates than he is lawfully entitled to; (ii) the provisions of this title pertaining to ballot squares shall not be applicable to punchcard or mark sense ballots; ~~and~~ (iii) any system approved pursuant to this title shall segregate ballots containing write-in votes from all others*; and (iv) any direct electronic (DRE) voting device shall be equipped to provide a paper copy record of the votes cast on a contemporaneous and continuous basis as the votes are cast and accumulated on the device.*

Any direct electronic voting device shall generate a complete paper record showing all votes cast by each voter that is visually verifiable by the voter before his vote is cast and he leaves the device. The paper record shall be in a format that protects voter privacy and is practical for supporting audits and recounts.

In the case of a discrepancy between the paper and electronic totals, the paper record shall take precedence in a recount unless the court finds clear and convincing evidence that there is reason to do otherwise.

Every electronic voting system shall ensure voting in absolute secrecy, and systems requiring the voter to vote a ballot that is inserted in an electronic counting device shall provide for secrecy of the ballot and a method to conceal the voted ballot. Systems requiring the voter to vote a ballot that is inserted in an electronic counting device shall report, if possible, the number of ballots on which a voter voted for a lesser number of candidates for an office than the number he was lawfully entitled to vote and the number of ballots on which a voter voted for a greater number of candidates than the number he was lawfully entitled to vote. Electronic voting devices shall be programmable, if possible, to allow such undervoted and overvoted ballots to be separated when necessary.

B1. The system shall provide the voter with an opportunity to correct any error before a permanent record is preserved.

C. After its examination of the equipment, ballots, and other materials submitted by the vendors, the Board shall prepare and file in its office a report of its finding as to (i) the apparent capability of such equipment to accurately count, register, and report votes; (ii) whether the system can be conveniently used without undue confusion to the voter; (iii) its accessibility to voters with disabilities; (iv) whether the system can be safely used without undue potential for fraud; (v) the ease of its operation and transportation by voting equipment custodians and officers of election; (vi) the financial stability of the vendor and manufacturer; (vii) whether the system meets the requirements of this title; (viii) whether the system meets federal requirements; and (ix) whether, in the opinion of the Board, the potential for approval of such system is such as to justify further examination and testing.

D. If the Board determines that there is such potential and prior to its final determination as to approval or disapproval of such system, the Board shall obtain a report by an independent electronics or engineering consultant as to (i) whether the system accurately counts, registers, and reports votes; (ii) whether it is capable of storing and retaining existing votes in a permanent memory in the event of power failure during and after the election; (iii) the number of separate memory capabilities for the storage of recorded votes; (iv) its mechanical and electronic perfections and imperfections; (v) the audit trail provided by the system; (vi) the anticipated frequency of repair; (vii) the ease of repair; (viii) the anticipated life of the equipment; (ix) its potential for fraudulent use; (x) its accessibility to voters with disabilities; (xi) the ease of its programming, transportation, and operation by voting equipment custodians and officers of election; and (xii) any other matters deemed necessary by the Board. Failure by an applicant to cooperate with the consultant by furnishing information and production equipment and ballots requested shall be deemed a withdrawal of the application, but nothing in this section shall require the disclosure of trade secrets by the applicant. If such trade secrets are essential to the proper analysis of the system and are provided for that reason, the consultant shall subscribe to an oath subject to the penalty for perjury that he will neither disclose nor make use of such information except as necessary for the system analysis. The report of the consultant shall be filed in the office of the Board.

E. If the Board determines that there is potential for approval of the system and prior to its final determination, the Board shall also require that the system be tested in an actual election in one or more counties or cities. Its use at such election shall be as valid for all purposes as if it had been legally approved by the Board and adopted by the counties or cities.

F. If, following testing, the Board approves any electronic system and its ballots for use, the Board shall so notify the electoral boards of each county and city. Systems so approved may be adopted for use at elections as herein provided. No form of electronic system and ballots not so approved shall be adopted by any county or city. Any electronic system and ballots approved for use by the Board shall be deemed to meet the requirements of this title and any applicable federal laws, and their use in any election shall be valid.

§ 24.2-671.1. Random audits of voter-verified paper records.

Each electoral board shall publicly conduct a random drawing to select at least five percent of the precincts for a postelection manual audit of the voter-verified paper records. The audit shall be performed using the same procedures established by the Board for conducting hand counts of voter-verified paper records during recounts. The audited precincts shall include all years and models of the election devices producing voter-verified paper records, including, but not limited to, DREs and optical scan tabulators. The drawing shall not occur until such time as all initial vote counts have been completed and announced publicly, but shall be completed with 48 hours of that time. Any candidate, qualified voter, or political party may petition the electoral board to include additional precincts in the audit. Immediately following the random drawing, the local Board shall publicly announce the time and location of the audits. Candidates and political parties may have representatives observe the audits.

No election results shall be certified until all audits have been completed.

If the local board finds that any of the hand counts conducted under this section show a discrepancy between the hand count and the initial device tally that totals more than 0.1% of the vote in the audited precincts, the local board shall conduct audits at such additional precincts as it considers appropriate to ensure the accuracy of the results.

With respect to votes cast other than at the precinct on the date of the election or votes cast by provisional ballot on the date of the election that are certified and counted by the electoral board on or after the date of the election, including votes cast by absent uniformed services voters and overseas voters under the Uniformed and Overseas Citizens Absentee Voting Act, the electoral board shall count by hand the applicable voter-verified paper records and compare its count with the machine tally of those votes.

If an error is detected with a voting device during the course of an audit, the results obtained from hand counting the voter-verified paper records shall form the official election results.

At the conclusion of each audit, the local board shall announce and publish the results of the audit, and shall include in the announcement a comparison of the results of the election in the precinct as determined by the local board under the audit and the initial tally in the precinct as previously announced by the local board.

§ 24.2-802. Procedure for recount.

A. The State Board of Elections shall promulgate standards for (i) the proper handling and security of voting and counting devices, ballots, and other materials required for a recount, (ii) accurate determination of votes based upon objective evidence and taking into account the counting device and form of ballots approved for use in the Commonwealth, and (iii) any other matters that will promote a timely and accurate resolution of the recount. The chief judge of the circuit court or the full recount court

may, consistent with State Board of Elections standards, resolve disputes over the application of the standards and direct all other appropriate measures to ensure the proper conduct of the recount.

The recount procedures to be followed throughout the election district shall be as uniform as practicable, taking into account the types of ballots and voting devices in use in the election district.

B. Within seven calendar days of the filing of the petition for a recount of any election other than an election for presidential electors, or within five calendar days of the filing of a petition for a recount of an election for presidential electors, the chief judge of the circuit court shall call a preliminary hearing at which (i) motions may be disposed of and (ii) the rules of procedure may be fixed, both subject to review by the full court. As part of the preliminary hearing, the chief judge may permit the petitioner and his counsel, together with each other party and his counsel and at least two members of the electoral board and the custodians, to examine any mechanical or direct electronic voting device of the type that prints returns when the print-out sheets are not clearly legible. The petitioner and his counsel and each other party and their counsel under supervision of the electoral board and its agents shall also have access to pollbooks and other materials used in the election for examination purposes, provided that individual ballots cast in the election shall not be examined at the preliminary hearing. The chief judge during the preliminary hearing shall review all security measures taken for all ballots and voting devices and direct, as he deems necessary, all appropriate measures to ensure proper security to conduct the recount.

The chief judge, subject to review by the full court, may set the place or places for the recount and may order the delivery of election materials to a central location and the transportation of voting devices to a central location in each county or city under appropriate safeguards.

After the full court is appointed under § 24.2-801 or § 24.2-801.1, it shall call a hearing at which all motions shall be disposed of and the rules of procedure shall be fixed finally. The court shall call for the advice and cooperation of the State Board or any local electoral board, as appropriate, and such boards shall have the duty and authority to assist the court. The court shall fix procedures that shall provide for the accurate determination of votes in the election.

The determination of the votes in a recount shall be based on votes cast in the election and shall not take into account (i) any absentee ballots or provisional ballots sought to be cast but ruled invalid and not cast in the election, (ii) ballots cast only for administrative or test purposes and voided by the officers of election, or (iii) ballots spoiled by a voter and replaced with a new ballot.

The eligibility of any voter to have voted shall not be an issue in a recount. Commencing upon the filing of the recount, nothing shall prevent the discovery or disclosure of any evidence that could be used pursuant to § 24.2-803 in contesting the results of an election.

C. The court shall permit each candidate, or petitioner and governing body or chief executive officer, to select an equal number of the officers of election to be recount officials and to count ballots, or in the case of mechanical or direct electronic voting devices to redetermine the vote. The number shall be fixed by the court and be sufficient to conduct the recount within a reasonable period. The court may permit each party to the recount to submit a list of alternate officials in the number the court directs. There shall be at least one team of recount officials to recount paper ballots and to redetermine the vote cast on mechanical or direct electronic devices of the type that prints returns for the election district at large in which the recount is being held. There shall be at least one team from each locality in the election district to redetermine the vote on other types of mechanical voting devices. There shall be at least one team from each locality using electronic counting devices to insert the ballots into one or more counting devices. The counting devices shall be programmed to count only votes cast for parties to the recount or for or against the question in a referendum recount. Each team shall be composed of one representative of each party.

The court may provide that if, at the time of the recount, any recount official fails to appear, the remaining recount officials present shall appoint substitute recount officials who shall possess the same qualifications as the recount officials for whom they substitute. The court may select pairs of recount coordinators to serve for each county or city in the election district who shall be members of the county or city electoral board and represent different political parties. The court shall have authority to summon such officials and coordinators. On request of a party to the recount, the court shall allow each party to appoint one representative observer for each team of recount officials. The expenses of its representatives shall be borne by each party.

D. The court (i) shall supervise the recount and (ii) may require delivery of any or all pollbooks used and any or all ballots cast at the election, or may assume supervision thereof through the recount coordinators and officials.

The redetermination of the vote in a recount shall be conducted as follows:

1. For paper ballots, the recount officials shall hand count the ballots using the standards promulgated by the State Board pursuant to subsection A.

2. For mechanical lever machines without printouts, the recount officials shall open the machines and read the counters.

3. For mechanical lever machines with printouts and direct recording electronic *(DRE) voting* machines ~~(DREs)~~ *not designed to produce a voter-verified paper record,* the recount officials shall open the envelopes with the printouts and read the results from the printouts. If the printout is not clear, or on the request of the court, the recount officials shall rerun the printout from the machine or examine the counters as appropriate.

4. For optical scan tabulators *and DREs designed to produce a voter-verified paper record,* the recount officials shall ~~first~~ ~~examine the printout to redetermine the vote. Only~~

randomly select at least five percent of the precincts, beyond any precincts audited during the normal certification process, for a manual audit to determine the accuracy of the voting equipment. (i) For the audited precincts, the recount officials shall count the votes for the office or issue in question in the recount by hand using the standards promulgated by the State Board pursuant to subsection A. (ii) If the totals found in the hand recount do not match the totals reported by the tabulators or DREs in the audited precincts within the more stringent tolerance of either 0.1 % of the totals reported in the hand recount or the margin of victory in the audited precincts reported prior to the recount, then the recount officials shall count the votes by hand in the remaining precincts using the same standards promulgated by the State Board. In that case, the State Board shall also conduct an investigation into the reasons for the discrepancies and prepare a report for the public. (iii) If the totals found in the hand recount of the audited precincts match the totals reported by the tabulators or DREs within the tolerances specified in clause (ii), then the recount officials shall rely upon the tabulator or DRE results for the remaining precincts. In those precincts only if the printout is not clear, or on the request of the court, the recount officials shall rerun all the ballots through a tabulator programmed to count only the votes for the office or issue in question in the recount and to set aside all ballots containing write-in votes, overvotes, and undervotes. The ballots that are set aside and any ballots not accepted by the tabulator shall be hand counted using the standards promulgated by the State Board pursuant to subsection A.

5. For punchcard tabulators, the recount officials shall first examine the printout to redetermine the vote. Only if the printout is not clear, or on the request of the court, the recount officials shall rerun all the ballots through a tabulator programmed to count only the votes for the office or issue in question in the recount and to set aside all ballots containing write-in votes and, if possible, overvotes and undervotes. The ballots that are set aside and any ballots not accepted by the tabulator shall be hand counted using the standards promulgated by the State Board pursuant to subsection A and the standards set forth in this subdivision. The following standards shall apply in determining whether a ballot has been properly voted and should be counted. A chad is the small piece of a punch card ballot that, when removed by the voter in the voting process, leaves a hole that is recognizable by a ballot tabulator. A ballot on which the chad indicating the selection of a candidate or position on an issue is broken or separated from the card at two or more corners shall be deemed a vote and counted; a chad on which only one corner is broken or separated from the card shall not be considered a vote. No other depression, dimple, or other mark on the ballot shall be counted as a vote. On any ballot on which two or more corners of the chad indicating the selection of a candidate or position have been broken or separated from the card and the voter has also cast a vote for another candidate for the same office or position on the same issue, the partially punched chad also shall be deemed a vote and, if the voter has cast more votes than the number for which he was lawfully entitled to vote, the ballot shall be deemed an overvote and shall not be counted with respect to that office or issue.

There shall be only one redetermination of the vote in each precinct.

At the conclusion of the recount of each precinct, the recount officials shall write down the number of valid ballots cast, this number being obtained from the ballots cast in the precinct, or from the ballots cast as shown on the statement of results if the ballots cannot be found, for each of the two candidates or for and against the question. They shall submit the ballots or the statement of results used, as to the validity of which questions exist, to the court. The written statement of any one recount official challenging a ballot shall be sufficient to require its submission to the court. If, on all mechanical or direct electronic voting devices, the number of persons voting in the election, or the number of votes cast for the office or on the question, totals more than the number of names on the pollbooks of persons voting on the devices, the figures recorded by the devices shall be accepted as correct.

At the conclusion of the recount of all precincts, after allowing the parties to inspect the questioned ballots, and after hearing arguments, the court shall rule on the validity of all questioned ballots and votes. After determining all matters pertaining to the recount and redetermination of the vote as raised by the parties, the court shall certify to the State Board and the electoral board or boards (a) the vote for each party to the recount and declare the person who received the higher number of votes to be nominated or elected, as appropriate, or (b) the votes for and against the question and declare the outcome of the referendum.

E. Costs of the recount shall be assessed against the counties and cities comprising the election district when (i) the candidate petitioning for the recount is declared the winner; (ii) the petitioners in a recount of a referendum win the recount; or (iii) there was between the candidate apparently nominated or elected and the candidate petitioning for the recount a difference of not more than one-half of one percent of the total vote cast for the two such candidates as determined by the State Board or electoral board prior to the recount. Otherwise the costs of the recount shall be assessed against the candidate petitioning for the recount or the petitioners in a recount of a referendum. If more than one candidate petitions for a recount, the court may assess costs in an equitable manner between the counties and cities and any such candidate if both are liable for costs under this subsection. Costs incurred to date shall be assessed against any candidate or petitioner who defaults or withdraws his petition.

F. The court shall determine the costs of the recount subject to the following limitations: (i) no per diem payment shall be assessed for salaried election officials; (ii) no per diem payment to officers of election serving as recount officials shall exceed two-thirds of the per diem paid such officers by the county or city for service on election day; and (iii) per diem payments to alternates shall be allowed only if they serve.

G. Any petitioner who may be assessed with costs under subsection E shall post a bond with surety with the court in the amount of $10 per precinct in the area subject to recount. If the petitioner wins the recount, the bond shall not be forfeit. If the petitioner loses the recount, the bond shall be forfeit only to the extent of the assessed costs. If the assessed costs exceed the bond, he shall be liable for such excess.

H. The recount proceeding shall be final and not subject to appeal.

I. For the purposes of this section:

"Overvote" means a ballot on which a voter casts a vote for a greater number of candidates or positions than the number for which he was lawfully entitled to vote and no vote shall be counted with respect to that office or issue.

"Undervote" means a ballot on which a voter casts a vote for a lesser number of candidates or positions than the number for which he was lawfully entitled to vote.

Appendix C: Public Statements

1.   Model Legislation
     Virginia Verified Voting
     Submitted by Alex Blakemore 11/23/05

2.   Counting Mark-Sense Ballots
     Douglas W. Jones
     Submitted by Maggie Luca, Subcommittee member, 11/23/05

3.   Statement of Views
     Submitted by Joyce Braithwaite, Subcommittee Member, 12/02/05

4.   Statement of Views
     Libertarian Party
     Submitted by Steve Damerell 12/28/05

5.   Statement of Views
     Virginia Electoral Board Association
     Submitted by Arelia S. Langhorne, President, 1/3/06

6.   Statement of Views
     Edward A. O'Neal, Chairman, Norfolk Electoral Board
     Submitted 1/4/06

7.   Statement of Views
     Submitted by Cameron Quinn, Subcommittee member, 1/05/06

8.   Chairman's Suggested List of Items for Subcommittee Review and Action on
     1/5/06

Submitted by Alex Blakemore, Virginia Verified Voting, 11/23/05

Draft Model Legislation for Verified Voting
Bob Kibrick, Legislative Analyst, VerifiedVoting.org
May 1, 2005

Model legislation for verified voting must provide language to address the following:

1. Defining relevant terms
2. Requiring that all voting systems provide an accessible, voter-verified paper record (VVPR)
3. Requiring mandatory manual audits of the VVPRs in randomly-selected precincts
4. Enabling/authorizing the use of voting technologies/systems that support these requirements

The specific legislative language that will be required will vary from state to state depending on the existing definitions and provisions in each state's current election code. For example, some states (e.g., California) already require mandatory manual audits, while others already require that all voting systems must use some type of paper ballot.

1. DEFINING RELEVANT TERMS

A clear definition of the relevant terms is essential to any model language:

Voter-Verified Paper Audit Trail (VVPAT): a permanent paper record of the voter's vote printed by a touch screen or other direct recording electronic (DRE) voting machine and verified by the voter (as correctly reflecting the voter's intent) before the voter's vote is cast; a VVPAT is printed by a voting machine set up for voting at the polling place or at an early voting location designated by elections officials. Once the voter's vote is cast, the VVPAT is securely stored by the voting system as an official record of the voter's vote and constitutes the official ballot of record in the case of any audit or recount. The VVPAT may be read and counted using an optical scanner, a bar code scanner, or by hand.

Voter-Verified Paper Ballot (VVPB): a permanent paper ballot prepared and verified by the voter (as correctly reflecting the voter's intent), either manually or with the assistance of a ballot marking device, before the voter's vote is cast; a VVPB may be completed in the polling place or or mailed to an election official from a domestic or overseas location. Once the voter's vote is cast, the VVPB is securely stored by the voting system as the official record of the voter's vote and constitutes the official ballot of record in all cases, including all counts, audits, or recounts. The VVPB may be read and counted by an optical scanner or by hand.

Voter-Verified Paper Record (VVPR): a permanent paper record of the voter's vote that is verified by the voter (as correctly reflecting the voter's intent) before the voter's vote is cast, securely stored by the voting system as an official record of the voter's vote, and which constitutes the official ballot of record in the case of any audit or recount; both voter-verified paper audit trails (VVPATs) and voter-verified paper ballots (VVPBs) constitute instances of a voter-verified paper record (VVPR).

Ballot Marking Device: A voting device that enables voters with disabilities (including voters who are blind or visually-impaired) to mark and verify (as correctly reflecting the voter's intent) an optical scan paper ballot. Such devices may employ similar assistive interfaces (e.g., touch screens with adjustable font sizes, audio interfaces with support for multiple languages, sip-and-puff interfaces for voters who do not have use of their hands, keypads with tactilely-distinct buttons and markings in Braille, etc.) as are typically used by direct recording electronic (DRE) voting machines for providing voting access to voters with disabilities. A ballot marking device:
1) is used only to assist voters in marking and verifying a paper ballot,
2) will prevent a voter from overvoting,
3) will alert the voter if the voter has undervoted in any contest or question,
4) will permit the voter to correct any error before the paper ballot is marked, and
5) will enable the voter to verify that the marked paper ballot correctly reflects the voter's intent.
A ballot marking device does not maintain an electronic record of the voter's vote nor does it count votes. An optical scan paper ballot marked using a ballot marking device is not considered cast until it is either deposited into a ballot box or accepted by a precinct-count optical scanner.

Precinct-count optical scanner: An optical ballot scanner that is located in the precinct and into which marked optical scan paper ballots (either marked by hand or marked via a ballot marking device) are inserted for validation and counting. Such devices will alert the voter if the voter's ballot is overvoted or undervoted, and in such cases give the voter the opportunity to retrieve the marked ballot from the scanner (before it is accepted for counting) in order to make corrections to the ballot. In the case of an overvoted paper ballot (which is treated as a spoiled ballot), the voter can exchange the spoiled paper ballot for a new unmarked paper ballot and start over. If the paper ballot is free of undervotes and overvotes, or if the voter indicates that the ballot should be accepted with undervotes, the scanner will accept and tabulate the ballot, then deposit it into a secure storage container for use in any subsequent audit or recount.

Ballot Checking Device: A device that is located in the precinct and used by the voter to check the voter's marked optical scan paper ballot for overvotes or undervotes before the voter casts the ballot. Such devices will alert the voter if the voter's ballot is overvoted or undervoted so that the voter can correct the ballot before it is cast. In the case of an overvoted paper ballot (which is treated as a spoiled ballot), the voter can exchange the spoiled paper ballot for a new unmarked paper ballot and start over. A

ballot checking device does not maintain an electronic record of the voter's vote nor does it count votes.

Accessible voting system: A voting system is accessible if it enables all voters, including voters with disabilities, to complete all steps of the voting process in a manner that maintains the privacy of the voter's ballot, including:
1) marking the voter's selections on the ballot,
2) verifying that the voter-verified paper record (VVPR) of the voter's vote accurately reflects the voter's intent, and
3) casting the voter's marked ballot.
In addition, the voting system shall enable voters with disabilities to vote without assistance to the extent possible consistent with the voter's disability. For certain disabilities, a poll worker must provide some type of assistance to the voter, even in the case of voting systems that are already deemed by both the disability community and elections officials to be accessible. For example, a voter who does not have use of his or her hands will require a poll worker's assistance to insert a voter-access card into a DRE voting machine to initiate voting, and a quadriplegic voter who also requires use of an audio voting interface (due to a visual or reading impairment) will also require the assistance of a poll worker in order to place headphones on the voter's head. So long as well-defined procedures exist that enable a the poll worker to provide to the disabled voter, without compromising the privacy of the voter's ballot, any such assistance as required by the voting system, that voting system is deemed to be accessible.

Ballot privacy container: An opaque cover, envelope, sleeve, or cartridge that is used in conjunction with a voter's marked paper ballot to maintain the privacy of such a ballot in between the time that it is marked and the time when it is cast or counted. During that interval, the privacy container will conceal the marked portion of the voter's ballot so that it is not visible.

2. REQUIRING ALL VOTING SYSTEMS TO PROVIDE AN ACCESSIBLE VVPR.

A fundamental requirement of any legislation pertaining to verified voting is that all voting systems must provide an accessible, voter-verified paper record so that all voters, including voters with disabilities, can verify that their votes have been accurately recorded and so that meaningful manual recounts and audits can be conducted.

A requirement for an accessible VVPR can be written in terms of the above defined terms. However, a VVPR can be implemented either via an optical scan voting system (which provides a VVPB) or a direct recording electronic (DRE) voting system with an attached printer (which provides at VVPAT), or a combination of both. Each state needs to decide whether it wants to specifically mandate a single voting system solution statewide, or whether to permit each county to choose between an optical scan/VVPB system or a DRE/VVPAT system. That decision might depend on whether or not any DRE voting systems have already been deployed in that state, and whether or not any

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such deployed DREs meet HAVA's accessibility standards (or whether any such systems have been decertified, such as the Unilect Patriot systems in Pennsylvania).

In the case of a state where no DRE systems are currently deployed, or in a state containing older-style DREs that fail to meet HAVA's accessibility requirements and which will need to be replaced, the most cost-effective and verifiable solution is to mandate optical scan/VVPB systems statewide. A number of states (e.g., Arizona, Oklahoma, Rhode Island, etc.) currently use precinct-based optical scan systems exclusively, and will likely use ballot marking devices (such as the AutoMark system) to meet HAVA's disability access requirements, assuming such systems complete ITA testing and NASED/EAC certification within the next month or two.
In states where a significant number of counties already employ accessible DREs, it may make more sense to enable each county to decide which type of voting system (optical scan/VVPB or DRE/VVPAT) to deploy in order to meet the accessible VVPR requirement.

Accordingly, the model language presented here (which is derived from Representative Rush Holt's H.R. 550 and Senator Ensign's S. 330) establishes a generic requirement for a VVPR, and enables counties to meet that requirement using either of these two types of technology.

(A) VOTER-VERIFICATION AND AUDIT CAPACITY-

(i) The voting system shall produce or require the use of an individual voter-verified paper record of the voter's vote that shall be made available for inspection and verification by the voter before the voter's vote is cast. For purposes of this clause, examples of such a record include a paper ballot prepared by the voter for the purpose of being read by an optical scanner, a paper ballot prepared by the voter to be mailed to an election official (whether from a domestic or overseas location), a paper ballot created through the use of a ballot marking device, or a paper print-out of the voter's vote produced by a touch screen or other electronic voting machine, so long as in each case the record permits the voter to verify the record in accordance with this paragraph (A).

(ii) The voting system shall provide the voter with an opportunity to correct any error made by the system in the voter-verified paper record before the permanent voter-verified paper record is preserved in accordance with paragraph (B)(i).

(iii) The voting system shall not preserve the voter-verifiable paper records in any manner that makes it possible to associate a voter with the record of the voter's vote.

(B) MANUAL AUDIT CAPACITY-

(i) The permanent voter-verified paper record produced in accordance with paragraph (A) shall be preserved--

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(I) in the case of votes cast at the polling place on the date of the election, within the polling place in the manner or method in which all other paper ballots are preserved within such polling place;

(II) in the case of votes cast at the polling place prior to the date of the election or cast by mail, in a manner which is consistent with the manner employed by the jurisdiction for preserving such ballots in general; or

(III) in the absence of either such manner or method, in a manner which is consistent with the manner employed by the jurisdiction for preserving paper ballots in general.

(ii) Each paper record produced pursuant to paragraph (A) shall be suitable for a manual audit equivalent to that of a paper ballot voting system.

(iii) In the event of any inconsistencies or irregularities between any electronic records and the individual permanent paper records, the individual permanent paper records shall be the true and correct record of the votes cast.

(iv) The individual permanent paper records produced pursuant to paragraph (A) shall be the true and correct record of the votes cast and shall be used as the official records for purposes of any recount or audit conducted with respect to any election in which the voting system is used.

(C) ACCESSIBILITY AND VOTER VERIFICATION OF RESULTS FOR INDIVIDUALS WITH DISABILITIES. The voting system, including any procedures employed by poll workers to facilitate voting by voters with disabilities, shall:

(i) satisfy the requirement of paragraph (A) through the use of at least one accessible voting system equipped for individuals with disabilities at each polling place;

(ii) allow the voter the opportunity to complete any of the steps of the voting process in a manner that maintains the privacy of the voter's ballot, including:
(I) marking the voter's selections on the ballot;
(II)verifying that the voter-verified paper record of the voter's vote accurately reflects the voter's intent; and   (III) casting the voter's ballot;

(iii) in the case of a voting system employing paper ballots, including optical scan or marksense paper ballots, provide for the use of ballot privacy covers, envelopes, or cartridges as necessary to ensure that the privacy of the voter's ballot is maintained from the time it is marked until the time that it is cast.

3. REQUIRING MANDATORY MANUAL AUDITS OF THE VVPRs

In order to detect and correct any systematic errors in the tallies produced by any automated vote counting system (regardless of whether that system employs DRE voting machines or optical scan ballots), it is essential that there be mandatory, manual audits (i.e., hand counts) of the voter-verified paper records for a statistically-significant fraction of the precincts in every election. The precincts selected for such audits need to be selected at random using a uniform distribution so that all precincts have an equal chance of being selected for such an audit.

However, in order to develop specific language for a particular state it is important to know the scope of the audit you seek to achieve:

1. should it be limited strictly to verifying (i.e., hand counting) the VVPATs printed by polling place DREs on election day from a set of randomly-selected precincts, or

2. should it also include VVPATs printed by DREs used in early voting locations which may support a very large number of precincts at a single location (if so, it depends on whether separate DREs are used to service early-voters from different precincts, or whether the DRE-generated VVPATs for a large number of precincts end up in the same ballot box at that early voting location, since if you select precincts at random for audit, you may have a mix of VVPATs in the same ballot box, some from precincts selected for audit and others from precincts that were not), or

3. should it also include VVPBs (e.g., optical scan ballots) that are cast in the polling place on election day (since in many states you have some counties using optical scan, some using DREs, and starting in 2006, you may have some counties which use a mix of both in each polling place), or

4. should it also include provisional ballots (if so, different procedures may apply depending on whether provisional ballots are cast using [optical scan] paper ballots which are then put in special envelopes and segregated from non-provisional ballots or whether they are cast electronically and electronically tagged as provisional, in which case how do the "provisional" VVPATs get handled), or

5. should it also include absentee ballots (if so, different procedures may apply depending on whether such ballots are counted in the context of the precinct in which the voter would normally vote or whether they are aggregated into special, absentee-ballot precincts)?

Obviously there are various permutations and combinations that are possible, and these will vary from county to county and state to state. Bottom line: the more inclusive you make the audit, the longer and more complex (and less general) the audit language becomes. But if you don't make the audit inclusive, then those with malicious intent will simply attack the system at its weakest (i.e., unaudited) point, which at some level defeats the purpose of the audit.

In a sense, it depends on what sorts of errors you are most concerned about catching with the audit. Innocent errors (as might occur from a careless programming error, a malfunctioning hardware component, or a procedural error by poll worker) are likely to occur anywhere in the system and there is no reason to expect that they will be any more or less likely to occur in a portion of the system that is not audited compared with one that is.

Also, in addition to determining the scope of the audit you seek, it is also important to determine the time scale on which you need the audit to be completed. If you want the audit to be able to detect (and hopefully correct) any tabulation errors before the results are certified, then one can't wait for final (certified) results to be published before initiating the audit.

In the DRAFT language that follows, it is assumed the what constitutes a "voter-verified paper record" has been defined as described earlier.

DRAFT Mandatory Random Manual Audit Provision –

a) Mandatory Manual Audits in Randomly-Selected Precincts-

(1) IN GENERAL- The counties shall conduct mandatory hand counts of the voter-verified
*paper records in at least **X percent*** of the precincts.*

*Note: In California statute, it is **1%**. In the Holt bill -HR550--it is **2%**. In West Virginia's recently passed legislation, it is **5%**. In pending Hawaii legislation, it is **10%**. It may be cleaner to go with a percentage of precincts versus a percentage of machines, as that handles the more general case of either DREs or precinct-based optical scan (PBOS). If you specify machines, then you have to define which machines, and you would get uneven sampling if different technologies are used in different precincts, since PBOS has only one machine per precinct, whereas DREs would have multiple machines per precinct. Further, most county election data gets posted by precinct, not machine.

The other way of expressing this is to require random-selection of whole precincts until the votes cast in those precincts crosses some threshold (e.g., 2% of the total votes cast in the election). This is more complex and creates a chicken-and-egg problem since you don't know in advance how many votes will be actually cast in each precinct. Thus, a fixed percentage of the precincts is more practical to implement.

(2) PROCESS FOR CONDUCTING AUDITS-
(A) Timing of the audits: as soon as practical following the closing of the polls [or within whatever time limit is already imposed by the state election code], the County Board of Elections shall:

(i) complete the initial vote count for each and every precinct participating in the election in that County and publicly announce the results of each such initial vote count as soon as such results are available;

(ii) publicly conduct a random drawing as specified in subsection (b) to determine which of such precincts in the County will be selected for the mandatory hand counts of the voter-verified paper records as specified in paragraph (1), provided such drawing shall not occur until such time as all such initial vote counts have been completed and the results publicly announced, but no later than 48 hours after that time;

(iii) publicly announce the date, time, and location of such public random drawing at least 24 hours before such drawing is conducted;

(iv) publicly announce the date, time, and location of such public mandatory hand counts at least 24 hours before such hand counts are initiated;

(v) initiate such mandatory hand counts of the voter-verified paper records in the precincts selected as specified in clause (ii) no later than 48 hours after such selection of precincts is made; and

(vi) complete such hand counts no later than 24 hours after such hand counts are initiated
and publicly announce the results of each such mandatory recount as soon as such results are available.

You really want to have this audit occur as soon as possible after the polls have closed, but not until the initial tallies from each precinct have been publicly posted (as typically happens the day after the election). But you don't want to do the audit BEFORE those initial tallies are posted, else those will ill-intent can game the system by making sure that for any precinct that is chosen for audit, the initial tallies are "adjusted" to match the results of the audit.

The timing of when this audit occurs is critical. It's important to tailor the language of this section to use the relevant terminology found elsewhere in the state's election code. In particular, one must determine what deadlines the existing election code imposes on counties in terms of when (and in what format) they must publicly post and announce such initial tallies.

If you wait to conduct the audit until a "final" vote count is released, that may occur well past the deadlines for filing contests, recounts, or challenges. Again, one needs to determine the relevant deadlines as specified in the given state's election code.

The other potential problem that needs to be addressed is what happens if you have one or more problem precincts whose initial vote counts are not ready for release when expected (e.g., you have a balky DRE and elections officials are having difficulty extracting the vote counts from that DRE's electronic memory card; the manufacturer's technicians have been summoned to try to resolve the problem, but they have to fly in their expert from Vancouver, etc.). As a result, the audit is at a standstill, because the public announcement of the results of the initial vote count in each precinct in the County is not yet completed, because no initial vote count is yet available from the problem precinct(s). Meanwhile, the clock keeps ticking on the various deadlines for filing requests for contests, recounts, challenges, etc., as well as for the meeting of the Electoral College. Accordingly, someone who wants to delay the audit until it is too late to do any good need only find a way to forestall the initial vote count from a single precinct in that county.

NOTE: Several problems could be solved if we simply set a fixed deadline by which the initial (machine) vote counts for each precinct must be completed AND publicly announced. And if they aren't for whatever reason (including a balky DRE whose memory card was proving difficult to read, or a county that has something it wants to hide with respect to the initial vote counts in certain precincts), well then that is just too bad.

In that case, if the initial (machine) vote counts for any precinct aren't completed AND publicly announced by that deadline, then the voter-verified paper records from that precinct will be counted by hand and will be released as the vote count for that precinct, period. (This gives Counties a strong incentive not to dawdle and to complete and announce the results of all of their initial vote counts in a timely manner.) If such a precinct were also randomly selected by the public drawing, it would only be subject to one mandatory hand count. With this in mind, an **alternate formulation for subsection (a)(2)(A) reads as follows:**

(2) PROCESS FOR CONDUCTING AUDITS -
 (A) Timing of the audits: the County Board of Elections shall:
     (i) as soon as practical following the close of the polls, begin the initial vote count for each and every precinct participating in the election in that county;
     (ii) no later than 3 [business?] days following the close of the polls, complete each such initial vote count initiated in clause (i) and publicly announce:
          (I) the results of each such initial vote count, and
          (II) the date, time, and location of the public drawing described in clause (iii);
     (iii) on the fourth [business?] day following the close of the polls and at the time and location announced as specified in clause (ii)(II):
          (I) conduct in public view a random drawing as specified in subsection (b) to determine which of such precincts in the County will be selected for the mandatory hand counts of the voter-verified paper records as specified in paragraph (1), and
          (II) immediately following the random drawing conducted as specified in subclause (I), publicly announce the time, and location of the mandatory hand counts described in clause (iv);

(iv) beginning on the fifth [business?] day following the close of the polls and at the time and location announced as specified in clause (iii)(II), initiate and conduct in public view such mandatory hand counts of the voter-verified paper records:

(I) from the precincts randomly selected as specified in clause (iii)(I), and

(II) from any precinct for which the initial vote count was not completed and publicly announced as specified in clause (ii), in which case the results of the mandatory hand-counts of the voter-verified paper records from such precinct will be accepted and publicly announced as the initial count for that precinct,

(III) such that multiple mandatory hand counts of the voter-verified paper records from a precinct will not be required in the case where a precinct meets the conditions of both subclauses (I) and (II) of this clause (iv); and

(v) no later than 7 [business] days following the close of the polls, complete in public view each such mandatory hand count initiated in clause (iv) and publicly announce the results of each such mandatory hand count as soon as such results are available.

This language ensures that the audit moves forward on a relatively fixed and predictable time scale regardless of any snags that develop with the initial (machine) vote counts. The counts of days (from the close of the polls) to the start and end of each of these various activities can be adjusted as needed to conform with existing previsions of a given state's election code. One also needs to decide whether or not such activities can occur on nonbusiness days.

The language proposed above used the phrase "publicly announce" regarding the disclosure of the results of the initial vote counts and of the mandatory hand counts. That should probably be strengthened to include both an immediate public announcement as well as a more accessible and widely distributed form of disclosure, including, but not necessarily limited to: publication in at least one newspaper of record, posting to the county registrar's, county clerk's or other relevant agency's website, posting at a public location (e.g., county clerk's office, public library, etc.).

These specific details should not be spelled out in this subsection (a)(2)(A) (because that subsection is devoted to the TIMING of the audits, and not the publication of the results). Rather, the publication details should be addressed in subsection (d) of this bill, since that subsection pertains to "publication". Thus, subsection (d) probably should be cross-referenced from the language of subsection (a)(2)(A) above. For example, most instances of "publicly announce" should probably be replaced by something like "publicly announce and publish as described in subsection (d)".

(B) With respect to votes cast at the precinct or equivalent location on or before the date of the election (other than provisional ballots), the County Board of Elections shall require to be counted by hand the voter-verified paper records and compare those records with the
initial count of such votes as announced by the [precinct?].

This paragraph can refer to early voting, or to absentee ballots dropped off at a precinct location or office of the County Board of Elections, for example. The question mark by

[precincts?] is there because some states lump absentee ballots together in one "absentee" precinct. Others may sort absentees based on the voters' assigned precinct according to their address, while processing signatures as ballots come in.

(C) With respect to votes cast other than at the precinct on the date of the election or votes cast by provisional ballot on the date of the election which are certified and counted by the County on or after the date of the election, including votes cast by absent uniformed services voters and overseas voters under the Uniformed and Overseas Citizens Absentee Voting Act, the County Board of Elections shall count by hand the applicable voter-verified paper records and compare its count with the machine tally of those votes.

This is appropriate for all types of votes, whether optical scan or DRE, because even opscan absentee ballots are initially counted by machine. Problem is, how do you construct a sample of such ballots, since you probably can't mandate that every such ballot be hand counted? Similar problem exists for votes cast during early voting.

Do these absentee ballots eventually get mapped back to a precinct of the voter who cast them (i.e., their address of their last known residence in the state?), or are all absentee ballots lumped into one giant super-precinct? If that super-precinct is one of the precincts chosen for manual audit, do you hand count every ballot cast in that super-precinct? I can just see the SoS and County Clerks lining up to embrace that provision. This is a very hard problem.

(b) Selection of Precincts- The selection of the precincts in a County in which the County Board of Elections shall conduct hand counts of the voter-verified paper records as specified in this section shall be made publicly by the County Board of Elections on an entirely random basis using a uniform distribution in which all precincts in a County have an equal chance of being selected. The timing of when such random selection is made is as specified in subsection (a)(2)(A).

We also need to determine how the concept of "precinct" applies to votes cast by absentee ballot ; see note above.

(c) Additional Audits In case of discrepancy: If the County Board of Elections finds that any of the hand counts conducted under this section show a discrepancy between the hand count and the initial vote count in a jurisdiction within the County, the County Board of Elections shall conduct hand counts under this section at such additional precincts within the County as the County considers appropriate to resolve any concerns and ensure the accuracy of the results.

(d) Publication-

(1) IN GENERAL- As soon as practicable after the completion of an audit conducted under this section, the County Board of Elections shall announce and publish the results of the audit, and shall include in the announcement a comparison of the results of the

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election in the precinct as determined by the County Board of Elections under the audit and the initial vote count in the precinct as announced by the County Board of Elections as specified in subsection (a)(2)(A)(i)
[or (a)(2)(A)(ii)(I) in the alternate formulation], broken down by the categories of votes described in subparagraphs (B) and (C) of subsection (a)(2). Any discrepancies between the corresponding audit results and initial vote counts will be duly noted, along with a description of the actions taken by the County Board of Elections for resolution of such discrepancies.

We probably need to add some language to (d) to make explicit that both the "results ... determined under the audit" and the "audit results" specifically include the results of the **mandatory hand counts** that are described in subsection (a). This subsection should also provide more details regarding the methods used to publish the results, similar to what was previously noted (e.g., publication in newspaper of record, website posting, printed posting at a public location, etc.)

(2) DELAY IN CERTIFICATION OF RESULTS BY COUNTY - No County may certify the results of any election which is subject to an audit under this section prior to the completion of the audit and the announcement and publication of the results of the audit under paragraph (1).

We probably want to add some language here to cover the case where the initial (machine) vote count simply cannot be completed due to an irrevocable problem with the voting system (e.g., catastrophic failure to record electronic votes, as happened in Carteret County, NC in Nov. 2004), in which case we stipulate that the voter-verified paper records for any such machine will be hand counted and treated as the vote of record for that machine, so that the audit for the precinct in which that defective machine is located can be declared complete so that in turn the results from the precinct can be certified.

ALTERNATE DRAFT AUDIT LANGUAGE

Note: this example is much shorter than the more fully developed example above. It is based on West Virginia's legislative example, which just recently passed. It should be noted that WV already uses optical scan, centrally counted. As noted above, keep in mind the level of complexity may depend on what you want to accomplish with the audits.

During the canvass and any requested recount, at least five percent of the precincts are to be chosen at random and the voter-verified paper ballots are to be counted manually. Whenever the vote total obtained from the manual count of the voter verified paper ballots for all votes cast
in a randomly selected precinct:

(1) Differs by more than one percent from the automated vote tabulation equipment; or

(2) Results in a different prevailing candidate or outcome, either passage or defeat, of one or more ballot issues in such precincts for any contest or ballot issue;

then the discrepancies shall immediately be disclosed to the public and all of the voter-verified paper ballots shall be manually counted. In every case that there is a difference between the vote totals obtained from the automated vote tabulation equipment and the corresponding vote totals obtained from the manual count of the voter-verified paper ballots, the manual count of the voter-verified paper ballots shall be the vote of record.

It is important that any additional audits be triggered on the basis of clear criteria that can be objectively enforced, otherwise you will end up in court, and once you end up in court, opposing parties can stall, delay, and run down the clock on any recount deadlines or electoral college deadlines.

AUDIT PROVISION EXAMPLES FROM OTHER STATES (both statutes and pending legislation):

California (Statute)

15627. If in the election which is to be recounted the votes were recorded by electronic or electromechanical vote tabulating devices, the voter who files the declaration requesting the recount may select whether the recount shall be conducted manually or by means of the voting system used originally, or both.

15629. The recount shall be conducted publicly.

15360. During the official canvass of every election in which a voting system is used, the official conducting the election shall conduct a public manual tally of the ballots tabulated by those devices cast in 1 percent of the precincts chosen at random by the elections official.

If 1 percent of the precincts should be less than one whole precinct, the tally shall be conducted in one precinct chosen at random by the elections official.

In addition to the 1 percent count, the elections official shall, for each race not included in the initial group of precincts, count one additional precinct.

The manual tally shall apply only to the race not previously counted. Additional precincts for the manual tally may be selected at the discretion of the elections official.

Colorado (proposed legislation – we worked on this language but encountered tough resistance from the Secretary of State and County Clerks)

SB 79: Requires the secretary of state, immediately following a general election, to randomly and publicly select a specified number of precincts in the state.
Requires the secretary, in each of these precincts, to conduct a manual recount of the votes cast by the permanent paper records and to compare such votes with the vote tally recorded in that precinct by electronic voting or other vote counting machine used in the election.

West Virginia (legislation passed this session – awaiting signature)

SB 477 *If any candidate demands a recount of the votes cast at an election, the voter-verified paper ballot shall be used for requested recounts according to the same rules as are utilized in the original vote count pursuant to section twenty-seven of this article.*

*(d) During the canvass and any requested recount, **at least five percent of the precincts** are to be chosen at random and the voter-verified paper ballots are to be counted manually. Whenever the vote total obtained from the manual count of the voter verified paper ballots for all votes cast in a randomly selected precinct:*
(1) Differs by more than one percent from the automated vote tabulation equipment; or
(2) Results in a different prevailing candidate or outcome, either passage or defeat, of one or more ballot issues in such precincts for any contest or ballot issue; then the discrepancies shall immediately be disclosed to the public and all of the voter-verified paper ballots shall be manually counted. In every case that there is a difference between the vote totals obtained from the automated vote tabulation equipment and the corresponding vote totals obtained from the manual count of the voter-verified paper ballots, the manual count of the voter-verified paper ballots shall be the vote of record.

Alaska (pending legislation re audit language – AK already has a VVPB law)

An amendment offered to a recent bill, which "requires the automatic hand count of **at least one precinct (containing 5%+ of voters) per House District**, for each Alaska election. This mandatory manual audit, with the precinct to be counted selected randomly after voting finishes on Election Day, is a critically important element of reliable elections," as we stated recently in a letter of testimony.

Illinois (Statute)

Sec. 24C-2.5. Official paper vote; random audit.

(a) All voting systems submitted for approval under this Article must produce a voter verifiable paper ballot that is then counted by a machine not connected either physically or electronically to the machine that produces the paper ballot. The ballot as counted by this separate machine shall constitute the actual vote of the voter.

(b) An election authority using a voting system subject to this Article must conduct a random audit of the system consisting of the recount of votes cast in **5% of the precincts** using the system.

Connecticut (pending)

SB 55:
http://www.cga.ct.gov/asp/cgabillstatus/cgabillstatus.asp?selBillType=Bill&bill_num=55&which_year=2005&SUBMIT.x=12&SUBMIT.y=15

The relevant text of which reads as follows:

424	(4) Not later than five business days after each election in which a
425	direct recording electronic voting machine is used, the registrars of
426	voters or their designees, representing at least two political parties,
427	shall conduct a manual audit of the votes recorded on at least one
428	direct recording electronic voting machine used in each voting district.
429	Not later than five business days after a primary in which a direct
430	recording electronic voting machine is used, the registrar of voters of
431	the party holding the primary shall conduct such a manual audit by
432	designating two or more individuals, one of whom may be the
433	registrar, representing at least two candidates in the primary. The
434	machine or machines audited under this subdivision shall be selected
435	in a random drawing that is announced in advance to the public and is
436	open to the public. All direct recording electronic voting machines
437	used within a voting district shall have an equal chance of being
438	selected for the audit. The method of conducting the random drawing
439	may begin with a random number seed, use the last three digits of a
440	state lottery drawing determined in advance, use a random number
441	table recognized by statisticians as authoritative, or use any
442	combination of such methods or similar methods as may be
443	determined by the Secretary of the State in advance and publicly
444	announced. The manual audit shall consist of a manual tally of the
445	individual, permanent, voter-verified paper records produced by each
446	voting machine subject to the audit and a comparison of such count,
447	with respect to all candidates and any questions or proposals
448	appearing on the ballot, with the electronic vote tabulation reported
449	for such voting machine on the day of the election or primary. Such
450	audit shall not be required if a recanvass has been, or will be,
451	conducted on the voting machine. Such manual audit shall be noticed
452	in advance and be open to public observation. A reconciliation sheet,
453	on a form prescribed by the Secretary of the State, that reports and
454	compares the manual and electronic vote tabulations of each candidate
455	and question or proposal on each such voting machine, along with any

456   discrepancies, shall be prepared by the audit officials, signed and
457   forthwith filed with the town clerk of the municipality and the
458   Secretary of the State. If any contemporaneously produced individual,
459   permanent, voter-verified paper record is found to have been
460   damaged, the same procedures described in subdivision (3) of this
461   section for substituting such record with the self-generated, individual,
462   permanent paper record produced by the voting machine bearing the
463   identical machine-generated unique identifier as the damaged record
464   shall apply and be utilized by the audit officials to complete the
465   reconciliation. The reconciliation sheet shall be open to public
466   inspection and may be used as prima facie evidence of a discrepancy in
467   any contest arising pursuant to chapter 149 of the general statutes. If
469   the audit officials are unable to reconcile the manual count with the
469   electronic vote tabulation and discrepancies, the Secretary of the State
470   shall conduct such further investigation of the voting machine
471   malfunction as may be necessary for the purpose of reviewing whether
472   or not to decertify the voting machine or machines and may order a
473   recanvass in accordance with the provisions of subdivision (3) of this
474   section.

4. ENABLING/AUTHORIZING USE OF THE RELEVANT VOTING TECHNOLOGIES

The definitions and legislative language proposed above assumes that the relevant voting technologies (e.g., optical scan voting systems, precinct-count optical scanners, direct recording electronic (DRE) voting machines, ballot marking devices, etc.) are authorized for use in the given state. Some of these devices (e.g., ballot marking devices) might not be currently authorized for use, in which case specific enabling legislation will be required before such devices can be used in that state.

For example, West Virginia has recently passed legislation (H.B. 2950) which provides enabling legislation for ballot marking devices and for ballot checking devices (referred to as precinct ballot scanning devices):

§3-4A-9a. Authorization for ballot-marking voting systems; minimum requirements.

(a) For purposes of this section, "ballot-marking accessible voting system" means a device which allows voters, including voters with disabilities, to mark an optical scanning or mark-sensing voting system ballot, privately and independently. Th e ballot-marking device is capable of marking voter selections on an optically readable or mark-sensing ballot which shall be subsequently read and tallied on state certified optically readable or mark-sensing ballot tabulating and reporting systems. Counties are hereby permitted to obtain and employ ballot-marking accessible voting systems that are approved by the State Election Commission.
(b) The ballot-marking accessible voting device shall be a completely integrated ballot-marking device that is designed to allow voters to either view ballot choices through a

high resolution visual display or listen to ballot choices with headphones and then enter ballot selections directly through specially designed, integrated accessibility keys.

(c) Ballot-marking accessible voting systems may be used for the purpose of marking or scanning optically readable or mark- sensing ballots cast in all general, special and primary elections and shall meet the following specific requirements:

(1) The ballot-marking accessible voting system, system firmware and programming software must be certified by an independent testing authority, according to current federal voting system standards and be approved by the State Elections Commission prior to entering into any contract.

(2) The ballot-marking accessible voting system shall, additionally:

(A) Alert the voter if the voter has made more ballot selections than the law allows for an individual office or ballot issue;

(B) Alert the voter if the voter has made fewer ballot selections than the law allows for an individual office or ballot issue;

(C) Allow the voter to independently review all ballot choices and make any corrections, before the ballot is marked;

(D) Provide the voter with the opportunity to make a write-in ballot choice, where allowed by state law;

(E) Allow voters with disabilities to mark their ballots, in complete independence, and in conformity with both federal and state law concerning mandatory accessibility for disabled persons;

(F) Allow blind or visually impaired voters to vote in complete privacy;

(G) Provide voters with an opportunity to change ballot selections, or correct errors, before the ballot is marked for voting, including the opportunity to correct the error through the issuance of a replacement ballot if the voter was otherwise unable to change the ballot or correct the error;

(H) Provide voters with the ability to view all ballot selections through a high resolution visual display or to have all ballot selections read to the voter through headphones;

(I) Ensure complete ballot privacy, while employing the ballot-marking audio system and providing the voter with the option to turn off the visual ballot display;

(J) Include a completely integrated voter input keypad, using commonly accepted voter accessibility keys with Braille markings;

(K) Include the ability for a voter to employ a sip/puff device to enter ballot choices;

(L) Allow the voter to magnify all ballot choices and to adjust both the volume of the audio feature and the speed of ballot presentation;

(M) Allow the voter to employ his or her own headset as well as the headset provided with the ballot-marking device while being equipped with multiple output connections to accommodate different headsets;

(N) Have multiple-language capability; and

(O) Allow the voter to verify that:

(i) An optical scan ballot inserted into the device at the start of voting is blank; and

(ii) The voted optical scan ballot that is produced by the device is voted as the voter intended.

(d) The Secretary of State is hereby directed to propose rules and emergency rules for legislative approval in accordance with the provisions of article three, chapter twenty-

nine-a of this code designed to ensure that any system employed by a county under the provisions of this section is publicly tested prior to use in election.

§3-4A-9b. Authorization for precinct ballot-scanning device; minimum requirements.

(a) For purposes of this section, "precinct ballot-scanning device" means a device used by the voter at the precinct on election day or during early voting for the purpose of scanning the voter's ballot after the ballot has been voted but prior to depositing the ballot into the ballot box.

(b) The precinct ballot-scanning device may be used for the purpose of scanning optically readable ballots cast in all primary, general and special elections.

(c) The precinct ballot-scanning device, firmware and programming software must be certified by an independent testing authority, according to current federal standards and be approved by the State Election Commission. No election official may enter into any contract to purchase, rent, lease or otherwise acquire any precinct ballot-scanning device, firmware or software not approved by the State Election Commission.

(d) The precinct ballot-scanning device shall additionally:

(1) Alert the voter if the voter has made more ballot selections than the law allows for an individual office or ballot issue;

(2) Alert the voter if the voter has made fewer ballot selections than the law allows for an individual office or ballot issue; and

(3) Allow voters an opportunity to change ballot selections, or correct errors, including the opportunity to correct the error through the issuance of a replacement ballot if the voter was otherwise unable to change the ballot or correct the error.

(e) The precinct ballot-scanning device shall not be used for tabulating election results.

(f) The Secretary of State is hereby directed to propose rules and emergency rules for legislative approval in accordance with the provisions of article three, chapter twenty-nine-a of this code in accordance with the provisions of this section.

Counting Mark-Sense Ballots

Relating Technology, the Law and Common Sense

Part of the Voting and Elections web pages
by Douglas W. Jones
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> The mathemagician nodded knowingly and stroked his chin several times. "You'll find," he remarked gently, "that the only thing you can do easily is be wrong, and that's hardly worth the effort."
>
> From *The Phantom Tollbooth* by Norton Juster

The Problem

The problem of interpreting voter intent when hand counting paper ballots has led many people, over the past century, to press for the use of impartial machinery in all ballot counting. The following quotations from the recount battles following the controversial Florida presidential election in the year 2000 expresses this in a very typical ways:

> Voting machines are not Republican and are not Democratic, and are not subject to conscious or unconscious bias.
>
> James Baker, as quoted by CNN on Nov. 12, 2000.

> ... I refer to this vote counting model as the "machine model," because it counts as valid only those votes that the vote tabulating machine can read and record. The machine model thus relies on an objective tabulating machine that admits of no discretion to count votes - if a vote is properly cast according to the instructions given to the voter, the machine will count it.
>
> U.S. Court of Appeals, 11th Circuit, Dec. 6, 2000, Touchston and Shepperd vs. Michael McDermott

Certainly voting machines are not subject to conscious bias because, simply put, they are not conscious! Even the term unconscious bias does not apply because we are reluctant to attribute unconscious behavior to things that are incapable of conscious behavior. What I assert here is that the mechanical vote tabulating systems in use today have variability in their vote counting that is comparable to a degree of discretion and that, as a consequence, the machine model is not an appropriate basis for answering the question of what constitutes a valid vote on an optical mark-sense ballot.

The comparison of vote counting systems and gambling machines provides some useful insight. Gambling machines, even such trivial machines as dice, can certainly be biased. Such biases can be accidental, the result of imperfect construction, or, as in the case of loaded dice, they may be deliberate. A voting machine may be biased in exactly the same ways!

In the remainder of this work, I will discuss the evolution of mark-sense ballot scanning systems and the problems this technology poses, and then I will compare some of the alternative legal models for regulating this technology before proposing my own recommendations. I want to emphasize that mark-sense ballot tabulation remains one of the most reliable of voting technologies despite the technical and legal problems that I will be emphasizing! The number of votes brought into question by the problems pointed out here is likely to be well below one percent of the vote in a properly administered election.

Some Definitions

Mark-sense ballots are a form of Australian secret ballot designed so that the ballot may be machine counted. As such, they rest on the basic Australian ballot, first used in 1858. Whether hand or machine counting is used, voters using an Australian ballot are instructed to vote using a *prescribed mark* written in the *voting target*.

> *voting target*
> The space on a ballot reserved for marks made by the voter in order to indicate a particular preference with regard to an issue on the ballot.

OFFICIAL BALLOT
Random County, Somestate

INSTRUCTIONS: To vote for a candidate, make an X in the oval beside the name of the candidate you prefer.

PRESIDENT
(vote for one)

◯ G. Washington

◯ A. Lincoln

◯ _____
(write in)

U.S. CONGRESS
(vote for one)

◯ S. Rayburn

◯ J.G. Cannon

◯ N. Longworth

◯ _____
(write in)

Figure 1: An example Australian secret ballot.

> *prescribed mark*
> The form of mark a voter is instructed to make in the voting target in order to cast a vote.

On the classic Australian ballot, the voting targets were either square boxes or circles next to the name of each candidate, and the prescribed mark was an X. When designed for use with optical mark-sense scanners, the target is typically an oval or a broken arrow, and the prescribed mark is either a blot filling the oval or a line connecting the two halves of the broken arrow. The following instructions for making a prescribed mark are typical of those used for hand-counted Australian ballots:

> 168.576 Marking ballot ...

> Sec. 576. (1) An elector, after having received a ballot or ballots, shall enter a booth or voting compartment and, while there concealed from view, shall vote the ballot or ballots by making a cross or a check mark in the square at the left of the names of
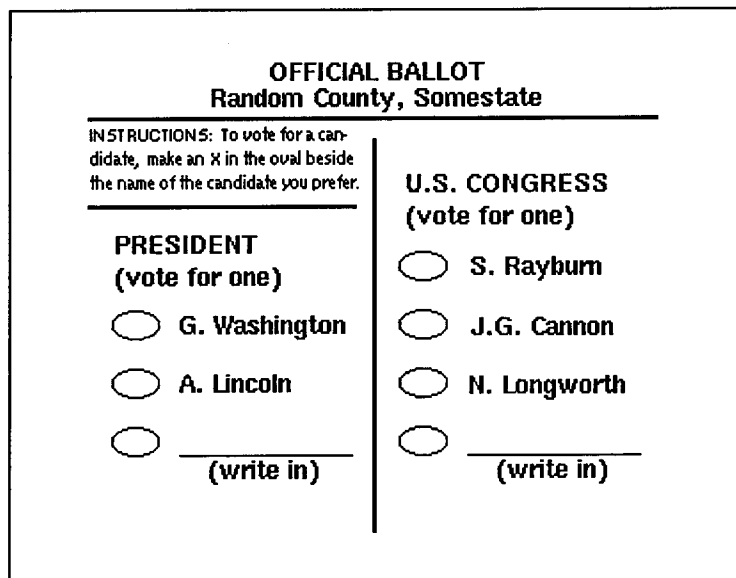
those candidates for whom the elector desires to vote ...

<u>Michigan Election Law, Chapter 168, Section 576, Act 116 of 1954, as amended through 1996.</u>

When counting ballots, we do not limit our count to ballots containing prescribed marks; instead, we count those containing *acceptable marks*.

> *acceptable mark*
> Any mark on a ballot that meets the legal requirements to be counted as a vote.

Obviously, under any reasonable code of law, voters who follows the instructions for making a prescribed mark should automatically produce acceptable marks, but the prescription does not usually delimit all of the forms of marking that are and are not acceptable. The Michigan code cited above illustrates this; while voters can easily follow these instructions, when it comes time to count the votes, the vote counters must have answers to these questions:

- What is a cross?
- What is a check mark?
- What does it mean for this mark to be in the square?

Michigan law answers these questions as follows for hand-counted paper ballots:

> 168.803 Counting and recounting of votes ...
>
> Sec. 803. (1) Except as otherwise provided in this act, the following rules shall govern the counting and recounting of votes: ...
>
> (b) A cross, the intersection of which is within or on the line of the proper circle or square, or a check mark, the angle of which is within a circle or square, is valid. Crosses or check marks otherwise located on the ballot are void.
>
> (c) Marks other than crosses or check marks used to designate the intention of the voter shall not be counted.
>
> (d) A cross is valid even though 1 or both lines of the cross are duplicated, if the lines intersect within or on the line of the square or circle.
>
> (e) Two lines meeting within or on the line of the square or circle, although not crossing each other, are valid if it is apparent that the voter intended to make a cross.
> ...

<u>Michigan Election Law, Chapter 168, Section 803, Act 116 of 1954, as amended through 1997.</u>

If the instructions for making the ballot are typical of those for optical mark-sense ballots, to fill in the oval next to the candidate's name using black ink or pencil, we must answer a different set of questions. For example, we might be tempted to ask:

- How much of the oval must be filled for it to be counted as a vote?
- What colors or shades of grey are considered to be black?

As with the acceptable mark rules for hand-counted Australian ballots, the above questions are legal questions, in the sense that their answers are typically set by statute or administrative rules, and they can be answered without regard to any particular tabulating machine! On the other hand, if the law says one thing and the machine judges marks differently, the machine may not be appropriate for use in this jurisdiction.

Our use of tabulating machines requires more terminology! Tabulating machinery counts only those marks actually detected; these are among the *detectable marks* on the ballot. Some marks will be *reliably detectable,* while others will be *marginal.*

Figure 2: Venn diagram of the universe of all ballot markings.

>*detectable mark*
>>A mark on a ballot that can be detected as a vote by a vote tabulating machine.
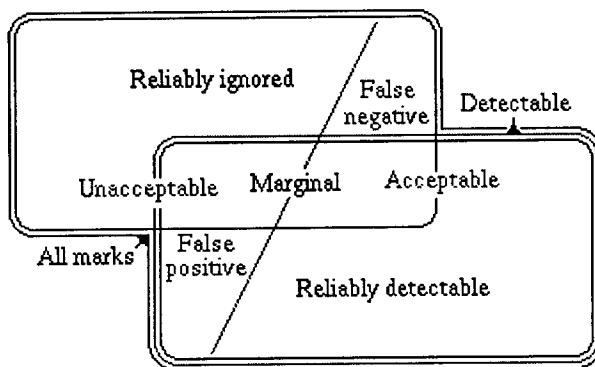
>*reliably detectable mark*
>>The form of mark on a ballot that will be detected and counted each and every time the ballot is run through a tabulating machine, irrespective of which voting target is being marked, and irrespective of the particular machine being used.

>*reliably ignored mark*
>>The form of mark on a ballot that will never be detected or counted no matter when the ballot is run through a tabulating machine, irrespective of which voting target is being marked, and irrespective of the particular machine being used.

>*marginal mark*
>>A mark on a ballot that may or may not be counted, depending on which voting target is marked, depending on what vote tabulating machine is used, and depending on when the count is made.

Well formulated voting laws governing the use of machine-counted ballots ensure that the prescribed mark will be reliably detected, and they ensure that, in practice, the vast majority of acceptable marks are reliably detectable and that the vast majority of reliably detectable marks are acceptable.

The machine model, as defined in <u>Touchston and Shepperd vs. McDermott</u> identifies acceptable marks with detectable marks, and it assumes that there will be no marginal marks. Equivalently, it assumes that all detectable marks are reliably detectable. Furthermore, this model is only just if the voter can easily determine, by eye, whether his or her mark is detectable. As we will see, all of these assumptions are false!

No technology based on machine-counted Australian secret ballots can eliminate all marginal marks, and with many voting systems, visual inspection by the person making the mark is not sufficient to determine if the mark will or will not be detectable! We must, therefore, allow for the

possibility of marks that are *false positives* and *false negatives*. These are standard statistical terms, but in the context of vote counting, we may define these terms for *misinterpreted marks* as follows:

false positive mark
> A mark on a ballot that does not meet the legal definition of an acceptable mark but that is, on some occasion, detected by a vote tabulating machine as a vote. False positive marks may be marginal marks or reliably detectable marks.

false negative mark
> A mark on a ballot that meets the legal definition of an acceptable mark but that is, on some occasion, not detected by a vote tabulating machine. False negative marks may be marginal marks or they may be reliably ignored.

misinterpreted mark
> A mark on a ballot that is misinterpreted by a vote tabulating machine; this term includes both false positive and false negative marks.

Ideally, we would hope for vote tabulating machines that guaranteed that there would be no marginal marks, no false positive marks and no false negative marks. Unfortunately, there is no technology for machine tabulation of Australian secret ballots that can accomplish this, for two different reasons! First, no technology can eliminate the possibility of a marginal mark, and second, mark-sensing machinery cannot generally duplicate the judgement of a human examining the ballot. To understand these two limitations, we need to understand something about mark sensing technology.

Mark Sensing Technologies

The original mark-sensing technology dates back to the 19th century, when it was developed for use with the very earliest of facsimilie machines; these relied on the ability of the fax scanner to detect the electrical conductivity of marks on the surface. First, this was done with insulating ink on conductive stationary -- they actually used tinfoil stationary in some early systems. In 1937, IBM introduced the Type 805 Test Scoring Machine for processing standardized educational tests, and shortly after this, they began to offer mark-sense options on punched-card forms used in business applications. These systems used the slight electrical conductivity of pencil marks on paper to detect marks. The very first mark-sense ballots, tried in Kern City, California, in 1962, may have used electrical mark-sensing, but I have been unable to find details about these early trials.

Optical mark-sensing also dates back to the facsimilie machine, and by the 1920's, it had been developed to the point that grey-scale photographs could be reliably transmitted by telephone and radio. In the 1950's, a group working under Professor E. F. Lindquist at the University of Iowa developed an optical mark-sense scanning system to score the ACT college entrance examination, and this scanner is the ancestor of the experimental mark-sense scanners used for vote counting by Westinghouse Learning Corporation in the 1970's. American Information Systems, an ancestor of Election Systems and Software, licenced this technology from Westinghouse when the former abandoned this venture.

Discrete-sensor Infrared Mark Sensing

The first generation of mark-sense scanners used for vote counting use infrared light. Such a scanner has an array of sensors, typically packed on 1/4 inch or 1/2 inch centers, but sometimes fewer. Each sensor consists of an infra-red light-emitting diode and phototransistor, matched to each other so that the peak sensitivity of the phototransistor is close to the wavelength emitted by the diode. Typically, the light-emitting diode and phototransistor are mounted side-by-side with a barrier between them so that the only light reaching the photosensor will be that reflected from the ballot. The ballot feed mechanism inside the ballot scanner feeds the ballot past the sensor array in such a way that some sensor in the array scans down each column of voting targets on the ballot. The Election Systems and Software Models 550 and 650 optical mark-sense ballot tabulating machines are typical of this class of scanners, although unlike the illustration in Figure 3, they use fiber optics between the light-emitting diodes, the photosensors and the ballot. Chatsworth Data Corporation also makes scanners that are similar the illustration in Figure 3.
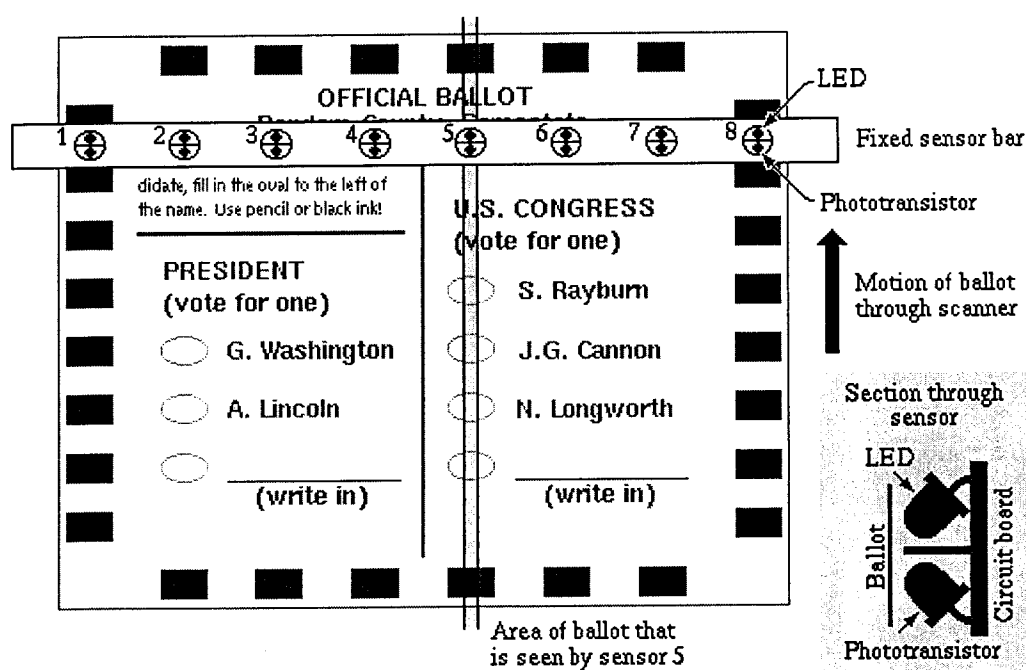
Figure 3: The mechanism of an optical mark sense scanner using a single discrete photosensor for each column of marking positions.

Note that the voting targets on infrared optical-scan ballots are typically printed in a carefully selected ink that is invisible to the sensors; in visible light, this ink frequently appears red, as shown in Figure 3. Typical scanners have sensors over many different columns of potential voting targets, both because of the evolution of such scanners from test grading machines, and because the extra sensors allow more flexible ballot layouts, for example, allowing the voting targets to be to the left or right of the candidate names and allowing the ballot to be arranged in two or three columns.

In addition to the sensors over the columns of voting targets on the ballot, the machine typically has one or two sensors that detect index marks on one or both edges of the ballot; these are needed because the machine cannot see the voting target itself, so it uses the index marks on the edge to tell it when it is looking at a row of potential voting targets. Additional index marks on the top and bottom are used to detect misaligned ballots; only if all of these marks are seen does the scanner

consider the ballot to be correctly aligned.

The area of the ballot seen by each sensor is a narrow stripe running along the direction of ballot motion through the scanner. Although these areas are shown with sharp borders in Figure 3, the areas seen by real sensors usually have diffuse borders. As a result, each sensor is usually most sensitive to marks that include the center of the stripe it sees, and less sensitive to marks falling to the sides. In formal mathematical terms, the sensing profile is typically described by something close to a Gaussian function.

The Effect of Sensor Geometry

The index marks along the vertical edges of the ballot and positions of the sensors along the sensor bar define the potential voting targets on the ballot. In the example shown in Figure 4, there are 48 potential voting targets arranged in 6 columns, corresponding to the 6 sensors that are available to scan columns of targets, and arranged in 8 rows because there are 8 index marks down the edge of the ballot. The intersection of each row, as defined by index marks on the ballot edge, with each column, as defined by the position of a sensor, defines a potential voting target.
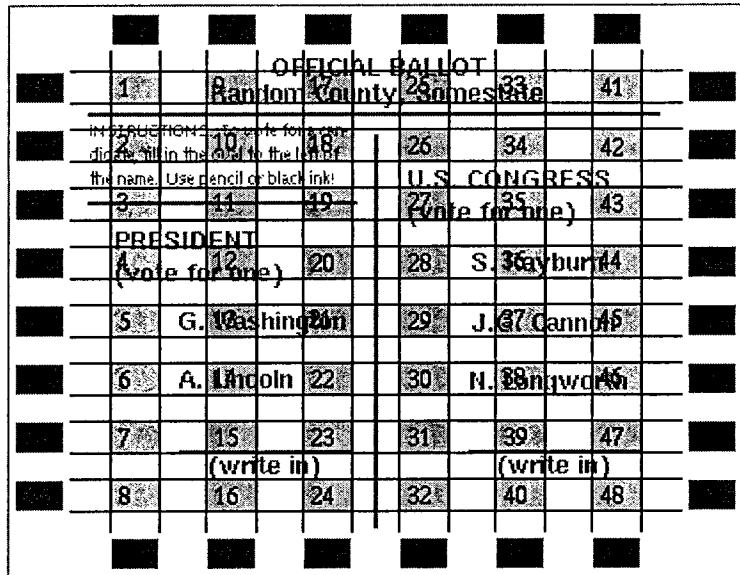

Figure 4: The actual voting targets on the example ballot.

The most common form of voting target printed on the ballot is an oval, but the actual area that the scanner sees on any particular scan of the ballot is the rectangular intersection of the area scanned by one sensor and the row defined by the index marks! Perfect mechanical alignment is impossible, so from one scan of the ballot to the next, the sensor may follow a slightly different path across the ballot. All of the possible paths of the sensors across the ballot typically required to be within the area defined by the index marks at the top and bottom of each column, so the effective voting targets are the rectangular areas at the intersection of the rows and columns defined by the index marks. These are shaded in Figure 4.

Typically, we number the potential voting targets by counting down the columns, leftmost column first, as shown in Figure 4. The scanner hardware actually detects any mark in any voting target, and it is up to the vote tabulating software to ignore marks in the targets that are not part of this election. In the example shown in the figure, only positions 5 through 7 and 28 through 31 are relevant. It is very likely that a scan of the example ballot will detect marks in positions 13 and 21, because the name "Washington" passes through these, but the software should ignore this!

It is worth noting that paper ballots change size slightly with changes in humidity! Commercial printers use the rule of thumb that a 10% increase in relative humidity causes paper to expand by about by one part in 1000; as a result, the size of a piece of bone-dry paper could expand by as much as 1% as it picks up moisture in an extremely humid environment. This comes to 1/10 inch in 10 inches, while many mark-sense voting targets are about 1/8 inch in their short dimension!

The early mark-sense scanners used for scoring tests solved the problems caused by humidity changes by storing all test papers in a controlled atmosphere for some time prior to tabulation, but on modern mark-sense vote tabulators, the design accommodates humidity changes by spacing the sensors to the midrange of variation in paper size and using voting targets that are wider than the sensors.
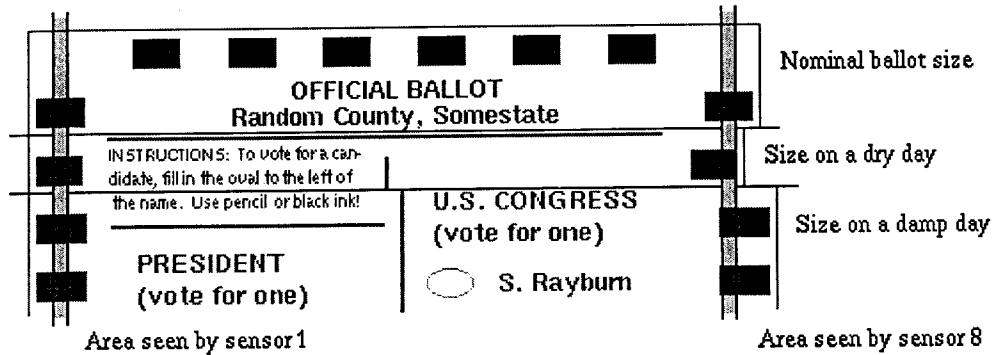

Figure 5: The effect of changing humidity, somewhat exaggerated, on the alignment of photosensors with voting targets and index marks.

If one or more of the top or bottom index marks are not seen on a pass through the scanner, the scanner typically stops with an error message indicating a misfeed. This could be due to an extreme dimensional change in a ballot, for example, because the humidity is too high for reliable scanning or because the paper has been crumpled and then flattened, or it could be because the paper passed through the scanner on a diagonal.

The fact that sensing tracks are narrower than the voting target means that a mark may be seen on one pass through the scanner and not on a later pass, perhaps because of a humidity change from one pass to the next. The fact that a ballot may be on a slight diagonal as it is scanned introduces the possibility that identical marks in two different places on the ballot might be counted differently, even when they are seen by the exact same photosensor.
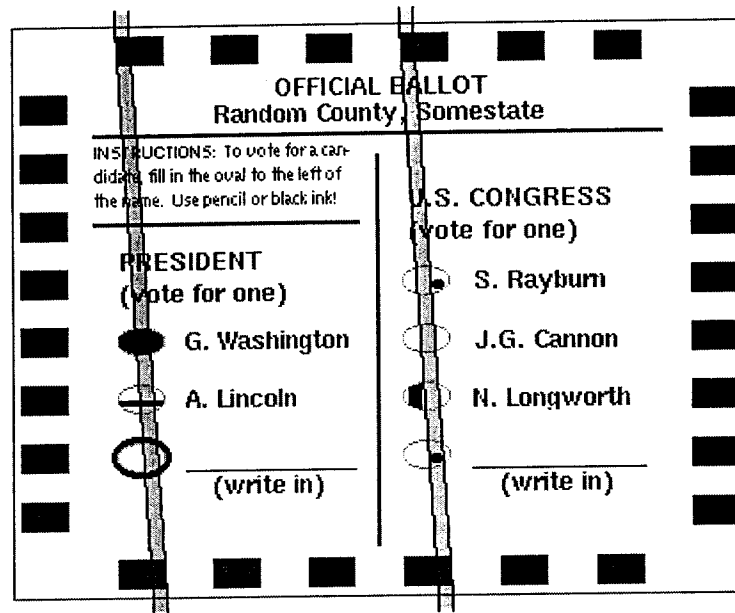
Figure 6: The areas seen by photosensors 2 and 5 on a ballot that was fed through the machine on a slight diagonal.

Several marks have been made on the ballot shown in Figure 6 to illustrate some of the marginal marks that are possible because of the geometry of the ballots and photosensors:

- A reliably detectable mark for G. Washington was made by carefully following the instructions for the prescribed mark.

- A mark for A. Lincoln. With most optical mark-sense vote tabulators, this mark will be reliably detectable because it is dark and spans all possible tracks of the detector over the ballot.

- A marginal mark by the write-in blank for President. Although this oval mark is entirely outside of the voting target printed on the ballot, parts of the oval are within the rectangular area that is actually scanned. Had the sensor passed over the center of the target on this pass, the parts of this mark it sees would all be outside the actual target area. The farther off center the scan is, the more likely this mark is to be seen!

- A marginal for N. Longworth. Although this vertical mark covers a larger percentage of the voting target than the horizontal mark for Lincoln, it will only be seen if the sensors happen to pass over the left side of the target. On the pass through the scanner illustrated in Figure 6, this mark will not be detected.

- A marginal mark for S. Rayburn. This small dot will not be seen on the pass through the scanner illustrated here.

- A marginal mark by the write-in blank for Congress. This small dot is identical to that by S. Rayburn, but on this pass, it will be detected. In fact, this mark will be seen by the sensor as a larger mark than the one for A. Lincoln!

Conclusion: The fraction of the target area filled in by the voter does not necessarily determine which marks will be counted on a particular mark-sense ballot tabulating machine; in fact, many machines will detect and count some marks that are entirely outside of the target printed on the ballot.

Conclusion: It is quite possible for a ballot to be counted in two different ways on two successive passes through the same voting machine.

The fact that such scanners can reliably detect horizontal lines in the voting target but cannot reliably detect vertical lines in the target has led to the development of an alternative style of voting target with an alternative statement of the prescribed mark: The voting target is a broken arrow and the prescribed mark is a line connecting the two halves of the arrow. This is common with the Optech line of precinct-count ballot tabulators originally made by Business Records Corporation and now available from Sequoia Voting Systems and from Election Systems and Software.
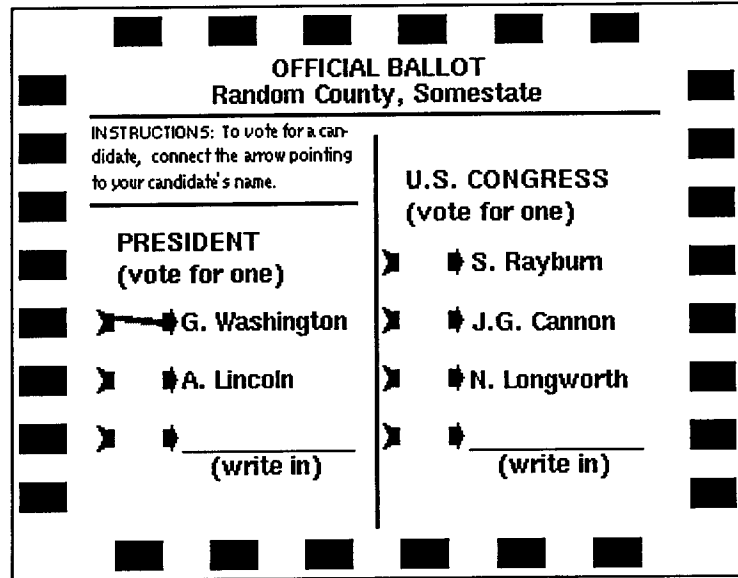
Figure 7: Alternative voting targets for optical mark-sense tabulation.

The example ballot shown in Figure 7 is entirely interchangeable with the example used in the previous figures in the sense that it could be scanned on the same ballot scanners with no change to the ballot tabulating software. The only differences between these styles of voting target lie in the area of human factors. While the oval target is familiar from other domains such as educational testing, the broken arrow was found by some early users to invite fewer marginal marks from voters. Whether this remains true today and whether it is relevant with more modern scanning mechanisms is not clear.

The Effect of Sensor Threshold

Each particular sensor in a mark sensing scanner will have a threshold. Marks that are below this threshold will not be sensed by this sensor, while marks above this threshold will be sensed. It is also theoretically possible that there will be marks that are just at this threshold, but this possibility does not produce a significant number of marginal marks.

The two primary problems leading to marginal marks that can be traced to sensor thresholds are as follows:

- In general, no two sensors will have identical thresholds! This follows from the simple fact that sensors are physical devices and the fact that, in general, no two physical objects are identical in any attribute. We can work to make our sensors as nearly similar as possible,

but the greater the similarity we demand, the higher the price.

- In general, no sensors will have a constant threshold! This follows from the simple fact that sensors are physical devices and the fact that, in general, all physical objects change with time. Dirt and scratches slowly accumulate on the photosensors, and temperature variations change the behavior of the electronics. We can try to build devices that are stable over time, but the greater the stability we demand, the higher the price.

With the first generation of discrete sensor optical mark-sense ballot scanners, it was common to have a small trimmer control for each sensor on the scanner. Prior to each election, a technician must run a special form through the scanner printed with a special test pattern while monitoring the output of the sensor electronics. This allows the technician to adjust the trimmer controls in order to set the thresholds of all of the sensors to acceptable values. It is not difficult to use this technique to set all of the sensors within a few percent of each other.
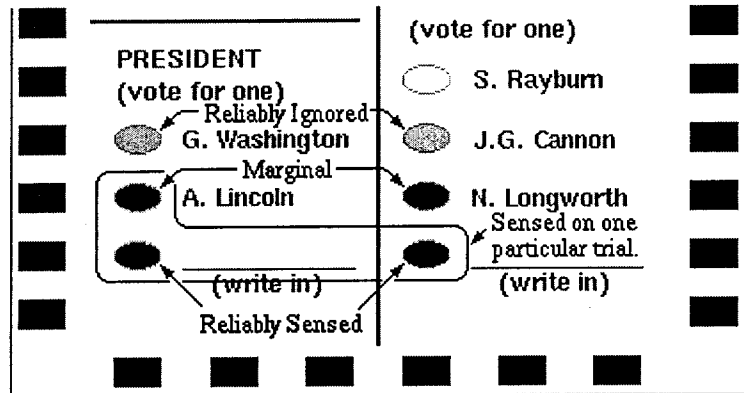

Figure 8: Marginal marks that result from different sensor thresholds.

More recently, discrete sensor systems have been designed that are self calibrating. These typically compare the darkness of black index marks with the brightness of the adjacent paper as they scan each ballot, and then set the threshold to an appropriate intermediate point between these. The newest central count mark-sense scanners from Election Systems and Software use this approach. An even better approach would be to print, on each ballot, calibration marks that are just above and just below the threshold. With widely available electronics, this approach can be used to calibrate things to within about 1 part in 250, and with modestly more expensive electronics, it can be used to calibrate the sensors to within about 1 part in 4000.

It should be noted that each sensor in a discrete sensor optical mark-sense scanner has two different thresholds, one for the darkness of the mark and one for the width of the mark. Both dark narrow marks and broader light marks may be acceptable. The relation between these two is usually not simple; rather, the darkness required is usually set at such a level that a broad smudge resulting from a poor erasure will not be seen as a mark, while the scanner will usually detect and count a single dark pencil stroke across the marking area.
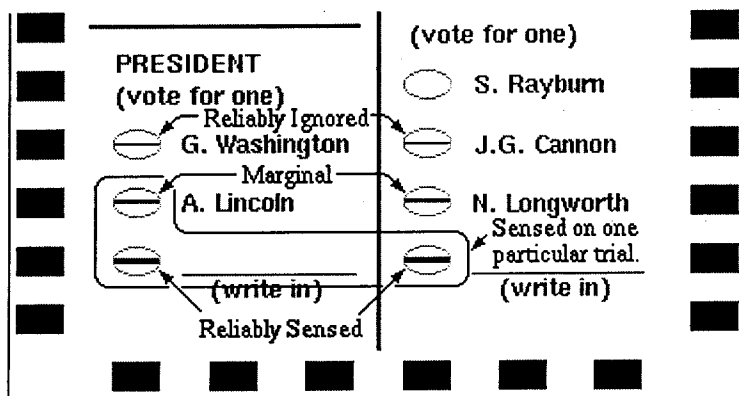

Figure 9: Marginal marks that result from different line width thresholds.

Note that all of the marks shown in Figure 9 are of identical darkness, and are as dark as the

darkest marks in Figure 8. Had these marks been of marginal darkness, only the widest would be likely to be sensed at all.

> **Conclusion:** Neither the darkness of the mark nor the width of the mark, taken alone, determine which marks will be counted on a particular mark-sense vote tabulating machine.

Discrete-sensor Visible Mark Sensing

The fundamental problem with infra-red mark sense scanners is that they sense marks using a wavelength of light that the human eye cannot see! As a result, some marks that are clearly evident to the human eye will be invisible to the photosensors in the scanner, while other marks may well be visible to the photosensors but invisible to the human eye!
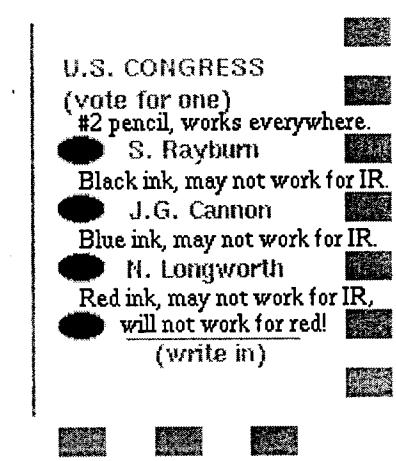
The classic instructions for mark-sense forms say "use number two soft lead pencil". This instruction is safe because pencil graphite is equally dark in the visible and infrared wavelengths. The same is true of india ink, but this cannot be said of inks based on organic dies. A black ink made from a mixture of red, blue and green organic inks may look identical to black india ink, but it may be invisible to an infra-red sensor.

If voters always voted using the marking device provided at the polling place, this would not lead to problems, but absentee voters frequently reach for any available pen or pencil, and if the point breaks off of the pencil provided in the voting booth, voters will frequently use their own pens or pencils, particularly when lines are long and the polling place officials are harried.

Figure 10: Color sensitivity of different photosensors.

The solution is obvious! We can replace the infra-red light-emitting diodes and phototransistors in the mark sensor with light-emitting diodes and photosensors that work with visible light. Reliable red light-emitting diodes and phototransistors sensitive to red light were available within a few years of the original generation of infrared sensors, and like infra-red sensors, these are generally insensitive to light red ink, allowing the scanner to easily ignore the printed red voting targets while reliably sensing marks made by the voter.

The documentation for the mark-sense readers from Chatsworth is quite open about the impact of the shift from infra-red to visible illumination; the data-sheets for all of their standard readers end with a footnote saying: "The I.R. option limits the marking instruments but allows for greater selection of background colors for printing. The Visible Red option allows for a greater range of marking instruments but limits the background printing to a 'Warm Red' color." Few vendors of voting systems have traditionally given this much detail.

Curiously, the very first generation of optical mark-sense scanners used for scoring the ACT exam in the 1950's used white light from conventional incandescent lamps. The problem with incandescent lamps is that they burn out too frequently, and as a result, only when white LEDs came on the market did some optical mark-sense scanners return to the use of white light.

Conclusion: The apparent darkness of a mark, as seen by the human eye, does not necessarily determine whether that mark will be counted on a particular mark-sense vote tabulating machine.

Fax-bar Mark Sensing

The advent of inexpensive facsimilie machines in the 1980's opened a new path to mark-sense tabulation. from Alexander Bain's first fax machine in 1843 to the present, all fax machines have incorporated page scanning mechanisms of some sort. In the new generation of inexpensive fax machines introduced in the late 20th century, the scanning mechanism is packaged as a *fax bar*, or more formally as a *contact image sensor*. The fax bar consists of a linear array of integrated circuit photosensors plus a source of illumination for the copy being scanned. The fax bars used in facsimilie machines typically have close to 200 photosensors per inch; similar sensor arrays made specifically for scanning mark-sense documents are available with resolutions closer to 16 per inch.
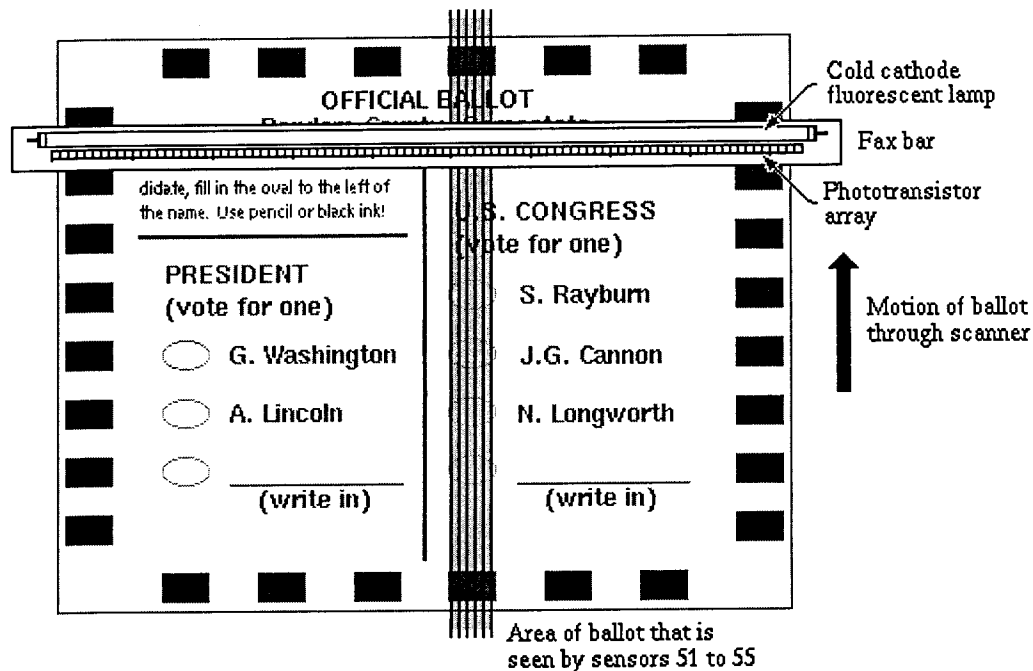
Figure 11: The mechanism of an optical mark sense scanner using a (very low resolution) fax bar photosensor assembly.

Typical modern fax bars include either a cold cathode fluorescent lamp or an array of light emitting diodes for illumination. When light emitting diodes are used, they are usually green because green is a rare ink color; black, blue and red are far more common. The cold-cathode lamps used in fax bars are very small, 1/8 inch diameter is typical, and they produce the same quality of white light associated with common household fluorescent lamps. As a result, fax bars are typically able to sense those marks that most people would judge to be intentional.

When a ballot is scanned using a fax bar or similar scanner, each sensor is checked repeatedly as the ballot is

moved past the sensors, and the result is processed by the computer attached to the scanner as a pixelized image. Figure 12 shows the result of pixelizing a small part of the ballot image for the scanner and ballot shown in Figure 11.

At a low level, the sensors used in fax bars report the brightness of each pixel in the document, but because today's facsimilie machines do not transmit the brightness of each pixel, this information is frequently simplified to a simple indication of black and white before the pixel data is given to the computer. For each column of pixels, we can therefore find the brightness threshold above which the sensor will report no mark, and below which it will report that there is a mark.

Because we are using visible light sensors, most fax bars on today's market are able to see voting targets printed in colors such as red, although some cannot sense a light shade of pink or green (depending on the color of LED used in the fax bar). In the example in Figure 12, we have assumed that the sensors are sensitive to the shade of ink used in the voting target, and as a result, blank voting targets are seen by the scanner as having around 14 dark pixels. In contrast, the marked target shown in the figure has 27 dark pixels.
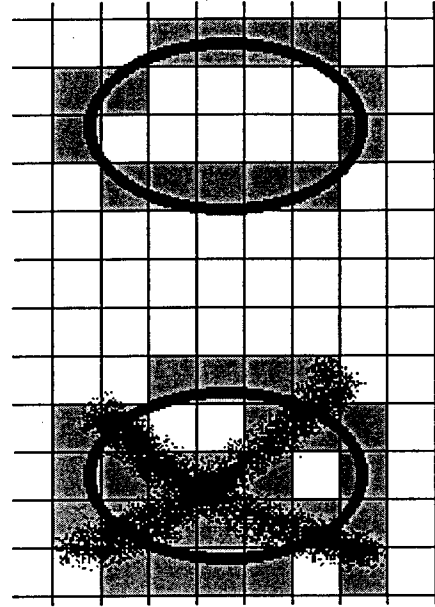
Figure 12: Partial pixelized image of a scanned ballot.

The number of pixels reported as being dark when scanning any particular mark on the ballot may vary from one scan to the next depending on how the grid of pixels happens to align with the mark. Shifting the mark half a pixel left, right, up or down may add or subtract a few pixels from the total. As a result, some scans of an unmarked voting target might show as few as 12 pixels, while others might show as many as 16 pixels.

Given that our example marked target has 27 dark pixels and our example unmarked target has only 14 dark pixels, an obvious strategy to use in with this scanning system is to declare a voting target to be voted if more than, say, 18 pixels in the vicinity of the target are found to be dark. Such a threshold strategy requires no attempt at complex image analysis! All that is needed is software in the voting system that finds the index marks, and then using that information, finds the locations on the ballot where voting targets are expected.

> **Conclusion:** The use of advanced technologies such as visible light sensing and fax bars cannot eliminate the class of marginal marks; at best, such technologies can reduce the number of marks that might be marginal.

The threshold method outlined here is probably typical of today's ballot scanners, but it is important to emphasize that voting system manufacturers generally do not reveal anything about how their scanners identify marks! Frequently, the publically available documentation on the scanners does not even reveal whether they use discrete sensors or fax bars.

The Election Systems and Software PBC 100 precinct-count optical mark-sense ballot tabulating machine is an exception. This machine is advertised as using an intelligent mark recognition

algorithm based on image processing. For classical elliptical voting targets, this algorithm uses exactly the kind of pixel-counting threshold method documented here; for Optech-style broken arrow voting targets, it takes advantage of the boldly printed half-arrows by using them as index marks to locate the precise top and bottom bounds of each voting target.

These relatively crude schemes for identifying marks on the ballot using a fax bar scanner are generally significantly better at reading the ballot than a discrete sensor scanner. They can easily distinguish between small dots in the voting area and a line crossing the target in any direction, and they are generally insensitive to the direction of the line. Because the designers of fax bars are very sensitive to the requirements of fax machines, these sensors are generally good at reading any reasonable weight of pencil stroke or any common shade of ink, and they are generally good at ignoring all but the worst erasures.
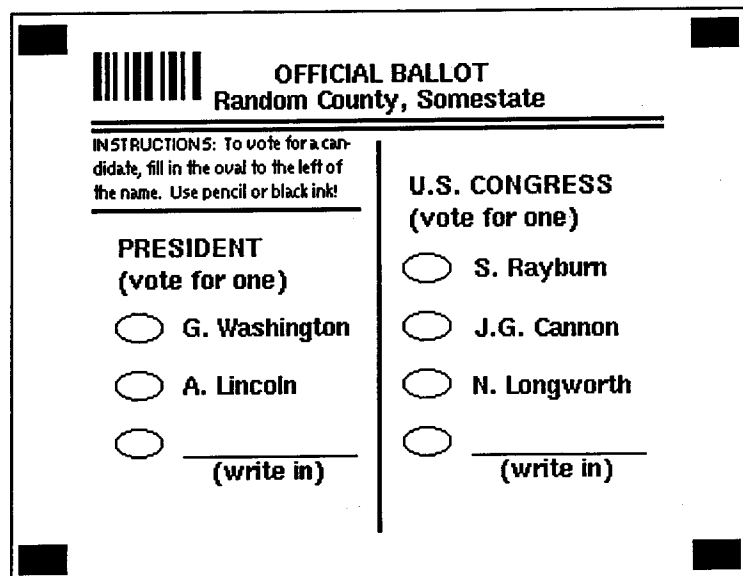
In theory, it would be possible to use advanced computer-based image processing methods to do even better. Imagine software that located the voting target and all marks near it on the ballot using image processing techniques and then classified the marks as spots, pen or pencil strokes, or other marks. Having located the apparent pen and pencil strokes, the software would then classify them as dashes, checks, Xs, etc before applying a standard derived from the applicable law in order to determine which are votes.

One problem with the use of such advanced image processing algorithms is that most voting system manufacturers do not have the necessary expertise to oversee development of such software. Furthermore, the inclusion of such complex software in a voting system significantly increases the difficulty of certifying the software for the voting application.

The different sensors in a fax bar or similar scanning system generally have different thresholds! This is an unavoidable consequence of the integrated circuit manufacturing process used to make the sensors, and unlike scanners that use discrete sensors, we can do little to calibrate the sensors in the fax bar. Instead, we rely on the fact that each voting target is seen by a large number of sensors; for example, the low resolution scanner in Figure 11 sees each target with 6 or 7 sensors, depending on how the ballot is aligned. So long as the variations in sensor threshold are random, the more sensors that see each voting target, the more likely it is that each voting target will be seen with a similar range of sensor thresholds.

It is perfectly feasible to use a fax bar or a more advanced image sensing scanner with a ballot that uses index marks such as those commonly used with discrete-sensor scanning systems, but when new ballot formats are developed for use with these modern scanning technologies, it is common to use a different approach to locating the voting targets on the ballot.

Figure 13 illustrates a ballot design appropriate for such an environment. Here, instead of marking each row and column with index marks, the ballot contains only four special marks, in the extreme corners of the ballot. Such

OFFICIAL BALLOT
Random County, Somestate

INSTRUCTIONS: To vote for a candidate, fill in the oval to the left of the name. Use pencil or black ink!

PRESIDENT
(vote for one)

◯ G. Washington

◯ A. Lincoln

◯ _____
(write in)

U.S. CONGRESS
(vote for one)

◯ S. Rayburn

◯ J.G. Cannon

◯ N. Longworth

◯ _____
(write in)

marks are called fiducial marks. The
software used to interpret the
pixelized image of the ballot first

Figure 13: Fiducial marks for use with a pixel scanner.

locates these fiducial marks and then measures from these in order to locate the voting targets. This approach can easily correct for ballots that are fed into the scanner on a diagonal and it can correct for uniform changes in ballot dimensions caused by humidity.

Another common feature found on ballots designed to be read on fax bar scanners or other scanners that pixelize the image prior to processing is a bar code to identify, for example, the precinct or ballot style. Simple codes for identifying this information have been used with older generations of ballot scanning systems, for example, by using wide and narrow index marks along the top or bottom rows of the ballot, or by reserving a column of the ballot for a code track, as is usually done on the <u>Election Systems and Software</u> Models 550 and 650 optical mark-sense ballot tabulating systems.

It is important to note that the developers of ballot tabulators that use fax bars or other image sensing technologies generally work to maintain compatibility with earlier discrete scan mark sensors. While it would be possible, in theory, to build an image sensing mark-sense tabulators that requires a very accurate reproduction of the prescribed mark, in general, this is not done. If it were done, the new tabulating system would reject votes that were accepted by the earlier tabulating system, and this would be unacceptable to most jurisdictions.

Image Scanners for Mark Sensing

Today, fax bars are in competition with an even higher performance class of scanning mechanisms, those designed for image scanning. Todays image scanning mechanisms have resolutions of 300 pixels per inch or more, and with complete scanners available at costs of under $100, it is not surprising to find these being incorporated into new ballot tabulators.

Aside from a higher resolution, the most important feature of image scanning mechanisms is that they deliver either an overall brightness report for each pixel, in the case of black and white scanners, or separate red, green and blue brightness reports for each pixel in the case of color scanners. Given brightness reports for each pixel, the software can easily compare the paper background to the index marks in order to calibrate the sensors for the extremes of black and white found on the ballot. The ballot shown in Figure 13 has no index marks, but the heavy horizontal line that separates the ballot heading from the body of the ballot can serve exactly the same purpose.

With color scanners, it is possible, in theory, to distinguish between special inks and the colors of pen or pencil that are required, but I have seen no evidence that the voting systems on the market today are doing this. As with fax bar scanners, however, the vendors do not generally disclose to the states the actual method they use to distinguish between marked and unmarked voting targets.

> **Conclusion:** The exact same ballot format may be used with a variety of different mark-sense ballot tabulating machines, where the different tabulating machines count marks in distinctly different ways, applying different criteria to determining which marks are and are not counted as votes.

Other Sources of False Positives

There are several sources of false positives that plague all optical mark-sense scanners. The most important of these are the result of ballot defects. The following types of ballot defects are relatively rare, but all of them occur occasionally.

Printing errors

All printing processes produce occasional smudges and ink splatters. Small defects the size of a pencil mark can easily escape the kind of quality control methods traditional in the printing industry, yet if these accidentally fall in a voting target, they can be read as a vote by the scanner.

Defects in the paper

Ballots are usually printed on relatively high quality paper or lightweight cardstock, but this does not guarantee that the paper will be free of defects. The most common defects found in such paper are flecks of foreign material, usually a light brown color. If such a fleck occurs in a voting target, it can be read as a vote by the scanner.

If we demanded that all ballots be scanned prior to issue to the voter and we reject any that contain votes on this preliminary scan, we would eliminate the few ballots that are accidentally pre-marked in the manufacturing process, but there are other sources of marks that make such a precaution largely irrelevant.

Accidents

Whenever people handle pieces of paper, there is the possibility that they will leave marks. Generally, ballots are handled by at least two people at the polling place, the voter and the worker who hands the ballot to the voter. In central count systems and absentee voting, even more hands typically touch each ballot. While we can ask everyone involved to work with clean hands, there is still the possibility that, for example, a pencil point will break somewhere nearby and that a ballot or stack of ballots will be set down on the broken pencil point, leaving a mark.

Hesitation marks

One particular class of accidental mark is of special importance. Many people, when holding a pencil while reading a text, use the pencil point as a pointer, resting it on the paper beside each line while reading that line. Unfortunately, wherever the voter rests the pencil point, it will generally make a faint mark, and the obvious place to rest the pencil point beside a line on the ballot is in the voting target for that line.

Most accidental marks are small spots, and most mark-sense ballot tabulating systems have thresholds set so that they ignore typical hesitation marks, but some voters make darker hesitation marks than others. Voters with mild vision problems frequently find it helpful to use a pointer when reading, and the same mild vision problem that leads a voter to use the pencil as a pointer may make that voter unable to see the marks it leaves.

Erasures

While the instructions frequently prohibit erasures, most mark-sense vote

tabulating machines are fairly good at disregarding cleanly erased marks. Some erasures, however, are dark enough that they will be read as a mark.

The instructions forbidding erasure are frequently quite blunt, sometimes to the extent that some voters may believe that erasures actually invalidate their ballots.

Do not erase or cross out. Obtain a new ballot if you make an error.

Official Ballot, General Election, Nov 7, 2000, Walton County, Florida.

Unfortunately, while it is easy to state a prohibition against erasure or correction, it is extremely difficult to enforce it. At a polling place where the lines are long and the polling place officials are harried, voters may hesitate to ask for replacement ballots and instead opt to erase, and it may be completely impossible for an absentee voter to obtain a replacement ballot.

> **Conclusion:** If erasures are forbidden by law, we must face the fact that most of the available mark-sense vote tabulating systems will disregard most competently made erasures. If, on the other hand, we allow erasure, we must face the fact that some erasures will be so darkly smudged that most mark-sense scanners will detect them as marks.

If a voter casts a vote in some race and the scanner encounters a false positive in some other voting position in the same race, it will generally convert the voter's intended mark into an overvote. Ballot scanners that can reject overvoted ballots and return them to the voter for correction can protect voters against such problems, but this is only helpful for precinct-count voting systems and offers no protection for absentee voters or those voting in jurisdictions that use central-count systems.

Even when precinct-count vote tabulating machines are used, some voters will leave the polling place without properly feeding their ballots into the machine or without noticing that the machine has not accepted their ballot. As a result, polling place workers need to have procedures to deal with ballots that have been abandoned by the voters.

When absentee ballots are sent through the postal system, there has always been the possibility that they will be damaged in transit. Because such damage is not the fault of the voter, most states have instituted carefully thought-out procedures for reconstructing the voter's intended ballot when a damaged absentee ballot is received.

> **Conclusion:** If we apply the procedures for correcting damaged absentee ballots to all of those ballots where a vote tabulating machine detects overvotes and the voter is unavailable to make corrections, we can interpret apparent overvotes due to false-positives caused by accidents, defects or erasures, thus offering these voters at least part of the protection available to voters who use precinct-count ballot tabulating systems.

Legal Considerations

There is a strong tradition in American case law that argues in favor of a very forgiving model of what marks on a ballot are to be accepted as votes.

> Ballots will not be treated as void merely because of technical or minor errors or because of irregular or unauthorized markings which appear to have been innocently made as the result of accident, awkwardness, nervousness, inattention, mistake, ignorance, or physical infirmity, if the lawful intent of the voter can be ascertained ...
>
> *Corpus Juris Secundum* Volume 29, Elections, Page 494.

> If the voter's intention can be ascertained with reasonable certainty, ordinarily the ballot should be given effect and counted in accordance with that intention, provided the voter has substantially complied with statutory requirements and no essential mandate of the law is thereby violated.
>
> *Corpus Juris Secundum* Volume 29, Elections, Page 496.

> Because the right to vote is so highly prized, these statutes must be construed liberally in favor of giving effect to the voter's choice, and every vote enjoys a presumption of validity.
>
> Devine vs. Wonderlich 268 NW2d 620, 623 (Iowa Supreme Court, 1978)

The Michigan law cited previously is quite narrow in its definition of an acceptable mark, but it includes one clause that is very permissive:

> 168.803 Counting and recounting of votes ...
>
> Sec. 803. (1) Except as otherwise provided in this act, the following rules shall govern the counting and recounting of votes:
>
> (a) If it is clearly evident from an examination of any ballot that the ballot has been mutilated for the purpose of distinguishing it or that there has been placed on the ballot some mark, printing, or writing for the purpose of distinguishing it, then that ballot is void and shall not be counted. ...
>
> (g) Erasures and corrections on a ballot made by the elector in a manner frequently used for this purpose shall not be considered distinguishing marks or mutilations.
>
> Michigan Election Law, Chapter 168, Section 803, Act 116 of 1954, as amended through 1997.

Clause g gives the voter the right to correct a mismarking in any manner that is "frequently used for this purpose." Frequently used correction methods include erasure, crossing out, scribbling over and a variety of other markings that have obvious meaning to a human reader but may be very difficult for a machine to evaluate.

Manufacturers of optical mark-sense ballot tabulating systems have consistently responded to this tradition of lenience by designing successive generations of mark-sense scanners that accept wider and wider varieties of non-prescribed markings while still successfully ignoring hesitation marks, erasures and small defects in the ballot itself. Thus, while early discrete scan ballot tabulators counted some circled voting targets by accident, more recent pixel-based tabulating systems

intentionally scan an even larger area around the voting target in order to deliberately detect and count such nonstandard marks.

Despite these efforts, today's mark sense vote tabulating systems do not and cannot be expected to count some of the apparently bizarre marks seen on real ballots and widely reported during the contested 2000 presidential election in Florida. When poorly designed ballots or poorly written instructions lead voters to misinterpret the prescribed mark in wild ways, for example, connecting the point of the arrow to the candidates name instead of connecting the two halves of the arrow, or coloring in the space between two index marks, the machine cannot be expected to fully automate the lenient vote counting rules that judicial precedents demand.

The battle over the contested presidential election in Florida has added a significant new dimension to the question of what ballot markings should be accepted as votes:

> Florida's basic command for the count of legally cast votes is to consider the "intent of the voter." ... This is unobjectionable as an abstract proposition and a starting principle. The problem inheres in the absence of specific standards to ensure its equal application. The formulation of uniform rules to determine intent based on these recurring circumstances is practicable and, we conclude, necessary.
>
> Bush vs. Gore, 531 U.S. 00-949 (United States Supreme Court, Dec. 12, 2000) [PDF]
> Also available from Findlaw [HTML]

Prior law had effectively demanded a lenient and therefore potentially subjective interpretation of markings on ballots in those cases where automatic machinery was unable to interpret the vote or where the count made by such machinery was being challenged. It was quite evident in the Florida recounts of 2000 that this standard allowed considerable latitude, so markings accepted as votes by one recount board were being rejected by another recount board. The supreme court found this lack of uniformity to be an unconstitutional violation of the equal protection clause of the constitution.

> **Conclusion:** If it is unconstitutional for one human recount board to count as a valid vote a mark that would not be accepted by another recount board, the very same considerations bring the machine model into question because of the possibility of marginal marks being interpreted differently by different machines or even by the same machine on a different trial.

The Florida legislature responded to Bush vs. Gore and more generally to the controversy surrounding the contested general election of 2000 by enacting sweeping changes to their election law, including a provision calling for a mandatory manual recount of close elections:

> 102.166 Manual recounts.--
>
> (1) If the second set of unofficial returns ... indicates that a candidate for any office was defeated or eliminated by one-quarter of a percent or less of the votes cast for such office ... the board responsible for certifying the results of the vote on such race or measure shall order a manual recount of the overvotes and undervotes cast in the entire geographic jurisdiction of such office or ballot measure.

(2)(a) If the second set of unofficial returns ... indicates that a candidate for any office was defeated or eliminated by between one-quarter and one-half of a percent of the votes cast for such office ... [the] candidate, [or] the political party of such candidate ... is entitled to a manual recount of the overvotes and undervotes cast in the entire geographic jurisdiction of such office or ballot measure, ...

(3)(a) Any hardware or software used to identify and sort overvotes and undervotes for a given race or ballot measure must be certified by the Department of State as part of the voting system ...

Florida Election Law, Title IX, Chapter 102, Section 166, 2001

This law assumes several things:

- That the total number misinterpreted marks should normally be under one-quarter of one percent of the total number of votes cast for an office.

- That the total number misinterpreted marks will never exceed one-half of one percent of the total.

- That the only ballots requiring manual recounting in order to resolve misinterpreted marks will be those containing either overvotes or undervotes.

It is curious that the number of overvotes and undervotes itself does not trigger a manual recount! For example, if the working hypothesis is that misinterpreted marks will generally be detected as overvotes or undervotes, then why not have a mandatory recount when the sum of overvotes plus undervotes in an election exceeds the margin of victory for the apparent winner in the election?

Is it sensible to assume that misinterpreted marks will show up as overvotes or undervotes? We can identify the following mutually exclusive possibilities for false positives and false negatives in a normal vote-for-one election:

- A false positive occurs in a race where the voter intended to abstain. This converts the voter's vote from an undervote in that race to a vote for some candidate, and this ballot will not be hand examined under Florida's recount statute.

- A false positive occurs in a race where the voter cast a vote for some other candidate. This converts the vote to an overvote, and it will be resolved by hand examination under Florida's rules.

- A false negative occurs in a race where the voter intended to cast a single vote. In this case, the outcome will be an undervote, and it will be resolved by hand examination under Florida's rules.

- A false negative occurs in a race where the voter intended an overvote. This error will lead to one of the voter's votes being counted.

If we assume that very few voters intentionally abstain, and that few voters intend to cast overvotes, then the Florida rules will result in human inspection of the vast majority of

misinterpreted marks. These assumptions generally hold for top-of-the-ticket races for offices such as the presidency or the governorship.

The problem with Florida's law arises in bottom-of-the-ticket races for minor local offices. It is common for the majority of the voters to abstain from such races, and when this occurs, the majority of the false positives will be counted as legitimate votes and will never be inspected in a hand recount.

> **Conclusion:** If hand examination of ballots is limited to those ballots that are classified as overvotes and undervotes, the recount will correct the vast majority of misinterpreted marks in top-of-the-ticket vote-for-one races.
>
> **Conclusion:** If hand examination of ballots is limited to those ballots that are classified as overvotes and undervotes, the recount will not properly account for false positives in bottom-of-the-ticket races.

The fact that the majority of voters commonly cast undervotes in bottom-of-the-ticket elections provides the answer to the question posed above about having an automatic recount when the sum of overvotes plus undervotes exceeds the margin of victory. Such a standard would be very expensive because it would force recounts in almost all minor races. We can, however, demand an automatic hand recount if the number of overvotes taken alone exceeds the victory margin of the apparent winner. Given that modern precinct-count voting systems can automatically return overvoted votes to the voter, we can do even better!

> **Conclusion:** We can reasonably ask that all ballots on which the vote tabulating machinery detects an overvote be subject to human inspection. Ideally, the voter should do this, taking advantage of precinct-count election systems, but if this is not possible, for example, with absentee ballots or with central-count systems, we can require hand interpretation of such ballots.

Florida's revised election law lays down the following framework for establishing state administrative rules to define what is and is not an acceptable marking on the ballot:

102.166 Manual recounts.--

(5)(a) A vote for a candidate or ballot measure shall be counted if there is a clear indication on the ballot that the voter has made a definite choice.

(b) The Department of State shall adopt specific rules for each certified voting system prescribing what constitutes a "clear indication on the ballot that the voter has made a definite choice." The rules may not:

1. Exclusively provide that the voter must properly mark or designate his or her choice on the ballot; or

2. Contain a catch-all provision that fails to identify specific standards, such as "any other mark or indication clearly indicating that the voter has made a definite choice."

Florida Election Law, Title IX, Chapter 102, Section 166, 2001

In effect, these rules require the production of a catalog of acceptable ballot markings as part of the administrative rules for each approved voting systems. This approach to meeting the mandate of the Supreme Court has merit, but in light of the conclusions we have already drawn, it raises some thorny issues:

- How do we anticipate the likely non-prescribed markings?

- How do we deal justly with a non-prescribed markings that was not anticipated by the administrative rules and yet has an obvious meaning?

- How do we ensure that the rules for one approved voting system are comparable to those for another approved voting system?

The newspaper sponsored examinations of Florida's ballots after the disputed 2000 general election revealed several consistent patterns of mismarkings that were immediately proposed for incorporation into Florida's administrative rules; the result of this approach is a set of rules that deals effectively with the errors voters have made in the past. Unfortunately, some of these errors were the result of specific misinterpretations of voting instructions that were invited by poor ballot design or badly worded instructions, for example:

1S-2.027 Clear Indication of Voter's Choice on a Ballot

(2) The following are guidelines for determining on an optical scan voting system whether or not there is a clear indication on the ballot that the voter has made a definite choice: ...

(e) If a voter circles or underlines the name of a party next to a candidate's name, the vote shall count for that candidate.

Florida Department of State proposed administrative rule 1S-2.027 (May 18, 2001).

This rule covers a specific response by voters to the fact that, in many Florida counties, three letter party abbreviations were placed in a column to the right of the candidate names, while voting targets were placed in a column to the left, with the size and shape of the three letter abbreviation very similar to that of the voting target. Furthermore, the instructions on the ballot included only a filled target, not an empty one, and the example filled target was to the right of the text explaining it.

OFFICIAL BALLOT
GENERAL ELECTION
ST. LUCIE COUNTY, FLORIDA
NOVEMBER 7, 2000

Completely fill in the oval next to the name of each candidate you wish to vote for as shown: ⬤ . To cast a vote for a Write-in candidate, write the name of the person on the line provided and completely fill in the oval: ⬤

ELECTORS FOR PRESIDENT AND VICE PRESIDENT	STATE	COUNTY
President and Vice President (Vote for One Group)	**Treasurer** (Vote for One)	**Tax Collector** (Vote for One)
◯ GEORGE W. BUSH / DICK CHENEY — REP	◯ TOM GALLAGHER — REP / ◯ JOHN COSGROVE — DEM	◯ JACQUELINE "JACKIE" BUTTS — REP / ◯ BOB DAVIS — DEM
◯ AL GORE / JOE LIEBERMAN — DEM	**Commissioner of Education** (Vote for One)	**County Commission District #1** (Vote for One)
◯ HARRY BROWNE / ART OLIVIER — LIB		
◯ RALPH NADER / WINONA LaDUKE — GRE	◯ CHARLIE CRIST — REP	◯ JOHN D. BRUHN — REP

Figure 14: A badly designed ballot inviting a specific error.

This design flaw was present only in the ballots used by some of the counties that used the Accu-Vote line of precinct-count optical mark-sense ballot tabulators made by Global Election Systems, among them the ballots used in Citrus (.03%), Leon (.01%) and St. Lucie (.3%) counties. Not all Global customers made this mistake! Others used various strategies to discourage this voter error, including Calhoun (0%), Hernando (.009%), Monroe (0%), Polk (.002%) and Walton (.01%) counties. The percentages listed after the county names give the fraction of voters who made this mistake, computed from the Miami Herald, Knight Ridder, USA Today data on voter errors; I have not seen sample ballots for the other Florida counties using the Accuvote system.

There is no way to anticipate, in advance, all non-prescribed markings that voters will make on ballots, and if some of these markings are specific responses to flaws in the ballot design or instructions, we cannot anticipate the markings without also anticipating the mistakes we will make in ballot design. Florida's revised election law, by prohibiting a catch-all provision, makes it very difficult to deal justly with such problems!

Michigan election law suggests an excellent solution to the problem of avoiding the catch-all provision that Florida Law and the Supreme Court decision have forbidden while not requiring anticipating every voter error. At the end of a section that otherwise leans toward a rather strict version of the machine model, we find this:

> 168.803 Counting and recounting of votes; rules; intent of voter.
>
> (2) If an electronic voting system requires that the elector place a mark in a predefined area on the ballot in order to cast a vote, the vote shall not be considered valid unless there is a mark within the predefined area and it is clearly evident that the intent of the voter was to cast a vote. In determining intent of the voter, the board of canvassers or election official shall compare the mark with other marks appearing on the ballot.
>
> Michigan Election Law, Chapter 168, Section 803, Act 116 of 1954, as amended through 1997.

In contrasting this with Florida's law, we see that Michigan does not provide for nonstandard markings outside the voting target, while Florida does. On the other hand, so long as the mark is

within the voting target, Michigan avoids an enumeration of marks and instead takes advantage of an important feature of a general election ballot -- the fact that the ballot generally contains multiple races, and therefore, that it will generally contain several attempts by the voter to cast votes.

> **Conclusion:** We can distinguish between a deliberate but nonstandard mark and an accident by looking at how the voter marked other voting targets on the same ballot. If a similar mismarking is repeated in other races in a manner otherwise consistent with the requirement for voting, whether or not the mark is in the voting target, it is extremely likely that the mark is an expression of voter intent.

Florida's law calls for "specific rules for each certified voting system," raising the question of how we ensure that the specific rules for one voting system are comparable to the rules for another. The proposed administrative rules that respond to this clause address all optical mark-sense voting systems as if they were the same. This is probably the correct response to a flawed law, despite the fact that different voting systems may have distinctly different responses to identical markings within similar voting targets on similarly constructed ballots.

> **Conclusion:** Voters do not respond to technical details of how mark-sense scanners operate, they only respond to the instructions they are given and to the layout of the ballot. Therefore, the rules governing the interpretation of voter markings should depend only on these factors and not on the details of the scanning mechanism.

A far greater problem with uniformity arises in the area of ballot layout and voter instructions. Florida's election law requires the following:

101.151 Specifications for ballots.--

(8)(a) The Department of State shall adopt rules prescribing a uniform primary and general election ballot for each certified voting system. The rules shall incorporate the requirements set forth in this section and shall prescribe additional matters and forms that include, without limitation:

1. Clear and unambiguous ballot instructions and directions;

2. Individual race layout; and

3. Overall ballot layout.

(b) The department rules shall graphically depict a sample uniform primary and general election ballot form for each certified voting system.

Florida Election Law, Title IX, Chapter 101, Section 151, 2001

As we have seen, there was a specific design flaw in the 2000 general election ballots in several

counties using the Accu-Vote line of tabulating systems. This flaw clearly traces to a "sample ... general election ballot form" that was distributed to the counties that use the Global Accu-Vote scanners. Some counties followed this sample form without modification, while others made one or another change to this form in order to reduce the likelihood of error. This ballot design error was not apparent on the two other optical mark-sense tabulating systems used in the state, and therefore, the class of voter error this design error elicited was not a problem in counties using the other systems. Sadly, in many cases, those counties made other errors.

> **Conclusion:** If it is unconstitutional for one ballot marking to be counted differently in two different jurisdictions, we must also ask if it is constitutional to use substantially different ballots and substantially different voting instructions in different jurisdictions, particularly when the differences are entirely avoidable and not necessary consequences of different voting systems.

Human Factors

Knowing that all systems for scanning physical ballots are able to misinterpret the voter's intent, we design ballots and voting instructions that reduce the likelihood that voters will make reliably detectable marks for those candidates they wish to vote for and will assure that all other marks on their ballot are reliably ignored. One of the central problems we face today is that we have no institutions in place for determining how well we are succeeding at this!

We need to know what fraction of the voters have difficulty following the voting instructions, and how they misinterpret the instructions. We need to know the frequency of false positive and false negative marks on ballots cast by real voters, and we need to classify these marks by their causes. Aside from false positives caused by ballot defects, all of these are human factors issues! That is, they turn not on the details of the technology, but on how people react to the technology.

Recounts provide us with some help here, and the data from the 2000 general election in Florida is exceptionally useful in this regard, but that is just one sample point.

> **Conclusion:** We need to routinely monitor the performance of our election systems, gathering statistics from every election in every county on the number of over and undervotes so that we can constantly monitor the quality of our ballot designs and voting instructions. At the very least, these numbers should be brought forward in the official canvass of every election.
>
> **Conclusion:** We need to routinely conduct hand recounts of some small but significant number of ballots in order to monitor the extent to which our ballot tabulating machines are successfully counting the marks voters are actually making on the ballots. An appropriate approach might be to require a hand count of all votes in one randomly selected race in one randomly selected precinct after every election.

Ideally, the over and undervote numbers, along with any discrepancies found in these manual recounts, should be brought forward to a state or national agency that searches for correlations between the voting system used and the problem rate observed. The results of these studies would be of incomparable value to all of those who administer voting systems.

Recommendation

It is important to remember that optical-scan mark-sense ballot tabulating systems remain one of the best approaches to vote counting that we have. Unlike direct-recording electronic voting systems, scanners rely on the original paper records of voter intent as recorded by the voters themselves, and as a result, a purely software based attack on the integrity of the voting system is impossible. The voter's intent is recorded in a form that most people are comfortable interpreting, with no recourse to obscure technologies that involve chad or even more obscure technologies.

Therefore, we must find ways to improve the conduct of elections that use mark-sense tabulating systems. The improvements we need fall into two distinct categories. First, we need to improve our control over the voting systems themselves, and second, we need to improve the laws governing the use of those systems.

Voting Machine Standards

As has been mentioned, the current generation of mark-sense voting systems are being sold to states, counties and municipalities with no documentation of the standards the machine uses to determine what is a mark. We must require full disclosure of the following:

- What kind of light is the system using for mark sensing? Ideally, the vendors should be required to state far more than the wavelength of peak sensitivity or worse yet, a simple statement that the system uses some unspecified visible or infrared light. I would prefer it if the vendors gave the spectral response of the system as a graph that was clearly labeled with the visible color spectrum for comparison purposes, as illustrated in Figure 15. The spectrum in the figure is typical of the spectra expected from scanners that use fluorescent light sources. Note that this is not simply a graph of the output spectrum of the light source in the scanner, nor is it simply a graph of the spectral sensitivity of the photosensors, but rather, it is a graph of the product of these two!
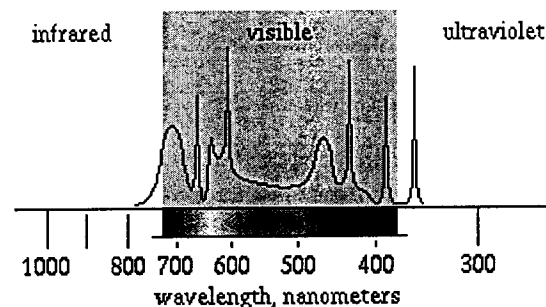
Figure 15: Appropriate documentation of the spectral response of a mark-sense scanner.

- What criteria does the ballot tabulator use to distinguish between acceptable marks and unacceptable marks? This involves answers to a number of subsidiary questions such as: Is the entire voting target inspected on each scan, or just a portion, as in a typical scanner based on discrete sensors? Is the area scanned larger than the target printed on the ballot? Is the mark recognition system more sensitive to marks in one region of the voting target or in one

orientation than in another region or orientation?

- What kinds of marks are reliably detectable by this ballot tabulator, what kinds of marks are reliably ignored, and what kinds of marks are marginal. Ideally, the documentation for the scanner should include samples of each class of mark. These serve to illustrate, by example, the criteria the system uses, and they also serve to illustrate how close to marginal the prescribed mark is and how reliably the system is in ignoring marks such as erasures and hesitation marks.

Conduct of Elections

The fact that mark-sense ballot tabulating equipment occasionally miscounts votes can be dealt with in several ways. In Florida, for example, when there is a recount, all overvoted and undervoted ballots are subject to hand examination. Michigan's law is closer to the machine model, but it too allows a hand recount and it too allows the examiners during a recount to interpret as votes at least some marks that the machine may have ignored.

In order to ensure an accurate count, we need to regularly audit our voting systems, we need to ensure that marginal marks are judged by humans. In order to accomplish these goals, we must require the following:

- Whenever practical, we must return overvoted and blank ballots to the voter for correction. This will allow the voter to correct overvotes, both those that were caused by false positives and those resulting from ineffective attempts to correct errors. This is easily done with precinct-count voting systems, but it is not possible with mail-in absentee ballots.

- When it is impractical to return an overvoted or blank ballot to the voter for correction, or when a voter refuses the opportunity to change a ballot that was returned by a precinct count scanner, this ballot should be subject to hand examination. This requires that central-count equipment sort out all overvoted and blank ballots, and this requires that such ballots found at polling places be set aside for inspection. The methods of ballot enhancement or duplication used for absentee ballots that have been damaged in the mail should apply to all such ballots.

Assuming that we have appropriately uniform rules for hand-interpretation of marks on ballots, and that these rules give the voter broad latitude for expressing his or her choice on the ballot, the above rules give central-count voters almost as much protection as they give voters who use precinct-count systems.

- To ensure that there are always a number of election workers who have had experience hand counting ballots, and to ensure that the counts reported by our ballot tabulating equipment are accurate reflections of the legal standards for what constitutes a vote, we should require routine hand counting of a small fraction of the ballots in every election. For example, we could require a hand recount of one randomly selected race in one randomly selected precinct after every election, with all discrepancies reported to the state. If the state finds that some voting system has a uniformly higher discrepancy rate than others, it

should trigger reexamination and possible discontinuation of the use of that system!

- To ensure that all ballots are accounted for, and in order to monitor the frequency of voter difficulty, we should require that the number of spoiled ballots be carried forward through the canvassing process in every election. Ideally, the total number of votes for each candidate in a race, plus the number of overvotes and undervotes in that race, plus the number of spoiled ballots, plus the number of challenged ballots, plus the number of unreturned absentee ballots ought to equal the number of ballots given to voters. This is a strong protection against many forms of election fraud. In addition, the number of spoiled ballots is a measure of the frequency with which voters had difficulty and therefore a measure of the likelihood that other voters may have had problems that went undetected.

When to Recount

Recounts are expensive, and therefore, no election administrator wants to encourage them. In order to reduce the frequency of recounts, some states require those requesting a recount to post bond, and many states forbid a recount unless the election is sufficiently close. The problem is, we must permit and in fact encourage recounts if it is even remotely possible that the miscounted votes in a race could change the outcome.

- It is appropriate to allow recount requests when the election is close, for example, if the margin of victory of the apparent winner is smaller than some set percentage. Given that it is common for recounts to come within 1 vote in 5000 of the first count in the absence of any accounting or procedural errors, allowing recounts when there is a margin of under 1 percent seems generous.

- There are some benefits that go to participants in an election even if they lose. For example, if a party gains 5 percent of the vote for any statewide office, some states grant that party special status -- automatic placement on the ballot in the next election, for example. Therefore, we need to allow recounts if a candidate comes within range of such a threshold. For example, we could allow a recount if a candidate comes within 1 percent of the number of votes required to achieve any statutory benefit from the election.

- We need some way to allow recounts if there is evidence that there were problems with the election! As many as 10% of the voters in some Florida counties made errors on their ballots in the 2000 general election. The count of spoiled ballots plus ballots that required enhancement or duplication provides a measure of the frequency with which voters had difficulty. If this number is high, there is a high likelihood that other voter difficulties went undetected. Therefore, if this number exceeds some threshold, no matter how close the election was, we should allow a recount. For example, we may allow a recount when the number of spoiled ballots plus ballots that required enhancement or duplication exceeds 1% of the total.

How to Recount

One purpose of a recount is to assure that an eccentric count of marginal votes is not a significant component of the outcome of the election. To ensure this, we must demand the following:

- The vote tabulating machines used in a recount should be tested and recalibrated prior to the recount in order to ensure that their sensing thresholds are correct. In addition, if possible, the tabulating machines used for the recount should not be the same machines used in the original count; this ensures that the ballots will be seen by different scanners and it maximizes the likelihood that marginal marks will be interpreted differently on the recount.

- Given that overvotes have been dealt with prior to the first count, therefore correcting most false positives, it is appropriate to hand inspect all ballots that show an undervote in the race being recounted in order to catch and correct most false negatives.

- If the number of spoiled ballots plus the number of ballots requiring enhancement or duplication exceeds the margin of victory of the apparent winner, it is highly likely that other ballots contain errors that did not lead to over or undervotes; in this case, it seems appropriate and perhaps necessary to allow a hand recount of all ballots cast in the race.

Hand Counting Rules

Whenever a ballot is examined by hand, whether to deal with a blank or overvoted ballot that the voter has not corrected during the first count, during a routine hand recount conducted for auditing purposes, or during a recount conducted at the request of a party to the election, the same criteria should apply to interpreting voter marks.

- The class of acceptable marks must include all reliably acceptable marks that are not the result of errors in ballot printing, erasures or other obvious corrections, or stray marks.

- The class of acceptable marks must include those marginal and reliably ignored marks that appear to be deliberately made as indications of voter intent. A mark should be accepted as an indication of voter intent when similar marks have been used in multiple contests on the ballot and where most such marks conform to the other rules of the election, for example, voting for no more than one in most vote-for-one races.

- Attempts at erasures, striking out an otherwise acceptable mark, and written notations indicating errors should be accepted at face value, despite rules forbidding erasure or correction.

- Defects in the ballot and stray marks that do not meet the criteria for acceptable marks should be ignored.

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election of 2000.

Dear Chairman Hugo and Fellow Committee Members,

As a registrar and committee member, I wanted to share some of my thoughts regarding VVPTs since our meeting time is so limited.

I have listened to the "computer experts" talk about the insufficiencies and vulnerabilities of DREs and the advantages of VVPTs. Some members keep referring to the "experts" and their opinions which they feel should be heeded. With no disrespect intended, I'm sure that they are experts in their field, but from what I've heard, they have very little knowledge of election administration. What about the "elections experts"? Our Election Laws, along with the policy and procedures developed by the State Board of Elections, have enabled election officials to conduct pure elections in Virginia regardless of the voting equipment in use. Virginia has long been a leader in establishing procedures for the conduct of elections. As a registrar in this great state, I like being a leader rather than a follower, especially to states that have not proven the merits of their VVPT systems.

As my favorite surgeon used to say, "If it ain't broke, don't fix it"! Until someone has evidence of fraud or irregularities in Virginia's elections, I think we would be wise to leave our technology alone. The only people I've heard talk about possible problems with the DREs are the "computer experts" and the people who have listened to their rhetoric. In an e-mail received before our last meeting, a survey showing the lack of DRE and VVPT complaints in Virginia was compared to the lack of complaints received by oil companies about the cost of gasoline. Unlike gas stations, polling places in Virginia have voter complaint forms. Voters unhappy with any aspect of the electoral process can complete the form and mail it directly to SBE. From my experience, voters with complaints will immediately tell the pollworkers or call the registrar if they're unhappy about ANYTHING! We're much more accessible and less intimidating than the major oil companies. If gas stations had complaint forms available to their customers, I'm sure the major oil companies would have had an earful. I feel the survey conducted by Charlottesville reflects the assurance voters have in our voting systems and election officials.

Voter confidence has been mentioned as a reason to require VVPTs. It would seem to me that voter confidence would be greatly diminished if election officials were required to attach another machine to their present voting equipment to verify its accuracy. Why would this be necessary when, in fact, no inaccuracies have been detected and voter confidence seems to be high? Of course, if required to go this route, someone would then say the newly attached equipment could be illegally programmed and the vicious cycle would continue. Like the gentleman from Manassas, I don't believe vendors selling election equipment would jeopardize their companies by fraudulently programming the voting machines, but why not prove this and promote voter confidence at the same time. The committee could suggest legislation be enacted to require additional safeguards and random audits of our equipment (hardware and software) before and/or after each election to prove their accuracy. I know the State Board of Elections would be more than happy to work with the committee on this endeavor. Election officials are committed to promoting the integrity of elections and would have no problem with such audits and safeguards.

From what I understand about the wireless voting systems, the expert's assertion of vulnerability is greatly overstated. The machines only communicate wirelessly at three different times: once when programmed, once when the polls are opened, and once when the polls are closed. They communicate for approximately one minute each time. In order for outside sources to attack the machines at these times, they would have to know the exact moment the machines were communicating. In addition, they would have to know the unique password which is generated for each election and each precinct when the ballots are programmed, making their vulnerability almost zero.

I would like to provide some facts to the members who have contemplated the suggestion of replacing all DREs with optical scan devices. Initially the cost of the equipment would be

cheaper, but in the long run, the continual purchase of ballots and their delivery costs would certainly equal the cost of the DRE equipment. The scanner has to be programmed before each election and, therefore, would be open to the same "programming fraud" as the DREs. The optical scanners have other vulnerabilities such as not being able to read ballots with improperly placed timing marks or blurred ink making it necessary to count those ballots by hand. They are not accessible to people with disabilities and the possibility exists of ballots being lost or defaced during transport. By law, all paper ballots must be stored and secured in the Clerk of the Court's office for two years after each election. The storage requirement alone would make exclusive use of optical scanners next to impossible for some offices. Obviously optical scanners are great for some localities, but, they are not failsafe. As with any system, making them work properly requires excellent administration.

I hesitate to make further comments on the list of items submitted by the Virginia Verified Voting group; however, before submitting such a report for our review and action, I think they would have at least known the facts regarding pollbooks and the criteria for voting a Provisional Ballot. I feel electronic pollbooks would greatly enhance our voting process. They would certainly be more accurate and up to date than the current hard copies which are printed about a month before each election. An expenditure of taxpayer dollars for electronic pollbooks would be money better spent than requiring the purchase of additional equipment for VVPTs.

Let's face it; there is nothing on the market for recording and tabulating votes that can't be manipulated. It is a well known fact that there are more chances for fraud with paper ballots than with any type of voting machine. Hand counting is by far the most unreliable method of tabulating ballots. You simply have to look at Florida in 2000 to realize that.

Before you recommend legislation that requires VVPTs in Virginia, please take into consideration what the costs and consequences may be. Don't just rely on the scare tactics of the "computer experts" and throw the baby out with the bath water. Consider the procedures already in place that preserve the integrity of our elections. Our election administrators and officials will continue to develop new policies and revise old ones in order to prevent election fraud and safeguard that integrity. The committee should have confidence in these officials and let them do their jobs so Virginia can continue to lead.

Thanks for taking the time to read this. Have a safe and wonderful Holiday. I look forward to seeing you all in January.

Joyce S. Braithwaite
Committee Member

Steve Damerell
<stevedamerell@gmail.com>
12/28/2005 03:39 PM

To mspain@leg.state.va.us

cc "James W. Lark, III" <jwl3s@virginia.edu>, Leonard Harris <liberty@leonard-harris.com>, Alex Blakemore <alexblakemore@comcast.net>

bcc

Subject Libertarian Party of Virginia endorsement of Verified Voting

History: 🗪 This message has been forwarded.

Dear Ms. Spain,

I received your E-mail address from Alex Blakemore of Virginia Verified Voting, who requested that I inform you of the Libertarian Party of Virginia's recent decision to endorse verified voting. The State Central Committee of the LPVA passed the following resolution without objection:

"Computerized voting equipment is inherently subject to programming error, equipment malfunction, and malicious tampering. It is therefore crucial that voting equipment provide a voter-verifiable audit trail, by which we mean a permanent record of each vote that can be checked for accuracy by the voter before the vote is submitted, and is difficult or impossible to alter after it has been checked. Many of the electronic voting machines being purchased do not satisfy this requirement. Voting machines should not be purchased or used unless they provide a voter-verifiable audit trail; when such machines are already in use, they should be replaced or modified to provide a voter-verifiable audit trail. Providing a voter-verifiable audit trail should be one of the essential requirements for certification of new voting systems."

Thank you for your work on this important issue, and for your consideration of the LPVA's viewpoint. Please do not hesitate to contact me if you have any questions, comments or concerns.

Thank you,

Steve Damerell
Chairman, Libertarian Party of Virginia
Chair@LPVA.com
(703) 851-4674

VIRGINIA ELECTORAL BOARD ASSOCIATION

January 3, 2006

Honorable Timothy D. Hugo,
Chairman Joint Subcommittee to Study Certification, Performance, and
Deployment of Voting Equipment
Members of the Committee
Attn: Mary R. Spain, Senior Attorney

Mr. Chairman and Members of the Committee:

I write you on behalf of the Virginia Electoral Board Association. Our membership consists of the three-member Electoral Boards of the 134 localities in the Commonwealth. We run elections on equipment certified by the State Board of Elections. The DREs in use in the Commonwealth are fully capable of generating from stored memory a paper ballot for each vote cast should paper ballots be required for a recount. Of all the paper ballots available for the December 20, 2005 recount for Attorney General only nine precincts in Gloucester County and one precinct in Lynchburg were ordered to manually recount. The remainder of the recount of nearly 2 million votes from 2,355 precincts consisted of checking the vote total printout tapes from each precinct.

The summary screen on the DRE gives the voter the opportunity to review their choices before touching the VOTE button casting their ballot. What would giving the voter an opportunity to verify on paper their cast ballot accomplish? We do not see a voter verified paper ballot helping with the accuracy of the election process. Rather, we see a voter verified paper ballot as opening pandora's box for inefficiency, confusion and delay.

All election equipment in the Commonwealth requires logic and accuracy testing before each election; the equipment is sealed and the memory cards are sealed. We begin use of the equipment and memory cards on the morning of the election with the printing of the zero tape and conclude the election with the printing of the first results tape unbroken from the zero tape. The tape shows what time the machines were turned on and what time the results tapes were printed. It shows how many votes were cast and that number is compared to the poll book count. All recount officials were satisfied with the recount and there were no questions or complaints about the results from the DRE's.

Voters are pleased with the use of DREs. They are familiar with and embrace this technology as the primary technology in use in banking transactions, in purchasing gasoline, groceries and retail purchases among others.

VEBA opposes legislation which would mandate that voting equipment print for voter verification a copy of their electronically cast ballot.

Respectfully submitted,

Arelia S. Langhorne, President
Virginia Electoral Board Association

STATEMENT BY EDWARD A. O'NEAL, CHAIRMAN, NORFOLK ELECTORAL BOARD

Mr. Chairman, I'm Ed O'Neal, Chairman of the Norfolk Electoral Board. I stand before you with the full backing of both of my colleagues on the Board and our Registrar.

We oppose any requirement that Direct Recording Electronic (DRE) voting devices be equipped to provide voter-verified paper ballots because we believe that it will add complexity to the system, reduce system reliability, slow the voting process, confuse voters, and increase the workload of the Officers of Election.

Prior to May 2002, Norfolk used obsolete punch-card voting machines. Although the punch card machines had performed flawlessly, we were unable to obtain replacement parts and the vendor had informed us that they would no longer program the machines for us. Consequently, we were compelled to seek new equipment. A study by Professor Steven K. Medvic, then of Old Dominion University, convinced us that optical scan systems are inferior even to punch-card systems and should be avoided. Thus we opted for a fully automated, touch-screen system. This system has proved to be accurate, reliable, and user-friendly. The machines afford the voter the opportunity to review, and if necessary change, his vote before finally casting the ballot.

The paper by Mr. Justin Moore, of this panel, recommends against DRE voting machines because of the number of under-votes recorded in last November's general election on that equipment. Unlike Dr. Medvic, Mr. Moore does not take in to account demographic factors which have proven to be evident in under-voting. Last November's election was marked by unusual political factors which certainly added to the number of under-votes. Many voters were not favorably impressed with either of the candidates in the statewide races and consequently did not vote. Further, Mr. Moore does not offer evidence that any votes cast were not counted. He only infers that undervotes somehow indicate failure of the equipment. I have spent many hours testing our DRE equipment. Never once has one of the machines failed to perform as expected nor have they ever failed to accurately record votes manually entered on the screen.

Adding a printer that would print out a paper ballot for each voter to check would introduce several major problems:

First, it would extend the time a voter must spend at the voting machine. Our voting machines already have a summary screen that displays the votes that are about to be recorded. This gives the voter the opportunity to change any choices. Addition of a second check, of a paper ballot, would require the voter to spend extra time in review. We also expect that this would confuse some voters. Extracting an erroneously marked paper ballot from the system would require that an Officer of Election deal with the problem, take more time, and keep the machine out of service until the problem is resolved.

Second, the additional complexity of a printer would increase the chances that a failure could occur. Electro-mechanical devices, such as printers, are much less reliable than purely electronic devices and would undoubtedly reduce the availability of machines in the precinct. A failed machine would be unusable for the remainder of the day. In our experience, printers are the least

reliable components of any computer system. Reduced machine availability would result in longer lines and increased voter frustration, especially in high-turnout elections.

Third, the burden on our Officers of Election, whose median age is 66, has been reduced somewhat by our adoption of the modern touch-screen equipment. The additional complexity of a printer would increase the workload for our Officers of Election and increase the chances that they might commit errors.

We take extraordinary steps to insure that our equipment is properly programmed and secure in order to preserve the integrity of every election. There is no evidence whatsoever that our voting machines, or any voting machines in the Commonwealth, record anything other than the voters' choices.

All voting systems in use in Virginia have been tested and approved by independent testing agencies and found capable of accurately recording voters' choices. There is no evidence that these systems have failed to do exactly that.

Mr. Chairman, there has been much concern generated among the public over the security of our voting systems, largely placing the blame on DRE equipment, yet there are other areas which, in our view, require more immediate attention. Those areas are the registration system, particularly in regard to third parties collecting applications, the absentee voting system, the lack of a positive voter identification system, and the practice of allowing persons to assist multiple, non-family members in the voting booth. We urge you to turn your attention to these areas first.

Mr. Chairman, all man-made systems have flaws. Electronic vote gathering and tallying systems are no exception, however, compared to the manual counting of ballots, automated systems provide a significantly increased capability to accurately count votes while limiting opportunities for human error and partisan manipulation.

Mr. Chairman, our DRE system is not broken. Please do not try to fix it.

Submission from Cameron Quinn 1/5/06

1) all VA voters get the option of a paper ballot (paper or optical scan or paper on DRE) by 7/06
2) SBE must certify as options at least one optical scan accessible machine and at least 2 certified paper ballot DRE machine options for localities to choose from by 12/06 so that those localities that choose may implement a VVPAT option.
3) *Beginning* with the first election after 7/06, at least 5% of all precinct results in the state (on at least 1/3rd of all DRE options within the state each year) must be audited within 70 days of Election Day statewide after every general election. If there are not enough recounts or contests statewide to fulfill this option, then SBE is directed to determine which localities must conduct a partial audit to meet this requirement. All jurisdictions are encouraged to voluntarily audit voting equipment results at least every three years.
4) At a minimum least 5% of all DRE precincts must do parallel testing each election, so that within a four year cycle no less than 20% of all DRE precincts have done parallel, and within every 8 years all DRE precincts must have conducted a parallel test. The State Board, working with local Electoral Boards will determine a pattern that balances regional, equipment variety and other interests in determining which jurisdictions conduct parallel tests.
5) All jurisdictions must have a security plan in place by 7/06. The plan must address emergency situations (such as emergency closing of a precinct) and must address voting equipment security from purchase to normal handling between elections to Election Day handling to post-Election Day handling. A copy of such plans must be on file with SBE and SBE may direct a locality to improve such plans if they are insufficient. The SBE is directed to put together an advisory group of computer experts from government, industry and academia, which, together with representatives of the local registrars offices are electoral boards, shall provide guidance on adequacy of security plans. All jurisdictions must reconsider the security plan on an annual basis no later than 6 months after every general election.
6) All jurisdictions should ensure that at least two non-election official witnesses are present for each pre-election testing of voting equipment; political parties are to be encouraged by letter from the Speaker to the chairmen of the political parties, to be sure they provide witnesses for the testing of election equipment.
7) By 7/06 all jurisdictions must test at least annually, which may be done in conjunction with the testing prior to each election, all voting equipment to ensure it (a) works correctly (b) is identical to the contract specifications (c) is identical to certified voting equipment. Any equipment that does not meet these requirements must be reported to SBE, and publicly, and may not be used in any elections until corrected. The SBE is directed to also call upon the aforementioned advisory group of computer experts from government, industry and academia to provide guidance on adequacy of testing procedures.

Chairman's Suggested List of Items
for Subcommittee Review and Action on 1/5/06

For a working outline to discuss possible recommendations to the General Assembly, the Chairman suggests using the following list of recommendations submitted by Virginia Verified Voting and e-mailed to the Subcommittee on 11/17/05. The Chairman has also added the final item on this list for a 1/1/09 effective date for legislation to implement recommendations.

Require Voter Verified Permanent Record (VVPR) for Every Ballot

To ensure the integrity of Virginia elections, detect errors and prevent fraud, we call for a voter-verified permanent record (VVPR) of every ballot cast. There are multiple ways in which a VVPR can be produced, such as an actual paper ballot, an optical scan ballot, or a printout produced by a DRE and inspected by the voter. It is critical that the VVPR:

- Ensure the voters' privacy
- Be verified by the voter at the time of voting
- Provide a means for the voter to correct the vote before casting
- Be practical for supporting recounts and audits
- Be accessible as required by HAVA

Paper Ballot as Ballot of Record

The VVPR must be protected with the same safeguards used for any ballot, which means among other things, that the voter cannot take the ballot from the poll. In the case of a discrepancy between paper and electronic totals, the paper ballot should take precedence in any recount or audit unless a court finds significant reasons to do otherwise.

No Partial VVPR

We strongly oppose proposals to only provide a voter-verified permanent record for a limited percentage of machines. There are good reasons why no state has enacted such a provision. With only a partial VVPR, many problems could easily avoid detection, and people intent on fraud could easily avoid the monitored machines. If a problem were discovered, there would be no remedy other than to spoil the election.

With printers attached to only a few machines, it is impossible to predict which machines would fail, but it is easy to predict which ones would be subject to tampering.

Random Audits of Selected Precincts

To safeguard the integrity of our elections, Virginia code should require auditing some precincts after each election to ensure that the electronically computed totals agree with the voter-verified paper ballots. Different states have chosen different percentages to audit (from 2%-10% of precincts.) North Carolina directed the SBE to develop standards after consultation with statisticians. It is important that:

- Some precincts be selected for auditing at random *after* each election (to deter fraud and to detect malfunctions).
- Campaigns, citizens (for ballot questions), or electoral boards be able to select precincts for auditing in response to voting pattern anomalies.

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Note that the software error that almost ruined NC Rep Louis Pate's 2002 election was only detected after an audit triggered by a voting pattern anomaly (more votes for obscure ballot measures than major races.)

Require Inspection of Optical Scan Ballots and DRE Generated Paper Ballots

Virginia code (§ 24.2-802-D) does not provide a provision to inspect optical scan ballots to ensure that the tabulators function correctly. Such audits should be mandatory for some precincts in every election, and especially in a recount. Current code simply requires that that the tabulator tape be inspected, or that the ballots be run through the tabulator again. Thus Virginia has no protection against tabulator errors of any kind (accidental or intentional) – even in the case where paper ballots exist.

The type of error (and incorrect result) that happened in NC Rep Louis Pate's 2002 election would not have been detected in Virginia. That is not because software errors cannot occur, but because Virginia procedures do not even check for tabulator errors. The fact that Virginia does not have straight party options on the ballot unfortunately does not prevent other kinds of software errors.

No wireless communication ability for voting equipment

We call in the strongest possible terms for an absolute ban on all wireless communication features on voting equipment – whether by RF, IR or any other means. Any such features must be permanently physically disabled, not simply turned off by software. Using a card key to enable a software switch does not physically disable the capability.

Wireless communication is simply too great a security risk to outweigh any minimal benefit it may provide election workers. For example, wireless communication devices could be used to launch a denial of service attack at key precincts, or to allow an adversary with inside access to completely defeat logic and accuracy tests – by triggering a hidden software feature to become active on election day.

Testing is Not Sufficient

Testing is an important step for producing reliable systems. However, testing cannot guarantee the absence of errors. The tabulators in the North Carolina 2002 election had not only been tested, but certified. The machines that failed in Carteret County in 2004 and lost over 4000 votes had likewise been tested and certified. The lever machine that lost votes in Hanover Grove precinct during Virginia's 2004 Republican primary had presumably been tested in prior elections. Testing simply cannot prevent all errors. We need additional safeguards.

In addition, testing is vulnerable to an adversary with inside access to the software source code. An insider (such as a programmer employed by a vendor) could easily defeat testing by providing instructions to alter votes that require some signal to be activated. The signal could be a special write-in ballot, key stroke combination, or wireless signal among other techniques. Such an adversary could pass every single logic and accuracy test, but still alter an election without leaving any trace.

Finally testing must be repeated in its entirety for every single change to the software, operating system or environment. Uncertified (and untested) software patches have been used in Georgia and California in violation of state election laws. VVPR can provide an important safeguard if a vendor ever attempts such shortcuts in Virginia.

No Paperless Electronic Poll Books

We oppose electronic pollbooks (as allowed by § 24.2-611) because of the risk that a pollbook error or alteration could deny voters the opportunity to vote unconditionally, or allow voters to vote multiple times without leaving any kind of audit trail.

We do support providing technology to election officers that allows them to easily direct voters to their correct polling location in cases where voters are not listed in the pollbook.

We commend the State Board of Elections for providing a form on their web site that allows voters to find their polling location in a way that preserves voter's privacy. We also commend the electoral boards of those counties, including Fairfax and Loudoun, which provide computer supported assistance to direct voters to the correct precinct.

Transition Costs and Technology Recommendations

We recognize that Virginia will face one-time costs by requiring VVPR, but strongly believe that the benefits of preserving the integrity of our elections far outweigh any costs.

Several studies have found that precinct-based optical scan technology is much less expensive than DREs over time. It is also a very reliable technology with few components that can fail during an election. By contrast, printers attached to DREs have reliability questions that need to be carefully addressed – although they are much preferable to DREs without printers. If DREs must be used, we recommend against reel-to-reel print systems because of privacy and recount concerns.

We encourage the committee to offer legislation that encourages or even mandates that jurisdictions use precinct-based optical scan machines. The most conservative engineering approach would be to require some form of paper ballots, such as precinct based optical scan balloting, and forbid DREs altogether.

We suggest that the committee consider the example of the North Carolina legislature earlier this year. North Carolina directed their SBE to issue an RFP for precinct-based optical scan tabulators which will be available to counties at the price obtained statewide. Counties may then obtain state funds up to a limit intended to cover the cost of purchasing precinct based optical scan machines, along with AutoMark type devices for disabled voters. In North Carolina, counties are free to spend their own additional funds if they choose to purchase more expensive technology.

Most of the electronic voting machines purchased by Virginia jurisdictions are really general purpose computers with touch screen interfaces. By installing different software, they could potentially be converted to other uses to further reduce transition costs.

No Grandfather Clause

We understand that jurisdictions may need a reasonable, but not unlimited, amount of time to implement VVPR, but we strongly oppose any attempt to avoid implementing VVPR by allowing existing DREs to persist indefinitely as "facts on the ground". The sanctity of the ballot is far more important than any costs or inconvenience of changing voting systems.

Effective date for implementing recommendations.

Legislation to implement proposals requiring a VVPR should take effect 1/1/09.