# FINAL REPORT

# Electronic Ballot Counting Device Advisory Committee

## HB 285, Chapter 134, Laws of 2008

## November 30, 2009

**HB 285 (Chapter 134 of the Laws of 2009) established the Electronic Ballot Counting Device Advisory Committee.**

# 1.0 CHARGE OF THE COMMITTEE

The charge of the committee was to:

"… facilitate the design of an electronic ballot counting device ("Future Tabulator"), or the identification of an electronic ballot counting device ("Future Tabulator"), for use at future elections in the state of New Hampshire that will be fail safe and provably correct and can be supported by an independent technical review to eliminate potential manipulation of election results by tampering. The committee shall also research the upgrades that are available for voting machines (tabulators) currently used in New Hampshire and recommend which upgrades should be required for the continued use of the machines (tabulators) by cities and towns."

## 1.1 Specific Elements of the Committee Charge

(a) Developing or identifying an electronic ballot counting device for use at future elections in New Hampshire that can be supported by an independent technical review to eliminate potential manipulation of election results through tampering.

(b) Security, storage, programming, testing, usage, verification of vendor services, and retention of data from electronic ballot counting devices.

(c) The feasibility of having the Department of State program memory cards.

(d) Issues related to public confidence in the integrity of electronic ballot counting devices.

(e) Methods for state testing of programmed memory cards before and after elections.

(f) Upgrades to existing voting machines (tabulators) and new products that could improve New Hampshire elections.

(g) Other issues related to the development of new electronic ballot counting devices or the use of optical scan ballot counting machines (tabulators), as requested by the Secretary of State.

## 2.0 PURPOSE OF THE STUDY

While the General Court acknowledges that New Hampshire elections meet high standards of performance, it is important to review areas that present potential security issues in order to maintain public confidence in New Hampshire elections.

## 3.0 COMMITTEE MEETINGS

The following is a review of each meeting. The minutes can be found on the Secretary of State's website http://www.sos.nh.gov/

1. Meeting of August 6, 2008 – This was the first meeting of the committee and was used as an opportunity for Secretary Gardner to introduce the committee members, to thank them for their willingness to serve and to distribute materials of interest to the committee to assist them in their work. Chairman Don Stritch, a former legislator and current Rockingham County Commissioner, explained that the purpose of the meeting was to complete introductions of the committee members, review the charge of the committee, and to plan for future meetings.

2. Meeting of September 29, 2008 – The documentary "Hacking Democracy" was shown and subsequently discussed by the committee members.

3. Meeting of December 15, 2008 – A demonstration of the Accuvote® - OS with version 1.94w firmware, the tabulator currently approved for use in New Hampshire elections, was demonstrated by Assistant Secretary of State Daniel J. Cloutier. LHS Associates, LLC (LHS), the local representatives for the producer of the Accuvote® - OS were present to answer questions.

4. Meeting of January 26, 2009 – Presentation by and discussion with Ronald L. Rivest, Andrew and Erna Viterbi Professor of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, and Chair, Security and Transparency Subcommittee, EAC Technical Guidelines Development Committee. The discussion covered a wide range of topics including the risks associated with the ballot tabulating technology currently in use and risk mitigation strategies, including approaches to random audits.

5. Meeting of March 9, 2009 – The meeting addressed the development of a mission statement and the establishment of goals and objectives.

6. Meeting of April 6, 2009 – Presentation by Gregory Miller, Co-Executive Director and Development of Open Source Digital Voting Foundation, appearing with Pito Salas of Pito Salas and Associates. Robert Dezmelyk, Newton Moderator, EAC Standards Board Member and President of LCS/Telegraphics

participated. Mitch Trachtenberg, Technology Director, TEVSystems, developer of open source "Ballot Browser" used by the Humboldt County (CA) Election Transparency Project, participated via conference call.

7. Meeting of April 27, 2009 – The meeting addressed the mission statement and refinement of goals and objectives. Pamela Smith, President of Verified Voting, participated via conference call, providing background on auditing election results.

8. Meeting of May 26, 2009 – Presentation and update by John Sebes, Co-Executive Director and Chief Technology Officer, Open Source Digital Voting Foundation, appearing with Pito Salas of Pito Salas and Associates. Participants included Kathy DeWolfe, Vermont Director of Elections, Jack Carroll, Engineer, and Robert Dezmelyk, Newton Moderator, EAC Standards Board Member and President of LCS/Telegraphics.

9. Meeting of June 22, 2009 – Meeting addressed mission statement, goals and objectives, and requirements.

10. Meeting of July 13, 2009 – Meeting addressed potential upgrades and security improvements to the Accuvote® - OS, product life cycle ownership costs, and transition challenges.

11. Meeting of July 27, 2009 – Meeting addressed uploading of information from tabulators, development of the Request for Information for the Future Tabulator, unofficial and official election results reporting, and establishment of a final report drafting group.

12. Meeting of September 14, 2009 – Meeting included discussion of ES&S acquisition of Diebold's Premier Election Systems Subsidiary, advantages provided by upgrade to Accuvote© -OS 1.96.13 firmware chip, absentee ballot issues, and structure of a contemplated Request for Information (RFI) draft based on Voluntary Voting System Guidelines Version 1.1 (VVSG 1.1).

13. Meeting of October 12, 2009 – Meeting to review work of the final report drafting group. Jeff Silvestro and Gerry Bergeron of LHS Associates, LLC responded to questions about the Existing Tabulator, the AccuVote® 1.94w firmware chip and the potential upgrade to AccuVote® 1.96.13 AVOS firmware chip, how the potential upgrade addresses outstanding security issues, memory card inventory, disabling the AccuVote® - OS port, the purpose of the clock chip, non-lucid read heads, and continuity under ES&S.

14. Meeting of October 19, 2009 – Meeting to review draft of Request For Information.

15. Meeting of October 30, 2009 – Presentation by Professor Andrew Appel, Chair of the Princeton Computer Science Department, focusing on tampering opportunities, and the virtues of the Existing Tabulator and the desirability of random audits.

## 4.0 BACKGROUND

The Premier precinct count optical scan AccuVote® - OS (the "Existing Tabulator"), formerly referred to as the Accuvote® ES-2000 by the National Association of State Election Directors (NASED), has been a workhorse in New Hampshire elections for nearly two decades. The New Hampshire experience has relied heavily on recounts by state and local officials to validate tabulator-counted results. While there may be documented vulnerabilities in the current vote tabulating technology, a properly programmed and secured precinct-count optical scan tabulator will produce an accurate count of properly marked ballots.

To the best of our knowledge, New Hampshire elections have been free of tabulator-related fraud; technical malfunctions have been handled at the local level and have not been found to alter the final election results. Election officials have been proactive and have cooperated with the Legislature to ensure clean elections.

The presidential elections in certain other states in 2000 and 2004 raised questions regarding the integrity of national elections, leading to concerns over the reliability and security of electronic ballot counting tabulators.

In December, 2005, for demonstration purposes, Mr. Harri Hursti, a recognized computer security expert, successfully modified the pre-election vote tally of individual candidates on the memory card of a Premier Accuvote® - OS optical-scan ballot-counting tabulator utilizing the 1.94w firmware, thereby changing the outcome of a Tallahassee, Leon County, Florida mock election. The change to the pre-election vote tally instructed the tabulator to reduce the beginning vote count of one candidate to a negative number and the beginning vote count of the opposing candidate to a positive number of equal value. This manipulation maintained an opening vote count of zero for that contest on the zero tape that must be produced at the beginning of each election. No evidence could be found of the manipulation.

Even though the Hursti manipulation did not take place under election-day conditions, it revealed significant vulnerabilities. The manufacturer subsequently acknowledged sixteen (16) security defects in the AccuVote® - OS 1.94w firmware chip. In March of 2006, the New Hampshire Ballot Law Commission certified the 1.94w firmware for use in New Hampshire elections in order to accommodate a legislated change in ballot style (to return to the original column-style ballot design). The AccuVote® - OS 1.94w firmware chip remains in use to this day. The widely publicized hacking provided justification for the need to conduct a thorough review of the security deficiencies in these tabulators.

To address the identified security issues, the manufacturer has developed and obtained EAC certification under the 2002 Voting System Standards for the AccuVote® - OS 1.96.13 firmware chip, which has been made available for purchase.

# 5.0 FINDINGS

The Committee report distinguishes between the "Existing Tabulator," the AccuVote – OS, and the "Future Tabulator," which the Committee has been charged to develop or identify. The Committee has found that the Future Tabulator does not exist, but there are efforts underway that could result in its development. Designing and developing the Future Tabulator may require several years and the cooperation of states, local jurisdictions, computer scientists, statisticians, test labs, vendors, open source entities, and the general public.

## 5.1 Address the following legislative charge to consider:

## "(a) Developing or identifying an electronic ballot counting device for use at future elections in New Hampshire that can be supported by an independent technical review to eliminate potential manipulation of election results through tampering."

In order to facilitate the design of an electronic ballot counting device, the Committee recommends the Department of State issue a Request for Information (contemplated RFI) to encourage proposals (and obtain feedback) aimed at achieving the purpose identified by HB 285 and the Electronic Ballot Counting Device Advisory Committee. House Bill 285 defined the following objectives for a Future Tabulator: "fail safe, provably correct and supported by an independent technical review to eliminate potential manipulation."

### 5.1.1 Address legislative charge to design or identify a Future Tabulator that is:

**"Fail safe"** (Future Tabulator). According to Encarta Dictionary, "fail safe" means "designed to switch equipment or a system to a safe condition if there is a fault or failure." In other words, the system can fail, but it must fail safely. To achieve fail safe status, there must be confidence on the part of voting officials that they can pick up where the tabulator left off. If a tabulator fails, or if a city or town cannot satisfy security and testing requirements, the election officials must be able to competently revert to a hand counting mode which is already required for ballots that cannot be processed by the tabulator. In such event, the Secretary of State should continue to train election officials in the best practices of hand counting and reconciliation, and they should be well-prepared to undertake hand counting efficiently and effectively. To the extent that local

election officials are ready to revert to hand counting all ballots, a tabulator is "fail safe".

The contemplated RFI for the Future Tabulator calls for an optical scan tabulator designed so that a ballot doesn't drop into the box under the tabulator unless the ballot has been counted. Hence, whenever the tabulator shuts down and there is sufficient time to print out a report, such report is current and the ballots in the box below the tabulator have already been counted. This would give the election official the choice of hand counting only the remaining ballots and adding in the results from the tabulator report (otherwise known as a tape), or electing to hand count all ballots.

### 5.1.2 Address legislative charge to design or identify a Future Tabulator that is:

**"Provably correct and supported by an independent technical review to eliminate potential manipulation" (of election results).**

Achieving "provably correct" status requires a combination of: (1) transparent design and (2) utilization of recognized engineering standards tested by Voting System Test Laboratories, and (3) a combination of recounting and random auditing. (See Section 5.4 below.)

#### 5.1.2.1 The Committee recommends transparency in system design to enable an independent technical review. (Future Tabulator)

The contemplated RFI will provide an option for ballot counting proposals that contain open source, disclosed source, and/or proprietary software. All three software licensing models can be analyzed using an independent technical review. Thus far, valuable technical reports of proprietary software have been released publicly. Proprietary software normally can only be analyzed by experts who sign non-disclosure agreements. Open source software and disclosed source software can be subject to adversarial testing by members of the general public, sometimes resulting in a more demanding review which could be less expensive to test. Whichever licensing model is used, detailed public reports will continue to be essential in order for the general public to have a comprehensive assessment of security risks.

In the short run, open source and disclosed source software may lead to discoveries of additional vulnerabilities, and in the longer term, these software licensing models may offer a lower cost method to implement robust software. Open source and disclosed source software may provide opportunities to review software upgrades more quickly and thoroughly, possibly reducing reliance on in-house experts who are not permitted to make public much of what they have found.

The contemplated RFI encourages modular design with interfaces that use election mark-up language (EML), or other open (royalty-free), structured language, standardized data formats and methods. Such open interfaces can enable public monitoring and forensics that could eventually lead to a higher level of trustworthiness and less conflict with nondisclosure agreements. Modular design of tabulators, by decoupling software into a device-independent layer from the hardware used to count ballots, can lead toward additional independent verification and further transparency.

New Hampshire's contemplated RFI would permit and encourage software code disclosure. The state will consider proposals for a Future Tabulator that contains open source, disclosed source or proprietary software. Ultimately, the successful vendor must provide assurance of high quality service and the ability to provide turnaround times that satisfy tight deadlines under election conditions.

New Hampshire's contemplated RFI will be a step in the evolution toward detailed system design requirements that are reviewed by many states. This approach can reduce costs substantially, since it keeps the system design process open longer in the acquisition cycle, and design improvements can be more extensively accomplished and understood in the public domain. Detailed system design specifications for a Future Tabulator, with requirements established in VVSG-NI Version 2.0, are already being developed in a loose collaborative effort involving NIST, members of the academic community, election officials, existing vendors and open source entities. This process can be expected to take a number of years.

Ballot counting software design efforts will have the opportunity to obtain input from the Voting System Risk Assessment team led by University of South Alabama's Professor Alec Yasinsac, a federally-funded project that is charged to evaluate, quantify and address voting system risk. The results of this project should help enable the general public, election officials, vendors and scientists to understand, evaluate and mitigate risks associated with the voting process.

Industry trends point toward more source code disclosure over time, as firms encounter more disclosure demands from the public and become more comfortable with the software code that they would disclose. On October 27, 2009, Sequoia, a U.S. voting system manufacturer, announced that it plans to fully disclose its source code in its next release for certification.

On October 23, 2009, the Open Source Digital Voting Foundation (OSDV) announced the availability of software source code for its prototype election system, including ballot design, election management, and ballot tabulation software. OSDV representatives have begun gathering specifications from a number of states, including New Hampshire. Other states have begun to

cooperate to refine specifications in the same manner. Other entities and individuals have previously released election-related open source code.

Open source software does not represent a single business model. Different approaches may be adopted toward licensing and moving enhancements through the certification process. One open source election software model depends on a viable trusted organization that can review enhancements, submit new versions for certification and provide ongoing support and maintenance.

Open source vendors normally achieve viability not by selling software licenses but by providing services, maintenance and integration. Some open source vendors are "dual-licensing," by which a defined group, such as non-commercial entities, can use their software for free, and another group, such as commercial entities, pay to use their licenses. Vendors are welcome to use open source software to compete against the original software creator. Linux is "open source," but some private vendors have succeeded by providing packaging, service, and enhancements of Linux. Existing election equipment vendors with proprietary software may elect to use open source components as they are tested and proven.

Disclosed source and proprietary source vendors achieve viability by selling software licenses as well as services, maintenance, and integration. These licensing arrangements normally prohibit competition against the software owner. Disclosed source and proprietary source vendors may use open source components at no cost. As time goes on, open source components may be integrated into disclosed source and proprietary source systems.

New Hampshire plans to delay software implementation until the design specifications have been fully vetted by other states and local jurisdictions. The software that is ultimately developed using these design specifications must be applicable to other states and local jurisdictions, allowing the supplier to spread costs among many users. These vetted design specifications should be useful to open source, disclosed source and proprietary source vendors.

With open source, disclosed source or proprietary software using open source components, more transparency in system design will enable independent technical reviews, both before and after implementation.

**5.2.1.2 Rely on recognized engineering standards** tested by Voting System Test Laboratories (VSTLs) approved by the National Voluntary Laboratory Accreditation Program (NVLAP) approved by the National Institute of Standards and Technology (NIST). The EAC's Voluntary Voting System Guidelines Version 1.1 (VVSG 1.1) identifies hardware and software requirements that address challenges for voting systems in areas such as

workmanship, security, integrity, testability and maintainability. By following the structure of the VVSG 1.1, with modifications to fit the state's needs, many of the requirements identified in the contemplated RFI can be testable to national standards by VSTLs selected by NIST. The engineering standards are clearly defined in the contemplated RFI, using well-recognized NIST, Federal Information Processing Standards (FIPS), Institute of Electrical and Electronics Engineers (IEEE), International Electrotechnical Commission (IEC), and American National Standards Institute (ANSI) standards. Notwithstanding this use of the VVSG 1.1 framework, there are major sections and details of the VVSG 1.1 that will be excluded from the contemplated RFI, including (a) all references to Direct Recording Electronic voting machines (DREs), (b) the Section 5.2.7 exception to prohibition of modification of executable or interpreted code in programmed devices, and (c) IEEE 1583, which is not approved.

**5.2.1.3 Following implementation of a Future Tabulator, the Committee recommends continuing hand-counted recounts and conducting post-election hand-counted audits** of randomly selected jurisdictions and randomly selected races, with sufficient statistical power to serve as a check against errors or fraud that might change the outcome of an election. See explanation of random audits in section 5.4 herein.

## 5.2 Address legislative charge to consider recommendations in the following areas:

## "(b) Security, storage, programming, testing, usage, verification of vendor services, and retention of data from electronic ballot counting devices."

### 5.2.1 Security and Tabulator Storage (Existing and Future Tabulator)

Security vulnerabilities can be mitigated by ongoing Department of State training and risk assessment aimed at (1) reducing access to tabulator and memory card storage locations, (2) the use of properly applied tamper-resistant security seals, and (3) comprehensive record-keeping that reflects dates, purposes and individuals present when seals are broken and replaced.

The Committee recommends permanently disabling the current Accuvote® - OS serial port by disconnecting the wire harness from the mother board and then cutting and removing the wire, but leaving the 9-pin connector attached to the RS232 port, thereby avoiding the creation of a hole in the back of the tabulator. The serial port pins could then be destroyed, rendering the port visibly disabled. The procedure would also remove any modems and disable the "telephone" and "line" ports. No wireless capabilities have been identified. This operation would be performed by an authorized technical representative of the service company

and formally witnessed by the clerk and another local election official. All parties would sign a document attesting that the operation was completed in their presence. The signed affirmation would be submitted to the Department of State as verification that the external serial, "telephone" and "line" ports have been disabled. This would serve as a cost effective and technically functional solution.

An inspector from the Department of Justice should regularly check (1), (2), and (3) above, as well as the disabled port.

### 5.2.2 **Programming** (Existing and Future Tabulator)

"Programming" is a term that is equivalent to the VVSG 1.1 term "election programming." Ballot preparation and formatting, as defined in the VVSG 1.1, are currently performed by the Department of State. Election programming is the process by which the Department's ballot preparation and formatting are used to define the voter choices associated with the contents of the ballots. Election programming includes the logical definition of the ballot, the allowable choices, the political subdivisions, the ability to select from a range of voting options, and the generation of all required master and distributed copies of the voting program.

Election programming for federal, state and local elections is currently performed by the Premier service vendor, LHS Associates, LLC, a Methuen, Massachusetts-based firm that has serviced New Hampshire voting systems for about two decades. LHS relies on paper ballot proofs submitted to the printer by the Department of State. The service vendor, LHS, is widely regarded by city and town clerks as effective and responsive to election officials.

The service vendor starts with the physical ballots (ballot preparation and ballot formatting) created by the Department of State for the printer, inputs this election-specific data in its GEMS system, proofs the data, and produces two tabulator memory cards (one of which is designated the backup and is tested in the same manner as the primary card) which are sent to the local clerks. If a memory card does not function during a test or an election, the backup can be used.

Election programming for a Future Tabulator might be done by a vendor or by the Department of State. The Committee recommends that the Future Tabulator's election management system be designed with the option of having the Department of State perform election programming for state and federal elections. Similarly, election programming for local elections might be performed by the towns and cities or by a vendor.

**5.2.3 Testing** (Existing and Future Tabulator)

The extent of pre-election testing of optical scan tabulators is currently constrained by the time available to election officials to obtain the ballots, fill in the ovals, run them through the tabulator, count the results, check the results, and submit the test tapes to the Department of State prior to state elections.

In the future, the testing of optical scan tabulators in advance of elections can be expanded by an election management system flexible enough to print test ballots with a wide variety of marks on them. Relying on an election management system that interfaces with ballot printing, substantial numbers of diverse test ballots can be printed with ovals filled in and sent to the towns and cities to test. This capability would help enable the counting of sufficient quantities of ballots marked in enough ways designed (a) to discover election programming mistakes and (b) to possibly notice tampering.

**5.2.4 Verification of Vendor Services** (Existing and Future Tabulators)

The Department of State has several ways to verify the quality of LHS vendor services, which it has found to be competent in recent years. The Department is in touch with clerks during the testing process; it receives test tapes from the clerks reflecting test results; it is in touch with the towns and cities on election day and is normally made aware of tabulator problems and service calls to the vendor; following the election, it receives copies of service calls made by the service vendor; and it follows up with clerks and LHS after the election if significant problems surface. The Department of State does not itself check the election programming, except when it is present during tabulator testing by the clerks.

Using a Future Tabulator and election management system, the state would have further opportunity for quality control and to verify election programming. Whether a vendor or state or local election officials conduct election programming, there would be more time available to proof ballots because far less manual effort would be required at the various interfaces (ballot layout, ballot printing, optical scan, accessible voting system, election reporting, etc.) that would now be automated. Using a comprehensive election management system described herein would create transparent interfaces observable by the general public, which could, to some extent, participate in quality control.

Using a Future Tabulator, ballot testing would involve more marked ballots, which would be easier to prepare and monitor. (See Section 5.2.3 above.)

If a Future Tabulator can decouple software into a device-independent layer from the hardware used to count ballots, modular design of tabulators can lead toward additional independent verification of the exchange of data between the

hardware and software. The Department can solicit or design software intended to check these components using their open interfaces for correct transmission of data and handling of errors.

**5.2.5 Retention of data from electronic ballot counting devices.** (Existing Tabulator)

The U.S. Department of Justice has advised the states that the election programming and data on memory cards must be retained for twenty-two (22) months after federal elections, but not the memory cards themselves. The Department of State might be able to retain and review the information if the state were to obtain (a) memory cards, (b) access to the data layout of memory cards, as offered by LHS, and (c) a method of data retrieval from the memory cards.

Obtaining complete and useful information from these cards and producing reports for the general public would require additional resources that could be contributed by the towns and cities that use the tabulators.

The Committee recommends the development of guidelines for the retention of original memory cards used during elections for a period of time sufficient to deter tampering. Since the election programming of the Existing Tabulator is done through the memory card, the memory card is the best source of information with respect to the validity of the election programming and the intended operation of the tabulator.

See Section 5.5 below, addressing "Methods for state testing of AccuVote programmed memory cards before and after elections."

## 5.3 Address legislative charge to consider:

## "(c) The feasibility of having the Department of State program memory cards." (Existing and Future Tabulator)

Election programming of memory cards requires software that interacts with optical scan tabulators. Recently, LHS, in collaboration with Diebold (the software owner), provided the Department of State a $1,495,000 estimate to purchase what is now the ES&S-owned Premier Elections Systems GEMS election programming software that is currently used to program AccuVote® memory cards for each election. This indicative pricing does not include interfaces with the state's accessible voting system or the blank ballot printer, both of which would be useful from a long term perspective. GEMS has some election reporting functionality, but it may not meet the comprehensive needs of the state in this area.

A fully functional election management system would include five major interfaces: (1) ballot layout, (2) the accessible voting system, (3) the optical scan system, (4) the ballot printer, and (5) election reporting to the public website. Such a system could potentially produce savings for the state (and other states and counties) if the necessary time is dedicated to developing detailed system design specifications. Detailed system design specifications must be compared and checked with other states and jurisdictions, thereby rendering the resulting hardware and software useful for these jurisdictions and keeping more of the system design in the public domain. (See Section 5.7.3 "Competition" below.)

Such an election management system project might take several years to accomplish, since other states would first approve the design, and might cost six or seven figures. If implemented well, it could reduce ballot proofing requirements at different ballot interfaces, reduce printing costs, increase tabulator testing capabilities and enable ballot rotations for state representative contests.

## 5.4 Address legislative charge to consider:

## "(d) Issues related to public confidence in the integrity of electronic ballot counting devices." (Existing and Future Tabulator)

Over the long run, public confidence relies on the state and local history of accuracy, security, transparency, and reliability in the ballot counting process. One of the most effective and least expensive ways to achieve these goals is to conduct random hand-counted audits of tabulator counts immediately after the election. Such audits are valuable because they check the accuracy of the initial counting method from end to end.

Academic computer scientists and statisticians have recommended implementation of state-wide post-election audits of sufficient statistical power, using randomly selected jurisdictions, to determine if enough error has occurred that would change the outcome of a contest.

A state-wide random audit described above may be augmented at the local level by the selection of closely contested high-profile races for immediate on-site post-election hand counts as checks on the tabulator. This should remain an option for local officials.

As local election officials continue to receive training in tallying, reconciling, and identifying extraneous ballot marks, election officials will learn to identify and address discrepancies on the night of the election, thereby potentially reducing the differences between initial counts and recounts and random audits.

## 5.5 Address legislative charge to consider:

## "(e) Methods for state testing of (AccuVote©) programmed memory cards before and after elections. " (Existing Tabulator)

LHS Associates, LLC, the Methuen, Massachusetts firm that programs ballots for and services the ES&S Premier precinct count optical scan AccuVote® - OS tabulator, has indicated that the state can have access to the memory card format, noting that it is proprietary and not subject to public disclosure. Accordingly, the Department of State has requested the memory card format. (ES&S has purchased the Diebold's Premier Election Systems subsidiary. This acquisition is currently subject to anti-trust review by the U. S. Department of Justice.)

The Committee favors conducting this kind of analysis but acknowledges the resource requirements demanded by such a program.

The Connecticut Secretary of State has engaged the University of Connecticut to conduct state testing of programmed memory cards before and after elections at a cost of over $300,000 annually. If New Hampshire were to obtain (a) memory cards, (b) access to the data layout of memory cards, as offered by LHS, and (c) a method of data retrieval from the memory cards, it might be able to review memory cards using in-house information technology resources. Producing reports comparable to those published by the University of Connecticut would require a substantial allocation of resources. The towns and cities that use the system might have to contribute funds to make such reports possible.

While this offers a useful first step and provides a route to an independent technical review, the proprietary software model places the burden of memory card testing on the state, which has limited resources for such a project. One possible option would be to establish a special fund managed by the cities and towns with tabulators which would address tabulator testing and security with assistance from the Department of State.

## 5.6 Address legislative charge to consider:

## "(f) Upgrades to existing voting machines (tabulators) and new products that could improve New Hampshire elections."

**5.6.1 Existing Tabulator**. The following upgrades to existing optical scan tabulators could improve security for New Hampshire elections. The state could upgrade to the AccuVote® 1.96.13 firmware chip for $75 per tabulator if the upgrade were scheduled in early 2010, when the regular maintenance visits are scheduled. This upgrade would require Ballot Law Commission approval.

Six New Hampshire communities own ten AccuVote® tabulators with "non-lucid" (non-visual light) read-heads. These read-heads require use of pens or pencils with a minimum of 60% graphite and do not count ballots whose voters did not use such markers. New Hampshire communities have gradually replaced the old read-heads over time. The Committee recommends that the Ballot Law Commission decertify tabulators using non-lucid read-heads.

According to the Diebold/Premier literature, the AccuVote® 1.96.13 AVOS firmware and GEMS 1.21.5 election programming software offers certain improvements over the current AccuVote® 1.94w firmware chip: In a Report of the California Secretary of State's Voting Systems Technology Assessment Advisory Board (VSTAAB) dated February 14, 2006 entitled "Security Analysis of the Diebold AccuBasic Interpreter" for the California Secretary of State, 16 security vulnerabilities were identified in the AccuVote® 1.96.6 firmware. In 2007, the California Secretary of State's Top-To-Bottom Review team completed a more comprehensive examination (TTBR) of all the voting systems in the state, including the precinct count optical scan AccuVote® tabulator.

The Committee has asked LHS, the local Premier service vendor, which of the 16 vulnerabilities identified by VSTAAB have been corrected. LHS's responses, received by the Department of State in October, 2009, are as follows:

> "… The FEC 2002 Voting System Standard ("VSS"), vol. II, section 1.5 Evolution of Testing requires the VSTLs to conduct extensive tests on a voting systems to evaluate it against new threats to a voting system as they are discovered, either during the system's operation or during the operation of other computer-based systems that use similar technologies to other voting systems. The VSTLs are required to expand their test to address the threats. Under the EAC Program, the VSTL is required to assess all reports listed on the EAC's website directory for Voting System Reports Clearinghouse and modify their test plans to include all applicable known threats."
>
> "As stated in iBeta Quality Assurance, Inc.'s Test Plan for the Assure 1.2 system, in accordance with VSS 2002 vol. II sect. 1.5, iBeta reviewed the body of knowledge deposited in the EAC's Voting System Reports Clearinghouse for impact to the Security Test Method submitted herein. The results of the California Top-To-Bottom Review of the Premier system concluded that the vulnerabilities within the system depend almost entirely on the effectiveness of the election procedures. The VSS 2002 vol. 1 sect. 2.2.1 states that "System security is achieved through a combination of technical capabilities and sound administrative practices". This testing is conducted as part of the FCA Security Review and no additional testing was determined as a result of review. Review of the Kentucky, Ohio, and Connecticut Reports resulted in no modifications to the Test Method as part of this Test Plan but did update the Security Test Case to verify that the Connecticut recommended tamper-resistant seals were incorporated into the Premier TDP. The review of the 3

March 2009 California Secretary of State report was also reviewed as well as the Premier Product Advisory Notices."

"GEMS 1.21.5 has blocked the use of MSAccess, improved database encryption/administrator password protection at sign in, and digitally signs the ABasic file."

"The firmware (AccuVote©) 1.96.13 uses a Secure Hash Algorithm (SHA) to verify that the digital signature matches the digital signature stored on the .abo file. The firmware also checks counters for overflow, sum of all counters equals public counter and all candidate counters match the public counter. These checks are conducted at start up, memory card insertion, and when the ender card is inserted."

Shedding light on the upgrade in the GEMS version 1.21.5 election programming software, Wired.com reporter Kim Zetter wrote about a problem of erased audit logs in an August 12, 2009 article:

"Gail Audette, quality manager at iBeta (a NIST-approved VSTL), said Tuesday that version 1.21.5 of the GEMS software passed their tests. The software now records all 'normal and abnormal' events, she says."

The AccuVote® 1.96.13 AVOS firmware chip and GEMS 1.21.5 election programming software appear to address a number of the security concerns identified by Harri Hursti and California Secretary of State's 2006 VSTAAB and 2007 TTBR reports. This software has been subjected to NIST 's National Voluntary Laboratory Accreditation Program (NVLAP)-approved VSTL review using the latest available EAC testing routines established by NIST and certified by the EAC, relying on the Federal Election Commission's 2002 Voting System Standards.

In a letter to the EAC dated October 13, 2009, Aaron Burstein and Joseph Lorenzo Hall, representing members of the California Secretary of State's Top-To-Bottom Review team, questioned whether all of the identified vulnerabilities had been understood and tested for by the VSTL. On October 20, 2009, Brian Hancock of the EAC stated, "all concerns contained in the report (reviewing the Assure 1.2, which included the precinct count optical scan AccuVote® - OS tabulator with firmware version 1.96.13) were covered by the testing proposed by the test plan and the test cases developed for that test plan as required by the federal testing and certification process." In a letter dated November 5, 2009, Hall and Burstein responded that "the test plan and test report, taken together, do not demonstrate how iBeta's tests covered the issues raised by the TTBR."

The Committee recommends further follow-up to determine what vulnerabilities the iBeta (the VSTL) tests addressed and to ascertain what the vendor has done to correct the vulnerabilities identified in the California VSTAAB and TTBR

reviews, as well as the Ohio Secretary of State's Evaluation & Validation of Election-Related Equipment, Standards and Testing (EVEREST) study in 2007.

In light of the considerably improved review process and the VSTL conclusions, the Committee believes that the Ballot Law Commission should rescind the approval of the AccuVote® 1.94w firmware chip and, pending completion of the above analysis, approve the AccuVote® 1.96.13 AVOS firmware chip and the accompanying GEMS 1.21.5 for election programming; and also require use of security seals and limit access to tabulators and memory cards. This change will affect two hundred thirty-nine (239) Accuvote® - OS optical scan tabulators in one hundred eighty (180) polling locations within one hundred ten (110) cities and towns, which include six (6) school districts. The Committee further recommends rescinding the approval of non-lucid read heads in six (6) towns (ten [10] tabulators.)

**5.6.2 Future Tabulator**. The legislative charge to consider "upgrades" to "new products that could improve New Hampshire elections" is addressed in Sections 5.1, 5.2, 5.3, 5.4, 5.7.2, 5.7.3, 5.7.4, and 6.2 herein.

## 5.7 Address legislative charge to consider:

**"(g) Other issues related to the development of new electronic ballot counting devices or the use of optical scan ballot counting machines (tabulators), as requested by the Secretary of State."**

### 5.7.1 Product Life Cycle (Existing Tabulator)

Following the 2002 passage of HAVA and a short-lived trial against direct recording electronic (DRE) voting systems, the precinct count optical scan (PCOS) protocol is becoming the dominant preferred procedure for volume ballot counting. Two precinct count optical scan systems that have sustained this trend have been the Accuvote® - OS and the ES&S M100. The workhorse role in counting the nation's votes has inspired scrutiny of the AccuVote® tabulator. Given that these systems were largely developed before the computer security evaluation of these systems gained momentum, security gaps have emerged.

The Accuvote® - OS (Existing Tabulator) is showing signs of obsolescence.

1. Its memory cards, which hold the election-specific data (candidate names and vote tallies) are becoming harder to find and increasingly expensive.

2. The ES&S purchase of Diebold's Premier Election Systems subsidiary raises some questions about how long the Premier Accuvote® - OS will be supported, and there have been reports that ES&S might move to consolidate

product lines and eventually eliminate the AccuVote. However, the President of ES&S has told the Department of State that ES&S will support the AccuVote® product as long as it possibly can. The AccuVote® 1.96.13 firmware chip may be the last AccuVote® firmware version intended for EAC certification, and perhaps the last possible upgrade for the Existing Tabulator.

The above upgrades may be enough to maintain this model's viability for a few years to come. Dr. Andrew Appel, Chair of Princeton's Department of Computer Science, supports using these Existing Tabulators (with upgrades) as long as possible, so long as statistically valid random audits are implemented. Even if individual products become obsolete, the optical scan protocol is likely to grow in its role as the dominant method of counting votes in this country.

### 5.7.2 **Competition** (Existing and Future Tabulator)

In a 2008 report by the Election Technology Council, a trade association of voting machine vendors, it was reported that 1990 Voting Systems Standards certification for a suite of voting system software and tabulators initially cost $640,000 under the certification regime administered by the National Association of State Election Directors (NASED). More recently, a suite costs $1.7 million for certification under the 2002 Voting System Standards administered by NASED. Currently, a suite costs $4.2 million for certification under the 2002 Voting System Standards administered by the EAC certification regime, which relies on NIST-approved test labs (VSTLs) that apply the more rigorous testing routines. (Compare VVSG 1.1.) These rising market entry costs tend to discourage new entrants and smaller industry participants, and may force further industry consolidation. This, together with potential rising tabulator equipment costs, may have negative consequences for smaller jurisdictions that cannot hope to move the market with their purchases.

The ES&S purchase of Premier Election Systems concentrates at least 75% of the voting system manufacturing into the hands of a single vendor. This development, while it is not finalized at the date of the report, may increase the risk of monopoly behavior in the industry.

Although New Hampshire's purchasing power is limited, the State should encourage vertical and horizontal competition within the election system industry. Accordingly, the contemplated RFI for a Future Tabulator will:

1. Encourage manufacturers to produce or utilize interoperable modular components of a voting system;

2. Specify transparent election mark-up language (EML) between modules;

3. Cooperate with other states and organizations to develop granular system design specifications to enable entities less familiar with complexities of election requirements to compete on an even footing;

4. Entertain proposals, where practical, that would provide modules rather than the entire system, relying on election markup language interface or its equivalent;

5. Encourage vendors to compete, initiating the acquisition process by issuing a Request For Information (RFI) to obtain vendor feedback prior to taking the next step toward acquisition, thereby maximizing vendor participation;

6. Reference commonly recognized engineering standards, such as FIPS, ANSI, IEC, IEEE, and ISO;

7. Rely, to the extent practical, on the structure and terms of Voluntary Voting System Guidelines Version 1.1, Volume I; and

8. Tie universal functional requirements to the testing requirements set forth in VVSG Version 1.1, Volume II.

9. Cooperate with other states and local jurisdictions that are owners of AccuVote® equipment to ensure future support.

### 5.7.3 **Response time for upgrades** (Existing and Future Tabulator)

Slow response time for upgrades has historically been a major challenge for states and local jurisdictions that own voting systems. The current structure of the industry and the complexity of the certification process have discouraged software revisions that might enable jurisdictions to conduct their elections more effectively. (It is critical that changes not be made and accepted immediately before an election.)

The New Hampshire Legislature periodically adopts changes in ballot styles and other ballot requirements that can require software enhancements. It is important for New Hampshire that reasonable software changes can be made with businesslike turnaround times at moderate cost. If the proposed upgrade is adopted for the Existing Tabulator, there may not be further opportunities for software upgrades without acquisition of a new tabulator. Every proposed ballot design change should be accompanied by a fiscal note.

### **5.7.4 Costs** (Existing and Future Tabulator)

Towns and cities are responsible for counting votes and for selecting the method they use to count ballots, within the legal parameters set forth in RSA 656:40-43-a and RSA 659:60-64. Local jurisdictions have always had the option of hand counting ballots. The law does not direct the state to subsidize hand counting or tabulator counting. The costs and responsibilities of tabulator and hand counting should be borne by those towns and cities that elect to use either method. The Ballot Law Commission approves the voting tabulators that may be used and can require protocols for their proper use.

Ballot counting accuracy, security and credibility are essential for a democracy to function. Ongoing efforts to test accuracy and maintain security for tabulators and paper ballots must be supported by the cities and towns responsible for counting ballots in elections. The primary cost of tabulator testing and security must be borne by the towns and cities. If towns or cities are unwilling or unable to make such commitments, the alternative is hand counting.

# 6.0 RECOMMENDATIONS

**The following is a summary of previous recommendations.**

## 6.1 Existing Tabulator

**6.1.1 Fail-Safe.** Train election officials in best practices of reconciliation and hand counting, which is the alternative if tabulators fail or are unavailable.

**6.1.2 Memory Card Retention and Review**. The Committee recommends the development of guidelines for the retention of original memory cards used during elections for a period of time sufficient to deter tampering. The committee favors conducting a review of memory cards, but recognizes that it requires resources and vendor cooperation. A separate fund aimed at testing and security might achieve this purpose.

**6.1.3 Physical Security**. The Committee supports ongoing (a) training and risk assessment efforts, (b) review of chain of custody procedures for tabulator security, and (c) periodic review of tabulator and memory card storage and records.

**6.1.4 Disable Serial Port.** The Committee recommends permanently disabling the current Accuvote® - OS serial port, with 3 witnesses attesting that the operation was completed.

**6.1.5 Upgrade AccuVote® Firmware Chip**. The Committee recommends that the Ballot Law Commission rescind the approval of the AccuVote® Version 1.94w firmware chip and tabulators with non-lucid read heads and approve the AccuVote® 1.96.13 AVOS firmware chip and the accompanying GEMS 1.21.5

election programming software. The Committee recommends that the manufacturer represent and certify that the foregoing software and hardware have been installed.

**6.1.6 Random Audits.** The Committee recommends a statewide post-election hand-counted audit of randomly selected jurisdictions and randomly selected races (focusing on those contests not covered by recounts), with sufficient statistical power to confirm that not enough error exists to change election outcomes. In terms of resource allocation, this deserves the highest priority.

## 6.2 Future Tabulator

**6.2.1 Issue RFI.** The Committee recommends the Department of State issue a Request for Information (contemplated RFI), which is currently in draft stage, to encourage proposals to achieve the goals identified by HB 285 and the Electronic Ballot Counting Device Advisory Committee. Characteristics of the contemplated RFI:

6.2.1.1 Encourage Competition**.** Encourage vertical and horizontal competition within the election system industry.

6.2.1.2 Encourage modular design. Encourage vendors to create interoperable modular components for voting systems, with EML between modules and cryptography where appropriate.

6.2.1.3 Election Markup Language Interfaces (EML). Enable public inspection and forensics between modules with EML.

6.2.1.4. Granular System Design Specifications. Cooperate with other states, scientists and organizations to design systems at a more detailed level, keeping design in public domain.

6.2.1.5 Transparency in System Design. Encourage transparency in system design to enable an independent technical review.

6.2.1.6 Common Engineering Standards. Rely on recognized engineering standards that can be tested by approved test labs.

6.2.1.7 Fail safe. Design optical scan tabulator so that a ballot cannot drop into the box under the tabulator unless the ballot has been counted.

6.2.1.8 Election Management System. Create a fully functional election management system that would include five major interfaces: (1) ballot layout, (2) accessible voting system, (3) optical scan system, (4) ballot printer, and (5) election reporting to any appropriate public website. This could

result in cost savings in ballot proofing, printing, ballot rotations, and election programming of optical scan tabulators and the accessible voting system.

**6.2.2 Election Programming.** The Committee recommends that the state have the option of performing election programming in both state and federal elections. Local election programming could be performed by a vendor or by the cities and towns.

**6.2.3 Pre-election Testing.** Expand pre-election testing by creating an election management system that can automate production of test ballots.

**6.2.4 Allocate Costs According to Responsibility.** Local governments should maintain their traditional role of counting ballots and cover reasonable costs to achieve accuracy, security, reliability, and maintain credibility. Otherwise, they should revert to hand counts.

**6.2.5 Random Audits.** The Committee recommends a statewide post-election hand-counted audit of randomly selected jurisdictions and randomly selected races (focusing on those contests not covered by recounts), with sufficient statistical power to confirm that not enough error exists to change election outcomes.

**HB 285, Chapter 134 of the Laws of 2009**
**COMMITTEE**

## COMMITTEE MEMBERS:

**Hon. Richard Drisko - House of Representatives**
**Hon. Suzanne Harvey - House of Representatives**
**Hon. Robert Perry - House of Representatives**
**Walter Fries, Town Moderator - Local Election Official**
**Donald Stritch, Town Moderator - Local Election Official**
**James Tetreault, Town Clerk - Local Election Official**
**Steven Edwards – Public Member**
**Adrienne Hutchison – Public Member**
**Assistant Secretary of State Anthony Stevens – Department of State**
**Assistant Secretary of State Thomas Manning – Department of State**

**GUESTS**

**Ronald L. Rivest, Andrew and Erna Viterbi Professor of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, Chair, Subcommittee on Security and Transparency, EAC Technical Guidelines Development Committee**

**Gregory Miller, Co-Executive Director and Chief Development Officer of Open Source Digital Voting Foundation**

**John Sebes, Co-Executive Director and Chief Technology Officer, Open Source Digital Voting Foundation**

**Pito Salas, Pito Salas and Associates**

**Kathy DeWolfe, Vermont Director of Elections and Campaign Finance**

**Robert Dezmelyk, Newton Moderator, EAC Standards Board Member and President of LCS/Telegraphics**

**Mitch Trachtenberg, Technology Director, TEVSystems**

**Pamela Smith, President of Verified Voting**

**Jack Carroll, Engineer, Nashua**

**John Silvestro, Jeff Silvestro and Gerry Bergeron of LHS Associates, LLC**

**Professor Andrew Appel, Chair of the Department of Computer Science, Princeton University**