

# **UniLect Corporation PATRIOT Voting System**

## **An Evaluation**

**Prepared for  
The Secretary of the Commonwealth of Pennsylvania**

**by**

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### **Summary**

This report contains the findings of the examiner appointed by the Secretary of the Commonwealth arising out of a certification reexamination of the UniLect Corporation Patriot Voting System conducted in Harrisburg on February 15, 2005 pursuant to Section 1105-A of the Pennsylvania Election Code.

Certification of Patriot should be revoked because the system upon reexamination failed to comply with at least eight provisions of the Pennsylvania Election Code.

## Statutory Requirements

The statutory process under which voting systems are certified in Pennsylvania changed in 2002 with the passage of Act 2002-150 (the “2002 Act”). To be certified for use in Pennsylvania, a voting system must have “been examined and approved by a federally recognized independent testing authority” and meet “any voting system performance and test standards established by the Federal government.”<sup>1</sup> Such a system must then be examined for compliance with Pennsylvania statutory standards: “No electronic voting system shall, upon any examination or reexamination, be approved by the Secretary of the Commonwealth, or by any examiner appointed by him, unless it shall be established that such system, at the time of such examination or reexamination” meets the 17 mandatory requirements of 25 P.S. §3031.7<sup>2</sup>. I was the “examiner appointed by him” for the Patriot examination.

To evaluate systems for conformance to the requirements, the Department of State formerly convened, from time to time, a panel of three examiners pursuant to statute. The examiners inspected and tested the proposed system and wrote separate reports to the Secretary. Based on these reports, which were designated public documents by statute, the Secretary, who was not bound by the opinions or findings of the examiners, would grant or deny certification. I served as one of the three examiners from 1980 until 2000.

In 2002, because of the emergence of voluntary voting system standards promulgated by the Federal Election Commission (FEC) and the passage of the Help America Vote Act of 2002 (“HAVA”), which gave statutory recognition to the process of Federal qualification, Pennsylvania revised its examination process as described above. The 17 mandatory requirements were retained. HAVA specifically allows a state to impose more stringent conditions on voting systems than the minimum specifications of HAVA<sup>3</sup>, and Pennsylvania has done so.

The 2002 Act eliminated the panel of three examiners, but did not disturb the sole power of the Secretary of the Commonwealth to decide whether a system should be certified. The statute does not require the Secretary to conduct a voting system examination personally, but may delegate the responsibility to any person of his choosing. I was retained as a consultant to the Department of State to conduct the examination and produce this recommendation, by which the Secretary is not bound.

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<sup>1</sup> Sec. 1105-A, as amended by Act 2002-150. The word “any” in the statute does not include obsolete standards.

<sup>2</sup> There are other mandatory requirements in other locations in the Act, such as the one stating that “the system shall produce a permanent physical record of every vote cast,” which is found under the definition of a “voting system” in Sec. 1101, codified at 25 P.S. §3031.1.

<sup>3</sup> HAVA Sec. 304, 42 U.S.C. §15484.

The first FEC Standards were issued in 1990<sup>4</sup>. By the end of that decade it had become clear that a full revision to the Standards was required. Accordingly, in 2002 the FEC published its “Voting Systems Performance and Test Standards,” usually known as the “2002 Standards”). The reason, as stated therein, was that “rapid advancements in information and personal computer technologies have introduced new voting system development and implementation scenarios not contemplated by the 1990 Standards.” It is clear then, that the 2002 Standards render the 1990 Standards obsolete and inoperative.

Section 301 of HAVA imposes further conditions on systems used in elections for federal offices, specifically that “the voting system shall produce a permanent paper record with a manual audit capacity for such system.”<sup>5</sup> While theoretically a system that is not used for federal offices would not need to meet HAVA requirements, it is not realistic for a jurisdiction to employ two entire voting systems, so as a practical matter any system that is certified must satisfy HAVA also.

## The Reexamination Process

The 2002 Act did not alter the mechanism by which Pennsylvania voters may request the Secretary to conduct a reexamination of a system previously certified: “Any ten or more persons, being qualified registered electors of this Commonwealth, may, at any time, request the Secretary of the Commonwealth to reexamine any electronic voting system theretofore examined and approved by him.”<sup>6</sup> The electors desiring reexamination collectively must tender a fee of \$450, after which it is in the discretion of the Secretary whether to compel an examination. He granted the request in this case, but was under no obligation to do so. Since electronic voting became legal in Pennsylvania in 1980, no group of electors had previously requested a reexamination and no such reexamination had ever been held.

The electors who requested the reexamination in this instance were residents of Beaver County who styled themselves “petitioners,” although the statute does not provide for any petition process, nor, indeed, any respondent party. The vendor whose equipment is to be reexamined has no standing under the statute to object to a demand by the Secretary of the Commonwealth to submit to a reexamination. On the contrary, the Secretary himself may order a reexamination at any time *sua sponte*<sup>7</sup>. The statute does not require that the request be made for any sound reason, nor indeed for any stated reason at all, though presumably the Secretary would not grant requests that were frivolous or brought merely to harass. Otherwise, a vendor could be subjected to the annoyance of virtually continuous reexamination.

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<sup>4</sup> *Performance and Test Standards for Punchcard, Marksense and Direct Recording Electronic Voting Systems*, Federal Election Commission (January 1990).

<sup>5</sup> This requirement takes effect on January 1, 2006, so it would not be useful for a jurisdiction to invest in a system in 2005 that failed to meet it.

<sup>6</sup> Act 1980-128, Sec. 1105-A(a), codified at 25 P.S. §3031.5(a).

<sup>7</sup> Act 1980-128, Sec. 1105-A, codified at 25 P.S. §3031.5.

There is a critical difference between an initial examination and a reexamination. At the latter the Secretary is able to consider information based on actual use of the system in Pennsylvania. Such experience may yield insight into problems that would not ordinarily be observed in a brief initial certification exam, particularly since average voters do not participate in such an examination. A good deal of information concerning the use of Patriot in Mercer County in November 2004 was made available at the examination.

## **UniLect Patriot**

Presented for reexamination are three components of the UniLect Patriot DRE system:

- County-level Windows personal computer for configuring ballots and accumulating votes, software version 2.45.
- Precinct control unit for activating voter terminals and accumulating machine totals, firmware version 2.52.
- Patriot touchscreen voting unit, firmware version 2.52.

For unexplained reasons, the mark sense components of the Patriot system, used for counting absentee ballots, were not presented for reexamination. Therefore, those components cannot be granted continued certification.

Patriot is certified for use in 15 states and is actually in use in approximately 30 counties nationwide. In Pennsylvania it is used in Beaver, Greene and Mercer counties. Certification was initially granted in Pennsylvania on August 15, 1994.

In Patriot, each county is outfitted with a Patriot Central Station personal computer and software for defining ballots and writing InfoPacks, which are portable electronic memories used for transferring ballot configurations, vote totals, log files, and electronic audit trails. The PC can physically be networked or connected to the Internet, although the vendor recommends that this not be done and that the PC should be dedicated to a single application. The PC can be used to assemble results from multiple precincts to produce a county-wide tabulation. It can also produce camera-ready ballot images for printing absentee ballots.

The precinct system includes a precinct control unit (PCU) that is capable of controlling up to 32 individual voting terminals. The proprietary design is based on an 8008 processor, and the unit does not run an operating system. Instead, all of its functions are controlled by a software program created by the vendor. It is not and cannot be networked, and has no communication

capability other than a modem connection. Such a structure has security benefits in that the usual methods of spreading malicious code such as viruses are not possible. The PCU is used by an election judge to activate individual Voter Units with specific ballot styles for individual voters. Voters do not touch or operate the PCU. The PCU receives information about the ballot styles to be used in a precinct from an InfoPack prepared at the county level.

The PCU includes an internal printer that is used for producing the initial zero totals tape, precinct vote totals, a log file of election events and, when requested, a paper audit trail containing the contents of all ballots cast in randomized order.

A Voter Unit consists of a resistive touchscreen, an internal processor and a socket from which the unit receives power and communicates ballots to the PCU. Under control of an election judge, the PCU uploads a multi-page ballot to the Voter Unit. The voter votes by touching the screen, navigating through the ballot and making selections. As the voter chooses a candidate, an "X" lights up next to the candidate's name on the screen. A candidate can be deselected by touching the active space containing the candidate's name an additional time. After the voter has made her selections, she is able to review all her choice son a summary page before taking the last act necessary to record the ballot.

When the ballot is cast, it is transmitted over a cable from the Voter Unit to the PCU. At the PCU, the ballot image is recorded in an internal memory and on the InfoPack installed in the PCU. Cumulative vote totals are stored redundantly in seven locations. When voting is complete for the day, the PCU and InfoPack contain duplicate copies of all ballots cast. The precinct totals can then be printed out and signed by the judges and/or the InfoPack can be transported to the county Central Station for accumulation. In an additional mode, not authorized in Pennsylvania, unofficial totals can be transmitted by telephone modem to the Central Station. If a modem is used, it dials a number set in the InfoPack when it is created at the County, and the connection is encrypted using a 128-bit AES key.

Vote files are not encrypted but are stored in a confidential format. If this format is discovered by an insider having access to either the PCU or the Central Station, there is the possibility of altering vote totals, although doing this undetectably would require a tremendous amount of knowledge of the system because of the use of checksums and redundant storage. For example, the audit trails on the PCU and InfoPack would both have to be modified to match the altered totals. This would have to be done prior to the close of polls since the totals are printed out at the precinct at that time and

signed by the judges. Any later alteration would be revealed in the canvass. The vendor regards such a manipulation as unrealistic, and I agree.

The only interface between the voter and the system is through the touchscreen. In addition, the Voter Unit does not store any ballots or vote totals other than the ballot currently being cast by the voter. Therefore a voter cannot affect or tamper with any votes.

The Voter Units are connected to the PCU in a “daisy chain” fashion similar to Christmas tree lights. When the PCU is plugged in and turned on, it performs a limited diagnostic self-test to determine whether it is in communication with all of its components. The random access memory (RAM) is tested, then the InfoPack is tested. The PCU then performs a scan looking for Voting Units and assigns numbers to them in the configuration presented. If all of these steps are performed successfully, the PCU indicates that it is “ready.”

At this point, the polls can be opened via a single button press. A zero totals tape is produced automatically (under most conditions)<sup>8</sup>, that contains all candidates and issues in all ballots styles to be used at the precinct. The front panel of the PCU contains a lamp for each Voting Unit form which the judge can determine a unit’s status. A flashing light indicates that a unit is ready and available for voting. When the unit is initialized with a specific ballot style and can be voted on by a voter, the light glows continuously. If the light is out, the unit is either not present or not able to be voted upon.

The process during voting is that each voter presents her credentials at the polling place. If the voter is eligible to vote, the judge activates a particular Voting Unit by hitting the “Next Voter” button and directing the voter to the corresponding machine. In the event that more than one ballot style is being used at the precinct, the judge selects the ballot style that is correct for that particular voter. When the voter finishes voting, the unit cannot be used until it is once again activated by the judge.

The PCU includes a public counter showing the total number of votes cast since the opening of polls. The Voter Units do not have such counters. 25 P. S. §3031.7(16)(i) requires that “the district component of the automatic tabulating equipment” of an electronic voting system have a “public counter, the register of which is visible from the outside of the automatic tabulating equipment component into

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<sup>8</sup> During the examination, the vendor’s representative revealed that it is possible to enter a code that will cause the PCU to omit the step of printing a zero tape. The existence of this capability is unfortunate since its use would violate 25 P.S. §3031.7(16)(v), which requires “a printed record at the beginning of its operation which verifies that the tabulating elements for each candidate position and each question and the public counter are all set to zero.”

which the ballots are entered, which shall show during any period of operation the total number of ballots entered for computation and tabulation.” In the Patriot system, the “tabulating equipment” is the PCU, so having the public counter there, and not on the Voter Unit, satisfies the statutory requirement.

The vendor submitted its source code to the examiner. I have examined it in cursory fashion. The programs are written in the C language and are well structured. The PC programs comprise about 1MB of source text, the PCU software about 900KB and the Patriot Voter Unit about 400KB, which relatively small for a system of this type. The code provided did not correspond exactly to the system submitted for reexamination. The source code for the PCU was labeled version 2.54, but the device presented was version 2.52.

## **The Reexamination**

Present at the reexamination on February 15, 2005 were the Commissioner of the Bureau of Commissions, Elections and Legislation, the examiner, various representatives of the Department of State, and Jack Gerbel and George Mitchell, representatives of UniLect Corporation. A limited number of members of the public and the press were permitted to attend the reexamination, as was a representative of the requesting electors. The examination began at approximately 10:10 a.m. in Harrisburg at the office of the Secretary of the Commonwealth. The proceedings, lasting approximately 5.5 hours, were recorded on videotape.

The vendor conducted a demonstration and explanation of the system and its component and answered questions. Thereafter, the examiner conducted various tests and cast predefined ballots, the totals for which had been computed in advance so the results could be compared with those produced by the system.

The process by which a judge selecting a ballot style, or a Voting Unit in case more than 16 are being used, is very cumbersome. This is because the PCU is very simple and has a limited number of buttons, no keyboard and only a small LCD screen. The election judge can only give it commands by depressing buttons in a certain sequence or by depressing multiple buttons simultaneously in chord-like fashion. As new system capabilities have been added, activating them requires more and more complex button combinations. At times during the examination, the vendor demonstrator himself was unable to recall the correct sequences. This is of significance since the selection of the wrong ballot disenfranchises a voter and might very easily go undetected.

After a Voter Unit is activated, the voter screen contains a rectangle with the text: "Touch here to begin voting." One in fact can touch anywhere on the screen to begin voting, in which case a more informative message would be "Touch anywhere on the screen to begin voting." The vendor countered that the message is just a text string in the unit's program and can readily be changed. While this may be true, it is an example of a number of confusing navigational messages produced by the system. In a certification we have many hours to review the behavior of a system, while a voter on election day only has minutes and is allowed only a single chance to get things right.

. Another example of instructions that are difficult to understand and follow appears on the write-in screen. If the voter desires to write in the name of a candidate, she selects a "write-in" rectangle under the desired office. A new screen appears that lists the letters A-Z in alphabetical order so the name can be spelled out. At the top of the screen are two "buttons": "Cancel Write-In" and "Start Over." If the voter misspells a write-in name, it would be natural to assume that "Start Over" would enable the voter to begin typing the name again. One would assume that "Cancel Write-In" means "I have decided not to cast a write-in vote. Please return me to the office in which I was voting." However, the buttons do not have these natural meanings. "Cancel Write-In" does not mean to cancel the write-in; it means to start typing in the write-in process over again. "Start Over" does not mean to start the write-in over, but to start the entire voting process over.

The vendor countered that any such confusion could be quickly dispelled if the voters would only read the documentation provided with the voting machine. Even assuming such an expectation were realistic, which it is not, the vendor admitted that not all of the system's navigational behaviors are documented.

There are further write-in problems. At our first attempt to tabulate votes during the examination, ballots were duly transferred from a PCU to a Central Station via the InfoPack and the votes were tabulated. The totals for registered candidates were correct, but the names of write-in candidates were not transferred. After some contemplation, the vendor explained that the InfoPack bearing the votes was not prepared on the Central Station that was being used to read the votes, and the Central Station was set up for a slightly different election. This explanation was plausible but frightening. There was no overt indication that there was any mismatch between the Central Station and the InfoPack. It was only when I asked where the names of the write-ins were that anything was discovered to be amiss. The votes were accepted and tabulated without objection from the machine.

Of course, in normal use the InfoPack would be written on the same machine that would later be used to accumulate votes, but that is not necessarily the case. Something might go wrong with the Central Station and it might have to be replaced. Worse, the scenario observed makes it possible for an insider to alter vote totals not by manipulating the proprietary files on the Central Station (which is difficult), but by changing the election setup on the Central Station, which is easy since software is provided to do it. The mode of attack would be to code an election normally and make InfoPacks. Precincts would test the election coding and find everything to be in order. An insider would then change the election coding at the Central Station at his leisure anytime after the InfoPacks had been created up until counting on election night. When the InfoPacks were returned, the votes on them would no longer correspond to the original voting positions on the InfoPacks, and the vote totals would be “correct” but would be credited to the wrong candidates. This attack is plausible because we observed it in an inadvertent way and on a small scale during the examination. It would be straightforward to guard against this attack by maintaining checksums of various files to detect a mismatch between the InfoPack and the Central Station.

### **Straight-Party Voting**

Pennsylvania requires that a voter be able “by one mark or act, to vote for all the candidates of one political party for every office to be voted for ... except with respect to those offices as to which the voter has registered a vote for individual candidates of the same or another political party or political body, in which case the automatic tabulating equipment shall credit the vote for that office only for the candidate individually so selected, notwithstanding the fact that the voter may not have individually voted for the full number of candidates for that office for which he was entitled to vote.”<sup>9</sup> This method of tabulating straight-party votes is unique in the United States and is known as the “Pennsylvania Method.” Over time, many vendors have failed to understand and implement it correctly. As far as selecting candidates, the Patriot system behaves properly.

UniLect, however, has chosen to implement a straight-party “deselect” feature that finds no basis in statute and is inconsistent and confusing. In the world of electronic voting, an analogy is often drawn between lever and DRE machines. Each has a finite number of on/off positions, and the levers can be moved up or down at the voter’s convenience, just as the electronic selections on the DRE can be toggled on or off.

On a lever machine, the effect of pulling the straight party lever is to pull down all of the levers corresponding to candidates of that party. No subsequent manipulation of the straight-party lever will remove any votes for any candidates. If the voter desires to do that, she can just push the relevant levers back to their unvoted positions. That is, there is

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<sup>9</sup> 25 P.S. §3031.7(3).

no “deselect” function for a straight party vote on a lever machine.

Patriot attempts to provide a deselect straight-party function, as follows. The first “office” on the ballot is the straight-party “office.” When the voter selects a party, the effect is to cause an X to appear next to the name of every candidate affiliated with that party. This is the normal, expected behavior. The voter is then free to peruse the ballot and “override” the straight party selection in one or more office by either selecting specific candidates for the same party or “crossing over” and selecting one or more candidates of other parties. In the event that a voter touches any candidate at all in an office in which a straight-party candidate has been selected, all the straight-party votes for the candidates in that office, other than the ones “individually so selected,” are removed pursuant to the Pennsylvania Method. Patriot indeed performs this function properly.

The problem occurs when the voter attempts to deselect or change the straight party choice in the straight party office. There is no statutory guidance for what should occur, and reasonable people might differ as to what the expected or “correct” behavior ought to be. In my opinion, the Patriot does not conform to any of the options a reasonable person might expect.

Suppose the voter selects straight Republican and then overrides the choice in a vote-for-two office (say, County Commissioner) by selecting a Democrat and a Republican. If she then goes back to the straight party office and deselects the Republican straight party choice, what should the system do? Under the Pennsylvania Method, it should not affect any of the choices in the County Commissioner race, since the voter individually selected candidates there. What Patriot does is to remove the vote for the Republican and leave the vote for the Democrat. While there might be some logic behind this (although it contravenes the statute), there is no logic to what happens if the voter again selects straight Republican. In that case, the system does NOT restore the vote for the Republican candidate whose vote it just cancelled, but it does retain the vote for the Democrat. Once a voter has made one or more individual choices in an office, there is no basis for treating the candidates differently based on party affiliation, nor is there any basis for altering any of the choices in that office.

The deselect behavior might not be so objectionable if the voter could see what is going on and thus have an immediate opportunity to correct the ballot, but straight party voting on DREs that do not display a full-face ballot, causes changes to be made on ballot pages that are not currently being viewed by the voter. In fact, it may cause the entire ballot to be changed. For the initial straight party choice everyone expects this. That’s what straight party voting is supposed to do – serve as a shorthand so that loyal party voters can abbreviate their action. However, any other behavior that is not completely understood and expected by the voter will cause unforeseen changes to portions of the ballot that are not in view.

The vendor replies that the voter always has a chance to examine the review screen and thus has an opportunity to verify the ballot and make any changes. This presumes

that the voter is diligent in doing so. The high undervote rate in the Pennsylvania Patriot counties demonstrates that voters do not necessarily make effective use of the review screen. A voter who votes straight party is specifically avoiding the need to examine individual offices, so the assumption that such a voter would perform a complete ballot review is unjustified. In general, voting systems should be designed so that the voter gets it right the first time, and is not obliged to undertake a minute inspection of the ballot for choices that might have been added or subtracted unexpectedly by the machine.

What's the answer? I would not offer any straight party "deselect" feature. If a voter attempts to change a straight party vote, a message should appear explaining that the way to accomplish this is to make choices in each office individually. This may be more cumbersome, but it eliminates the chance of inadvertent disenfranchisement, or, possibly worse, the voter casting votes for candidates she did not want.

### **Provisional Voting**

Despite the fact that it was announced prior to the examination that provisional voting would not be examined, the vendor demonstrated provisional voting anyway. Provisional voting in Pennsylvania is conducted on document ballots; the votes are not provisionally stored in a DRE machine as they are in some other states. It is possible that the Legislature may permit DRE provisional voting in the future, but it has not yet done so.

Anticipating problems that will arise with UniLect if DRE provisional voting is adopted here, I will take the time to describe my observations during the examination. To activate the Voter Unit to accept a provisional ballot, the judge is supposed to hit the "Accumulate" button on the PCU. Normally, "Accumulate" is not pressed while the polls are open, so when provisional voting was added and no specific button was added to initiate it, the "Accumulate" button happened to be available. So UniLect used it. I find it confusing when a button's label does not correspond to the button's function, but this is a problem with hardware devices that must be adapted for new needs and uses. Unlike a computer screen, which can display arbitrary text and images, a hardware panel cannot readily be changed.

But having an unconventional button label is not the only problem. Provisional votes do not advance the public counter, so a member of the public has no way of knowing how many provisional votes have been cast at any time during voting. The vendor counters that the voter could just ask a poll worker, but that does not satisfy the statutory requirement of a public counter under 25 P. S. §3031.7(16)(i). Likewise, there is no paper audit trail produced for provisional votes on the PCU, which contravenes the "permanent physical record" requirement of 25 P.S. §3031.1.

### **Security**

The very design of Patriot makes it inherently much more secure than many competitive products. By not networking the Voter Units, using no operating system on

the PCU and attaching no keyboard to either, the opportunities for malicious attack are significantly reduced. This does not mean that the system is invulnerable, however.

At the Central Station, a capability for “manual edit” of vote totals is provided. This means nothing less than the ability change vote totals to any desired numbers. It is true that any totals must conform to the canvass, but this is commonly not understood by the public and is not understood at all by the legion of computer scientists who have criticized DRE voting as inherently unsafe. Nevertheless, the public perception that an insider can alter vote totals, even if those totals are not used to declare an official winner, makes it imperative that it be prevented.

The vendor pointed out that any effort to change totals would be logged in a log file, so we explored that path during the examination. The “log,” both on the PCU and the Central Station, consists of a file of information. On the Central Station, this is an unencrypted text file that is editable by the user. It is possible, therefore, for someone to alter the vote totals and then edit the log to remove any mention of the change. Furthermore, the log only records events that are initiated through the Patriot software. Functions performed through the Windows operating system interface, such as copying, deleting or substituting a file, are not logged at all. So another way of altering vote totals is to replace the totals file by another, and this will also not be logged.

The precinct log, maintained at the PCU, is rudimentary. It does not record each event of voting, but only gross milestones such as the opening and closing of polls. It is not possible to tell from the log, for example, how many voters voted. It also contains no record of provisional voting at all.

A solution to the problem of log file editing is to keep the log on a write-once device, such as a CD-R or a paper printer. In an implementation provided by UniLect in Texas, a paper log printer must be connected to the Central Station and no functions can be performed if the printer is not in “ready” condition. In this way it is not feasible to alter log records, although certain events can transpire that would still not be logged.

It would be desirable to put every voting system, and not just DREs, through a thorough red team security review. This has not been done with Patriot, but my belief is that the simplicity and design of the system, combined with the highly decentralized method of reporting, tabulating and canvassing votes in Pennsylvania, makes it unlikely that security is a significant issue with respect to 25 P.S. §3031.7(16)(iii), requiring that all persons be precluded from “from tampering with the tabulating element.”

## **Reliability**

Among the complaints received about the Patriot system is that the touchscreen does not function reliably. That is, when a voter touches the screen, the touch is not necessarily sensed, which results in the voter incorrectly believing that she has cast a vote. This behavior was observed during the examination, when sometimes multiple depressions did not result in the touch being sensed. The vendor explained that the

screen is made up of a large number of individual “pouches” and that it is necessary to press a pouch in order for the vote to be detected. At times, the voter may touch the screen between two pouches, which has no effect.

While it is satisfying to some degree to understand why the screen does not always function, such an explanation would be of little solace to a voter whose choice was ignored as a result. The screen is supposed to have 44 voting positions that can be sensed. These are not marked on the screen and the vendor stated that there is no effective procedure for testing whether all 44 positions are working.

A different but possibly related problem is that the system occasionally enters a mode in which no touch at all can be recorded anywhere on the screen. This behavior can be observed at timing mark 2:30 on the videotape. The screen froze up and would not respond to any input. While the vendor did not respond to entreaties to explain what he was doing or what the nature of the problem might be, his solution was to disconnect the non-functioning unit. I was not able to determine whether the condition was caused by a malfunction of the screen hardware or whether it was a software problem. Nevertheless, it was consistent with reports that have been received concerning DRE screen failures. It is neither comforting nor compliant with statute. 25 P.S. 3031.7(11) requires that a system be “suitably designed for the purpose used, ... safely and efficiently useable in the conduct of elections and, with respect to the counting of ballots cast at each district, is suitably designed and equipped to be capable of absolute accuracy.” A system that fails to recognize voter choices is not capable of absolute accuracy. 25 P.S. 3031.7(13) requires state that a system “When properly operated, records correctly and computes and tabulates accurately every valid vote registered.” Between 2:30 and 2:52 on the videotape I can be observed operating the system properly, yet it did not record all of the votes I cast while being observed by Mercer County Commissioner Michele Brooks. It was at times necessary to touch the screen three times in order to get a vote to register.

### **The Standard Test**

Pennsylvania has developed a 12-ballot test to determine whether a system tabulates ballots in accordance with Pennsylvania law, and in particular tests the Pennsylvania Method of tabulating overrides to straight party votes. This test is not intended to stress the system or exercise all possible logical paths in its software, but merely to check whether the system correctly implements the particular requirements of the Commonwealth. This test was performed and all 12 ballots were tabulated correctly. It was sometimes necessary to press the screen several times during the test to cause choices to register properly.

### **Patriot Certification History**

Patriot has been examined several times for certification in Pennsylvania. From 1980 until 2000, I served as statutory examiner for the Commonwealth

and I examined every system presented for certification in Pennsylvania during those years. Because the UniLect Patriot system was ultimately certified, it has been suggested by citizens interested in the matter that by conducting a reexamination, I would have a conflict of interest in that (1) I might be unwilling to recommend decertification and (2) any recommendation of certification I might offer would lack credibility. These citizens are obviously not aware of the history of the UniLect certification, or they would know that I did not recommend certification of the system I previously examined.

Patriot was first examined for certification in Pennsylvania on July 7, 1993. I was present at the examination and wrote an initial report in which I concluded that Patriot was not “currently eligible for certification because of failure to conform to statutory requirements.” Among other problems, I observed that the “touch panel was found to be difficult to use in the sense that it did not respond to depression in some cases until the screen was pressed hard or multiple times.” I recommended requiring a second certification exam after the vendor was given an opportunity to rectify the problems.

This recommendation was accepted by the Secretary, and a second examination of Patriot was held on October 27, 1993. In my report following that examination, I listed four deficiencies that precluded certification, and offered the opinion that the system could be certified only if the deficiencies were remedied “to the satisfaction of the Bureau of Elections.”

Apparently the Bureau was eventually satisfied without requiring another formal examination, since certification was granted on August 15, 1994, nearly 10 months after the second examination. However, I never reviewed the changes that were made nor had an opportunity to inspect Patriot again prior to its certification. I am not aware of any further proceedings concerning UniLect prior to the request for reexamination.

In fact it is still the case today, as it was in 1993, that the touch panel is difficult to use, and some problems detailed in my prior reports have still not been eliminated.

## **Patriot in Pennsylvania**

Patriot was acquired by Beaver and Greene Counties in Pennsylvania in 1998 and by Mercer County in 2001.

By all accounts, including new reports, data from Mercer County and the vendor’s own admissions, the 2004 general election in that county was a

disaster from the viewpoint of both voters and election officials, resulting in an undervote percentage as high as 80% in some precincts. In the aftermath in December 2004, County Elections Director James Bennington resigned his post.

I reviewed two documents relating to the Mercer County experience and questioned the vendor about their contents during the examination. The first is an official report issued February 8, 2005 by an Independent Election Committee assembled by the Mercer County Board of Commissioners in the wake of the 2004 election (the “Mercer Report”). The second was a letter from “Members of Mercer County Citizens for Better Government” addressed to Jonathan Marks, an employee of the Department of State, and dated February 14, 2005 (the “Mercer Letter”).

### **The Mercer Report**

The Mercer Report is 22 pages long as lists as its purpose to serve “as a starting point for restoring the integrity of elections in Mercer County.” It contains summaries of various problems that occurred there and a list of seven recommendations. Among the problems related to the voting machines that were detailed are: inadequate testing, maintenance and preparation of machines, inadequate training of poll workers, insufficient election supplies (including paper tape for the voting machines), insufficient repair personnel, and an unacceptably high undervote count.

All of the issues raised in the Report regarding the UniLect system itself (as opposed to matters of election administration) are discussed in this reexamination document. The Report was of material help to me in understanding the events that transpired in Mercer County, and I am in agreement with all of the recommendations of the Independent Election Committee. The last of the Committee’s recommendations is that the Mercer County Board of Commissioners “explore the option of providing a voter-verifiable paper ballot to go along with each electronic voting unit.” There is no reason not to explore such an option<sup>10</sup>. However, a voter-verifiable paper trail would not have solved any of the problems observed in Mercer County, nor did the Committee suggest how it might have done so. There is no evidence that the Patriot review screen failed to provide an accurate summary of the voters’ ballots, and there is no evidence that any ballot cast by a voter was recorded incorrectly. The Committee did not even take note that the Patriot already produces a paper audit trail, and there is no indication that any such paper trail was ever printed or examined in Mercer County to diagnose any problem that occurred there.

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<sup>10</sup> The Report correctly observes on p. 14 that a verifiable paper trail cannot be used in Pennsylvania as contemplated by its proponents without an amendment to the Election Code.

## The Mercer Letter

The Mercer Letter was supplied to me minutes before the examination began. It raises four substantive questions that merit a public response.

First, the letter notes that 25 P.S. §3031.7(13) requires that, “when properly operated,” the system “records correctly and computes and tabulates accurately every valid vote registered.” It then states that significant undervoting (of the order of 8%) was observed in several precincts in which the ballots had not been misprogrammed and asks “how can the UniLect Patriot System be found to be compliant with the above stated requirement when these states 28 precincts recorded such large undervotes with no outward signs of malfunction.”?

The question, while earnest, misapprehends the function of a certification examination. It is not an acceptance test on a specific unit or batch of machines that have been delivered to a county. It is an examination to determine whether the system as designed is safe for use in Pennsylvania. The quoted provision is qualified by the term “when properly operated.” There are many reasons that undervotes may be observed in an election, for example:

1. Voters did not vote a full ballot (intentional undervote).
2. Voters were confused, either through insufficient familiarity with the machines or an inherently confusing human interface, and believed incorrectly that they had voted a full ballot.
3. Voters believed that touching the screen would cause a voting choice to be captured and did not realize that they needed to check to be sure the machine properly indicated the choice on its screen.
4. Voters undervoted inadvertently and did not notice, or ignored, the undervote warning on the review screen.
5. Machines malfunctioned and erroneously failed to alert the voters that they had undervoted.
6. Machines contained software errors that caused votes selected by the voters to not be recorded.
7. The ballot was set up incorrectly.

Neither the Mercer Letter nor the Mercer Report offers any insight into the reasons for high undervote in precincts that were not misprogrammed. There is no evidence at all that 5 or 6 occurred in these precincts. If it is alleged that a particular machine failed to record votes that were actually reflected on the screen, then such machine should be impounded and subjected to forensic examination. The same is true of any machine suspected of failing to warn voters that they have undervoted. Such a machine should also be impounded and examined. I am not aware now, five months after the election, that any such error was detected in any Patriot used in Pennsylvania.

The most likely explanation for high undervote in the present circumstances, aside from the precincts in which there was a ballot setup error, is a combination of several

factors, including unreliable screens, voter unfamiliarity with the system and a confusing user interface. It is probable that voters who did not intend to undervote either did not make use of the review screen, did not understand how to return to the undervoted offices, or were even unaware that they had been warned of an undervote.

Because there is some question as to whether the machines were “properly operated” by the voters per the instructions, I do not believe that §3031.7(13) is implicated. Instead, the averred facts go to the requirement that the system be “so constructed that a voter may readily learn the method of operating it,”<sup>11</sup> the second point raised in the Letter.

However, the performance of Patriot in Mercer County and events that occurred at the reexamination call into question whether the system is “safely and efficiently useable in the conduct of elections,” which is the touchstone of the Secretary’s determination. I have concluded that it is not. One might explain away the high undervote in Mercer County by pointing to the misprogramming and the relatively short time that the system has been in use there, but these do not explain the undervote in Beaver and Greene Counties.

The third point in the letter expresses concern that the UniLect system “contains no permanent verified paper record of votes and yet was certified by the State of Pennsylvania even in its absence.” As do all DRE systems used in Pennsylvania, UniLect does produce a paper record of all votes cast (except provisionals, as noted), but it is not “verified” in the sense that the voter does not ever see the paper record. A “verified” paper record is not required in Pennsylvania, and in 1994, when UniLect was first certified here, no state imposed such a requirement. Even today, only a tiny minority of states require a verified paper record. While having such a record may afford psychological comfort to voters, there is no evidence at all that votes shown to Pennsylvania voters on the UniLect screen were not faithfully recorded. While it is within the power of the Legislature of the Secretary to impose such a requirement, it has not done so, wisely, in my view.

One of the problems actually observed with Patriot was unreliability of the machines on election day. The addition of a printer to a voting machine to produce a verified paper record does not increase the reliability of the machine since it offers yet another device that can fail and increases the load on the machine’s power supply. There are several methods of introducing voter verification without using paper or printers.

At present there is not a single system that produces a verified paper record that is certified in Pennsylvania. It is not a HAVA requirement and there are no federal qualification standards for such a machine<sup>12</sup>. If one were required, no DRE machines

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<sup>11</sup> Act 1980-128, Sec. 1107-A(15), codified at 25 P.S. §3031.7(15).

<sup>12</sup> The legislative history of HAVA makes it clear that the Section 301 requirement of a “permanent paper record with a manual audit capacity” does not demand a voter-verified record.

could be used here, an entirely unjustifiable result given the state's 20-year history of DRE voting<sup>13</sup>.

The fourth substantive issue raised in the Letter is that the lowest recorded undervote rates in Mercer County were in precincts using paper ballots rather than UniLect. The question is raised how UniLect can be recertified in light of the fact that Patriot counties using UniLect have undervotes rates that are "considerably higher" than those in counties that do not use UniLect. The undervote issued was addressed above, the primary consideration being not just the fact of high undervotes, but the reason for them.

The last paragraph of the Letter raises questions about my objectivity, probably based on the mistaken belief that I previously recommended certification of the UniLect system and seeks "safeguards" to ensure that no one who previously participated in a voting system examination should be permitted to participate in a reexamination. Without commenting on the merits of this suggestion, I simply observe that it is illegal. The Secretary is charged by statute with evaluating the outcome of any examination or reexamination and deciding whether, "in his opinion, the system so examined can be safely used by voters at elections"<sup>14</sup> in Pennsylvania. The statute mandates that the Secretary, who may have certified a system initially, is also the person who makes the determination on reexamination. The request in the Letter, therefore, would violate statute and cannot be entertained. Under the statute, the Secretary is free to appoint as an examiner any person whose opinion he may value, subject only to the constraint that the examiner may not "have any pecuniary interest in any electronic voting system or in any of the components thereof, or in the design, manufacture or sale thereof."<sup>15</sup> Thus any change along the lines suggested by the Mercer citizens must be made by the Legislature.

The requesters from Beaver County did not furnish any facts or reasons that they believed justified decertification, nor were they required to do so. Their initial request was made before the 2004 general election and so was not based on any adverse experience in that election. There is no indication that it was motivated by any particular incident or observed deficiency. To that extent, their request was not helpful since it provided no insight into what aspects of the system ought to be reviewed on reexamination. However, there is no statutory requirement that a request for reexamination be justified or helpful. It is a safety valve so that citizens can be sure that the certification of a system may be challenged at any time.

I have no useful information concerning the use of Patriot in Greene County other than its reported undervote rate.

## **The Vendor's Response**

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<sup>13</sup> DRE voting has been used continuously in Dauphin County since 1984 and was used in eight Pennsylvania counties in 2004, including also Montgomery, Philadelphia and Potter Counties.

<sup>14</sup> Act 1980-128, as amended by Act 2002-150, Sec. 1105-A(b), codified at 25 P.S. §3006(b).

<sup>15</sup> 25 P.S. §3031.5(e). It is not alleged that I am disqualified as an examiner on these grounds.

The vendor does not appear to appreciate the gravity of the situation that occurred in Mercer County, and was inclined to blame it on ballot misprogramming and voter inexperience. However, numerous precincts in the county were programmed correctly but the overall undervote rate was still 7.29%, a number acknowledged by the vendor to be far out of any normal range. It was also not the first election conducted in Mercer County since the adoption of Patriot.

Appendix A is a chart of the undervote rate in 24 Pennsylvania counties assembled by Prof. Michael Coulter of Grove City College in Grove City, PA. Dr. Coulter was Chair of the Independent Election Committee in Mercer County. The table shows that the undervote rates in the UniLect counties of Beaver, Greene and Mercer were 5.29%, 4.5% and 7.29%, respectively. The average undervote in the 24 counties examined was 1.49%, so the UniLect system produced an undervote rate between 3.5 and 4.8 times the average. These Patriot statistics are completely anomalous, as political scientists have estimated that about 0.5% of the population undervotes intentionally. Any remaining undervote can be ascribed to the voting system rather than the voters. It is simply not responsible to compel Pennsylvanians to vote on a system that results in an undervote for one out of every 14 voters.

The vendor had no satisfactory explanation for this phenomenon. While there is no doubt that undervote rates can be reduced through voter education and pollworker training, the statutory burden is on the system, not the county. 25 P.S. §3031.7(15) requires that a system must be so constructed that a voter may readily learn the method of operating it.” It is implausible that more than five percent of the voters in the UniLect counties deliberately undervoted. Therefore either the system was not capturing the voters’ preferences correctly or the voters were not readily able to learn how to operate the system. In either event, it is not safely and efficiently useable in the conduct of elections” as required by 25 P.S. §3031.7(11).

The misprogramming in 13 Mercer County precincts merits explanation. In Pennsylvania, voting for President can be accomplished into two ways. A voter may simply vote for candidates whose names appear on the ballot. Alternatively, a voter may write in the names of up to 21 presidential electors, corresponding to the 21 votes Pennsylvania is accorded in the Electoral College. Any write-in vote for electors must cancel any other presidential vote. However, the office of President is not a vote-for-21 office, since a voter may select only a single pair of names for President/Vice President. Therefore, a certain degree of cleverness is required to set up a Pennsylvania ballot for a Presidential election.

The attempt was made in Mercer County to accomplish this by setting up two straight party offices, which were named STRAIGHT and STRAIGHT1. One of these was to deal with the vote-for-21 Presidential write-in situation. Unfortunately, when the ballot was created, the wrong association was made between the Presidential race and the

straight party office. The result was that when a voter voted straight party, no Presidential vote was recorded.

It is possible that a diligent voter inspecting the review screen would have seen that no vote was shown. I cannot determine whether or not this was so since I was not given an opportunity to inspect a misprogrammed machine. The point, however, is that a huge percentage of voters ultimately did not cast a vote for President. In Precinct Farrell 1-3, only 58 votes out of 296 cast included a vote for President, an undervote exceeding 80 percent.

It is also likely that the misprogramming would have been caught prior to the election if statutorily required testing steps had been carried out, which was apparently not done. Someone testing the machines would have noticed that a straight party choice resulted in no Presidential selection. The fact remains, however, that the system itself provided scant protection against such an occurrence, and setting up the Presidential ballot in Pennsylvania is not easy on the Patriot. The undervote warning is muted, and a voter may very well not realize that she has not fully filled out the ballot.

Early in the examination the vendor was asked whether it had ever been denied certification and answered “no,” apparently forgetting that it failed its first two certification exams in Pennsylvania.

### **Carteret County, North Carolina**

The vendor was asked to explain the happenings in Carteret County, North Carolina in November 2004, where a Patriot unit was used for early voting. There was confusion over the storage capacity of the PCU, the county believing it could hold approximately 10,000 ballots when in fact its capacity was only about 3,000. It is undisputed that over 4,000 of the ballots cast were irretrievably lost because they were never stored. This event received nationwide attention.

The vendor’s explanation was that when the PCU filled up with votes, any further attempt to activate it for voting produced a message on the LCD screen reading “Voter Log Fault,” and the judges should have seen this and halted the voting process. Unfortunately, the machine appeared to be accepting the votes anyway although it was not doing so, and voting was not halted. The message “Voter Log Fault” is not particularly meaningful and suggests only that some log function is not enabled. It fails to make it clear that casting even one more ballot would result in permanent, unrecoverable vote loss. The incident demonstrates very clearly that one cannot rely on messages, either to judges or voters, to avert voting disasters.

The Carteret County incident could have been avoided with a simple change to the system by which it would refuse to accept any votes after becoming full. The vendor even assured us that a suitable programming change had been made subsequently. As we do not employ early voting in Pennsylvania, the function being provided only by

absentee balloting, the issue is not one of present concern here except as it may reveal vendor attitudes and design choices.

## **Effect of Decertification**

An unfortunate aspect of the strict requirements of the Pennsylvania Election Code is that decertification of a voting system pursuant to Sec. 1105-A may protect voters in one sense but works a hardship on them in another, leaving them without a viable voting system and requiring their county to procure a certified system in haste, at least in time for the next election. Perhaps the Legislature failed to consider the radical effect of decertification and thus did not provide for a smooth transition, but the statutory language is unforgiving:

“[I]f, upon the reexamination of any voting machine previously approved, it shall appear that the machine so reexamined can no longer be safely used by electors at elections as provided in this act, the approval of the same shall forthwith be revoked by the Secretary of the Commonwealth, and no such voting machine shall thereafter be purchased for use in this Commonwealth.” Sec. 1105-A(c), codified at 25 P.S. §3006(c).

The law requires the Secretary to revoke approval “forthwith,” and provides for no period of delay for the convenience of a county.

## **Conclusions**

Certification of Patriot must be revoked for the following reasons, as discussed above:

1. Patriot does not possess a current federal qualification as required by 25 P.S. §3031.5(a). The Patriot system was federally qualified by Wyle Laboratories in 2001 under the 1990 Standards, but not the 2002 Standards. If it had been presented for initial examination now, such an examination would not have been permitted for failure to comply with the federal qualification requirement added by Act 2002-150. Patriot possesses no current federal qualification. For that reason alone, it cannot remain certified.

2. Because the Patriot screen does not reliably detect finger touches, voters will inadvertently fail to register their votes. This much was demonstrated by the high undervote rates in the counties that used Patriot in the 2004 election. It was also observed even in a brief examination that the screen can “freeze” and stop accepting any touches at all. Therefore, Patriot is not “safely and efficiently useable in the conduct of elections,” as required by 25 P.S. §3031.7(11). Likewise, a system that fails to recognize voter choices is not “capable of absolute accuracy,” as required by the same provision.

3. The Patriot exhibits several behaviors that does not allow the voter to “readily learn the method of operating it,” as required by 25 P.S. §3031.7(15). These include confusing choices presented to the voter on the touchscreen and displaying messages whose import is misleading or unclear.

4. The lack of a contemporaneous log printer means that the Patriot is susceptible to having an intruder conduct unauthorized activities but then erase his tracks by redacting the log files. This adversely impacts auditability of the system and its safe use.

5. The straight party deselect function is implemented in a fashion that violates 25 P.S. §3031.7(3), requiring that votes be counted for any “candidate individually so selected.”

6. An optional code exists to allow the PCU to omit the step of printing a zero tape at the opening of polls, in violation of 25 P.S. §3031.7(16)(v), which requires “a printed record at the beginning of its operation which verifies that the tabulating elements for each candidate position and each question and the public counter are all set to zero.”

7. Failure of the Patriot to include provisional ballots in the public count fails to satisfy the statutory requirement of a public counter under 25 P. S. §3031.7(16)(i).

8. Transfer of vote totals by modem is not authorized in Pennsylvania, so it is a feature of Patriot that must be removed from units used in this state.

In the event that UniLect presents a modified system for certification at a later time, certain alterations will be essential, including clarification of screen messages, removal of the straight party deselect feature, deactivation of the modem, deactivation of the zero totals circumvention feature, addition of a contemporaneous log printer and addition of a much more conspicuous undervote warning.

Respectfully submitted,



Michael Ian Shamos, Ph.D., J.D.  
Examiner  
Pittsburgh, PA  
April, 2005

## Appendix A

County:	Ballots Cast	Pres. Ballots Cast	Residual Vote	% Residual Vote	Undervote	% Undervote	Voting Method
Adams	42,360	42,250	110	0.26%	110	0.26%	Opscan
Franklin	59,320	58,790	530	0.89%	171	0.28%	Opscan
Somerset	36,875	36,778	198	0.54%	120	0.33%	Opscan
Lehigh	145,651	145,091	560	0.38%	560	0.38%	Lever
Clearfield	34,408	34,109	299	0.87%	155	0.45%	Opscan
Wayne	20,396	18,914	1,482	7.27%	105	0.51%	Lever
Huntingdon	18,319	18,055	250	1.36%	102	0.56%	Opscan
Juniata	10,190	10,044	146	1.43%	59	0.58%	Opscan
Berks	165,694	164,699	995	0.60%	995	0.60%	DRE (Danaher)
Jefferson	19,541	N/A	N/A	N/A	131	0.67%	Opscan
Bedford	22,907	22,907	214	0.69%	159	0.69%	Opscan
Cameron	2,451	2,431	20	0.69%	17	0.69%	Opscan
Centre	65,013	64,384	628	0.97%	467	0.72%	Punch Card
Washington	95,497	94,307	1,190	1.27%	781	0.82%	Punch Card
Indiana	36,910	36,499	411	1.11%	329	0.89%	Opscan
Columbia	27,015	26,753	262	0.97%	262	0.97%	Opscan
Sullivan	3,289	3,241	48	1.46%	41	1.25%	Opscan
Tioga	17,869	17,608	261	1.46%	261	1.48%	Opscan
Blair	54,635	53,746	889	1.63%	889	1.63%	Punch Card
Cambria	68,071	66,656	1,415	2.08%	1,414	2.08%	Punch Card
Venango	23,946	23,259	432	1.80%	354	2.87%	Punch Card
<b>Greene</b>	<b>16,307</b>	<b>15,565</b>	<b>742</b>	<b>4.50%</b>	<b>742</b>	<b>4.50%</b>	<b>DRE (Unilect)</b>
<b>Beaver</b>	<b>86,609</b>	<b>82,058</b>	<b>4,551</b>	<b>5.25%</b>	<b>4,551</b>	<b>5.25%</b>	<b>DRE (Unilect)</b>
<b>Mercer</b>	<b>55,621</b>	<b>51,564</b>	<b>4,057</b>	<b>7.29%</b>	<b>4,057</b>	<b>7.29%</b>	<b>DRE (Unilect)</b>
						1.49%	

Average Undervote for 24 Counties: 1.49%

Data assembled by Prof. Michael Coulter, Grove City College