Philadelphia City Commissioners Office
Report on Proposed "Ballot Receipts"
Risk Assessment of Danaher Controls DRE Electronic Voting System and Philadelphia Procedures
Prepared by: Bob Lee, Voter Registration Administrator
March 28,2001;   Revised – March 9, 2004

A.   *Receipt Proposal*

There numerous news articles about a small number of individuals who assert that existing Direct Recording Electronic (DRE) voting systems are not reliable because they lack a paper ballot or paper audit trail to verify each voter's individual ballot selections. These individuals have suggested that DRE voting systems should provide a printed receipt of voter selections that each voter can view either before, or after, executing and recording their ballot.

The proponents assert that a system that provides receipts would provide the following security advantages over current DRE systems:

1.   It would allow a voter to view a printed record of all of their candidate selections to ensure that the DRE device is accurately recording their ballot selections.

2.   The ballot receipts could be used after an election to provide a paper audit trail to conduct a recount to verify the electronic results reported by the voting device.

These individuals claim that computerized systems require these receipts because a person intent on corrupting the voting process, or programming errors, could result in a DRE device indicating to the voter that it was accurately recording the voter's selections, while actually altering the selections and recording votes for candidates not selected.

A superficial glance by a layperson might find the receipt suggestion attractive and based upon reasonable concerns.

However, the proponents have not explained how an individual intent on fraudulently altering results would obtain access to the electronic voting system and voting devices in light of the security features of the system or procedures in place to prevent such events. They have also failed to explain how this activity would go undetected.

This paper attempts to highlight issues related to these proposed ballot receipts, including:
·   The standards for testing and using existing DRE systems;
·   The capabilities and functionality of existing full-face ballot DRE systems;
·   The questionable value of these proposed receipts:
·   The pragmatic issues related to receipts; and
·   The impact of receipt production and review on the voting process.

This review evidences the fact that the addition of ballot receipts will not provide the outcome desired by proponents, that they are not necessary, not feasible and could be detrimental to the voting process.

B.   *Existing DRE Voting Systems*

After numerous and extensive constituent needs assessments Philadelphia decided to procure a DRE voting machine that provides a full face ballot sheet, allowing voters to view and vote all candidates and issues on the ballot without the need for scrolling or viewing numerous pages or screens. The full face DRE voting devices have provided a smooth transition for voters as Philadelphians had voted on full face ballot mechanical lever machines for more than fifty years.

After a comprehensive procurement and proposal evaluation process Philadelphia selected the Danaher Control's

Guardian Voting System which includes 3526 ELECTronic 1242 DRE voting machines and Guardian, Danaher's Election Management Software.

1.   Independent Testing & Qualification

The Danaher Controls Electronic Voting System, both the ELECTronic 1242 DRE Voting Machine and Guardian Election Management Software, have been tested, and listed as qualified, for Federal Elections Commission standards by an Independent Testing Authority designated by the National Association of State Election Directors. The NASED designated ITAs for testing the Danaher EVS were Wyle Labs for EVMs, and Nichols Labs for EMS.

The ITAs test for FEC standards that include technical specifications to be used consistently as guidelines to ensure that systems are accurate and secure. The standards include functional criteria along with technical requirements for hardware, software, quality assurance, and documentation. The standards also include testing procedures to ensure that systems meet the requirements.

Qualification tests encompass a selectively in-depth examination of the software; an inspection and evaluation of the system documentation; tests of hardware under conditions simulating the intended storage, operation, transportation, and maintenance environments; and operational tests verifying system performance and function under normal and abnormal conditions.

The ITA evaluates the completeness of the vendor's developmental test program including sufficiency of vendor tests and sample tests of the vendor's test modules. ***The FEC standards and testing by designated ITAs is designed to reduce risks of failure by helping State and local election officials ensure that the system they buy, and that the public vote on, work accurately and reliably.***

2.   Examination & Certification for Pennsylvania

The ELECTronic 1242 EVM and Guardian EMS were last examined by the Secretary of the Commonwealth in 1998 and certified for use in Pennsylvania. Pennsylvania election laws require that voting systems be examined and approved for use in conducting elections.

The Secretary of the Commonwealth designates an examination team to conduct tests on voting equipment to insure compliance with the Pennsylvania Election Code. This testing reduces risk by helping local election officials in ensuring that systems they buy have work in accordance with state law. City Commissioners personnel will perform conditional and final acceptance tests on the EVM that include voting scripts to verify compliance with Pennsylvania laws.

3.   Proven Usage

Approximately 43,000 Sequoia Pacific AVC Advantage or Danaher Electronic 1242 DRE, full face ballot, Electronic Voting Machines (EVM) are currently used across the country in conducting elections for Federal, State, and local offices. Both the Danaher and Sequoia full face DRE voting devices have been used extensively to conduct elections. These devices have proven track records.

The City Commissioners Office conducted research of DRE EVM usage and contacted 26 jurisdictions using over 23,000 DRE voting machines to assess experience with DRE system accuracy, reliability, durability, security, ease of use, and suitability for Philadelphia.

Approximately 20,000 Danaher ELECTronic 1242 EVMs are in use in 13 states. Various models of these 1242 EVMs have been used by some jurisdictions for more than 17 years. In 1998 Delaware selected these 1242 EVMs for its' statewide voting system.

Team members visited four jurisdictions to observe the use of two proposed full-face DRE systems in use to conduct official elections. The City Commissioners observed the use of the selected Danaher Controls EVS in Franklin County, (Columbus), Ohio consisting of 2800 *ELECT*ronic 1242 DRE EVMs, 7 RTCs and 734 Election Districts.

The minor problems discovered during our review have been almost exclusively caused by human error and most relate to timeliness in returning cartridges used to report unofficial election results.
These EVMs have proven through almost two decades of use to be durable, accurate, reliable, and easy to use.

4.   Security

The EVS is secure from unauthorized outside access, provides backup power, backup of data and is designed with redundancy to insure retention of data.

4.a   *ELECTronic 1242 Electronic Voting Machine Security*

Each DRE voting device contains all required general-purpose election logic and capabilities in its firmware on circuit chips. However, it does not in itself have any knowledge of the specific election that is being conducted.

The EVM firmware is not modified for the conduct of an election. The machine firmware resides on integrated circuit chips, which are sealed into the machines. The machines cannot execute instructions not residing in the chips, and the changing of the chips is very difficult to accomplish and very easy to detect.

Any attempt to fraudulently alter or switch voter selections would require that the fraudulent switching programs be contained in the circuit chips within each DRE voting device. Such an effort would require that chips in each DRE voting device be changed. Additionally any potential manufacturer of the fraudulent chips would need to know the candidates to be placed on the ballot and which positions on the DRE voting device would be assigned to each candidate.

Only City election personnel have access to the DRE voting devices. However, City personnel do not have access to the encrypted firmware, or replacement chips required for any alteration.

Only Danaher Controls and the escrow agent have access to the source code. Only Danaher Controls, through its proprietary hardware processes, can provide firmware on circuit chips. However, Danaher Controls does not have access to City DRE voting devices so they would be unable to change the chips without City knowledge.

Any firmware upgrades provided by the vendor to be installed on the City's voting devices would be installed by City civil service EVM technicians and would be followed by extensive conditional and final acceptance testing of the voting devices to insure accuracy.

Additionally, the vendor would have no knowledge of the names of candidates to be placed upon the ballot nor the positions such candidates would be assigned to in any election.

Ballot information is obtained via the election parameter data developed by City civil service election personnel and passed from the EMS via a Memory Cartridge (MC) to the machine. ***There are no telecommunication lines linking the EVMs to each other or the tabulation workstations.***

The above features of the Guardian EVS and ELECTronic 1242 DRE voting device combined with limited access to system components and separation of responsibility and duties preclude any individual or group of individuals the ability to fraudulently alter firmware to provide for vote switching.

4.b   *Central Tabulation and Computation Center LAN*

The Local Area Network's only telecommunication line is a Wide Area Network connected to other City Commissioners facilities and the Regional Transmission Centers (RTCs). ***This WAN is only used for the transmission of unofficial returns.*** There is no dial up connection to the Central Server.

4.c   *Election Management Software*
Security

The hardware configuration uses a multi-tier password protection scheme. The Guardian EMS has 4

levels of security including user ID and password in addition to access level and function. The   EMS protects the data files through an access mode which, locks the database and refuses to allow   any modifications or changes therein. There are probably 30 -40 different civil service employees   involved in preparing, proofing and testing an election setup. The EMS has an audit log function   that tracks user activities on the system. When a user logs on to the system, the audit trial starts by   recording the name of the user and the date and time he or she logged on and the modules the user   accessed.

Election database setup in the EMS is encrypted, locked and password protected to prevent anyone from tampering or altering any codes or programs for tabulating votes.

City election personnel will not have access to EMS source code and it will not be available for public inspection. The source code will be placed in escrow. Vendors and escrow agents who have access to source codes will not have access to the system for programming the DRE EVMs for elections.

The EMS is a closed loop system; it is completely secure from outside access where one might gain access to the System. Typically, if the System had the ability to be accessed through a dial up modem for entry to the file system, there could be a breach of security on the network. This feature is not available in the Guardian EMS. *City Commissioners' personnel will install any EMS updates from Danaher Controls directly on the System.*

4.d   Ballot Preparation, Proofing and Pre-election Testing – Separation of Responsibilities and Duties

There are probably 30 -40 different civil service employees involved in preparing, proofing and testing an election setup.

Ballot Configuration and Data Entry
Two civil service employees set the election configuration. Usually two - five Civil service employees work on data entry of office names, party names and candidate names into a specific election data base.

Data Verification
Four different civil service employees, at a different facility, verify the data entered by comparing system proof sheets against ballot certifications from the State. A second group of five different civil service employees at this facility perform a second verification of the same data using system proof sheets and the ballot certification from the state. Once the hard copies of data are proofed any necessary name corrections are made.

Ballot Layout
City election personnel design each ballot layout and setup each election ballot based upon Ballot Certifications issued by the Secretary of the Commonwealth and the County Board of Elections. The Ballot Certifications detail the order in which offices and candidate's names must appear on the ballot. For Primary Elections in Pennsylvania, the order in which names appear on the ballot is chosen by lottery. Often the Commonwealth does not transmit the certifications to the counties until 6 weeks prior to an election. Two administrative users design the ballot layout for placing offices, parties, candidates, questions, and instruction text on the ballot. This design layout designates which positions on the voting machine will be activated for use. *The Ballot layout is reviewed, and must be approved, by the three elected City Commissioners at a public meeting.*

Ballot Split Tests
Once the ballot design is approved, a single test ballot face and a corresponding test memory cartridge are produced for each ballot split or style in the election. A different group of three to five civil service machine mechanics proof each of the test ballot split face sheets against both the system proof sheets and the ballot certification to insure that all information is accurate and properly positioned on the ballot. After proofing the face sheet these civil service employees install each test ballot face and corresponding cartridge on/in our demonstration machines. *The mechanics fully test the split to insure that all ballot positions printed on the paper ballot face sheet correspond to activated and working button positions on the machine. A lamp test is performed to insure that all required position lights operate. Test votes are entered into the demo machines and verified to insure that the split test cartridge and paper tapes are accurately recording the test votes.*

4.e   *Electronic Voting Machine Preparation and Testing*

EVM Materials Production
At a third location, 16 - 18 civil service machine mechanics produce the voting machine materials.

EVM Memory Cartridge (MC)
Once the specific election data has been set, county election personnel will produce a memory cartridge for each machine. The Memory Cartridge contains the assigned machine number and election specific program instructions for each EVM, which identifies all active ballot positions. **The programmed Memory Cartridge will be manually inserted into the machine by City Commissioners' EVM technicians.**

Ballot Face
The ballot face sheet contains offices, titles, and candidate names corresponding to the ballot locations programmed in the Memory Cartridge for each election and assigned to a specific machine.
The ballot information includes lines which border the space on the ballot allocated to each office or

candidate label, and indicates with a printed outline of a push-button where the voter is to push to select the candidate. The ballot is fastened to the machine with a bezel secured from inside the printer compartment.

Pre-Election Testing
Each ballot face sheet has a ballot code to facilitate placement on the appropriate machine. City EVM technicians will verify that both the ballot and MC have been correctly installed during the during the pre-election EVM setup process The MC will only work in the machine it was programmed for.

In addition, City Commissioners' civil service EVM technicians will use a test election function in each EVM to test-vote each machine using the actual MC and ballot to be used in each election. This will provide verification that the offices, candidates and questions programmed for each machine corresponds to the ballot and memory cartridge and that each EVM is recording votes accurately prior to each election. After pre-election tests have been performed each EVM will sealed with recorded, numbered seals.

4.f   *Independent Random Pre-Election EVM Testing*

Prior to shipping the machines, the Committee of Seventy, a nonpartisan government watch group in Philadelphia and its' volunteers come to our warehouse to randomly select and test voting machines. They randomly select two machines per ward and test vote the machines. If any machine were to be judged not operating properly then the Committee of Seventy could test the two machines on either side, and so on and so forth. Once the Committee of Seventy has tested the machines they are reset and resealed.

4.g   *Pre-Election Network / System / Testing*

Before every Primary or Election we conduct five or six pre-election tests of the full system using a test database and test machine cartridges. We dispatch employees to the 7 RTCs to read test cartridges. This allows testing of the WAN, LAN, and workstations to be used for reading, transmitting and tabulating Unofficial Returns on election night.

4.h   *Operational Backup Battery Power*

Each EVM has an internal 12-volt rechargeable battery that remains connected at all times. **If power is lost during voting, the transition to back-up battery is instantaneous and transparent to the voter.** The EVM eliminates any "switch-over" time thereby eliminating the possibility for error.

When the machine is connected to a wall socket an internal charging circuit recharges the battery to 100% of its capacity automatically. The EVM is continuously connected to this battery, operating from its power whenever it is used. City Commissioners' personnel re-charge the batteries as necessary, while the EVMs are in stored in the City warehouse.

4.i   EVM Vote Recording and Retention

When the polls are first opened for an election, the DRE EVM electronically sets all counter storage tables to zero (0) votes. Voter selections are directly recorded into the DRE EVM results memory tables. **There are five (5) separate tables for recording vote totals, updated each time a voter casts a ballot.** Three of the tables are internal to the DRE EVM. These tables are stored in separate Random Access Memory (RAM) integrated circuit chips.

Once a voter has made a selection on the ballot, this choice-set is held in non-volatile RAM until the final step of casting a ballot. The voter may change selections at anytime until the voter presses the VOTE button, casting a ballot. Once a ballot is cast, the 5 separate RAM tables are updated. Upon closing of the polls, a sixth table verifies the other five.

The RAM memory requires constant application of power to retain data. **The EVM contains an internal, 10-year life, lithium battery cell that provides constant power to the machine CPU even when the machine is turned off. The results are maintained even in the event of a catastrophic machine failure.**

The other two counter storage tables are contained in the memory cartridge, stored in   Read Only Memory in an integrated circuit. This memory retains information even when electrical power is removed; it can only be erased electronically.

4.j   Central Tabulation Vote Retention

Unofficial election night vote tabulation will occur at the CTCC. The Philadelphia Police Department will retrieve the EVM memory cartridges (MC's) containing the electronic results and the certified paper results tape from each of the 1,681 polling places and transport them to Regional Transmission Centers (RTC).

City Commissioners personnel will use EVS workstations at 5 or 7 RTC's to electronically read the votes from the EVM memory cartridges. The EMS on the Central Server will call on each of the 5 or 7 RTCs on a continual, rotating basis, via a secure Wide Area Network (WAN) to retrieve encrypted files of vote results read from the DRE EVM memory cartridges. **As results are tabulated on the Central Server, they will be continually copied to a Backup Server located on an identical LAN (BTCC) at a different City Commissioners facility.**

This redundancy will allow the City Commissioners' personnel to switch the citywide tabulation of unofficial results to a backup location in the event of power outages at the CTCC. Once all cartridges have been read, they will be transported to a secure central location. **The CTCC configuration will include an uninteruptable power supply and the BTCC will include a 6-hour power generator.**

The CTCC and BTCC configurations include provisions for daily backup of the EMS, election ballots, and election results.

The use of many different civil service employees under controlled, limited specific access to the election database to enter data, produce materials, perform pre-election proofing, conducting numerous pre-election tests, and results reporting ensures adequate separation of duties and responsibilities. There are so many involved in preparing for an election that any attempt at altering something would become easily evident to many employees before an election.

5.   Accuracy - Elimination of Known Vote Counting Problems

The use of the Danaher Controls DRE voting machine to conduct elections has enabled the City Commissioners to efficiently increase accuracy in recording and reporting unofficial and Official

election results.

The EVM has eliminated one of the most common problems associated with using the City's old machine lever machines - hand transcription and addition of hundreds of thousand of votes, with its inherent probabilities for error.

The system also eliminated discrepancies between the unofficial returns reported election night and the Official returns certified by the City Commissioners. Under the old manual process on the lever machines, discrepancies between the unofficial and Official returns had often confused candidates and provided false perceptions about the validity of the vote tabulation.

5.a   *Election District Returns*
The old lever machines required that polling place official's record and report results by one official reading the counters on the machines and calling out the vote while other officials hand transcribed the results onto four Official Divisional Return Sheets.

This totally manual process, performed by approximately 8300 officials in 1,681 election districts, after working a 13 hour day conducting an election, was a process inherent with the probability of errors in recording and reporting returns. *For instance, in the 1999 Primary Election polling officials were required to write up to 2,074 numbers in each election district, resulting in a potential of 3,486,394 manual transcriptions by poll officials city-wide.*

The DRE EVMs will not require a single manual vote transcription or addition by any polling place official.

After the close of the polls, officials press the CLOSE POLLS button and the EVM tabulates the votes cast and prints a paper return tape containing each candidate name and votes. The EVM also writes the votes to an electronic memory cartridge. Results are also maintained in the EVMs and cartridges and printouts can be re-produced.

5.b   *Unofficial Election Results*
The manual recording of votes did not end at the polling place. The old system used by the City to report unofficial election results on election night required that City personnel use the unofficial tally sheet from each election district to key in the vote totals for each candidate. Again, in the *1999 Primary Election this required manual reading and data entry of 205,082 numbers into the City's mainframe computer.*

This manual reading and typing of numbers also provided the opportunity for error, resulting in instances where the unofficial vote reported on election night differed from the number tabulated during the subsequent official canvass of returns. Discrepancies between unofficial vote reports and official vote computation often lead to confusion and suspicion on the part of candidates and their supporters.

The DRE Electronic Voting System (EVS) will virtually eliminate the requirement for manual entry of vote totals. City Commissioners civil service personnel tabulate the Unofficial returns by reading the memory cartridges on election night, with civil service personnel operating the central tabulation system. If used in the 1999 Primary Election, the proposed EVS would have required manual entry of only 146 numbers for the cumulative absentee vote totals.

5.c   *Official Canvass of Returns*
The City Commissioners, by law, must conduct an Official Canvass and certify the election returns. The old paper based election district return system required a manual central computation process.

The City Commissioners personnel wrote the vote totals for each candidate from one of the Divisional Return Sheets from each election district onto a Ward Tally Sheet for tabulation. *In the 1999 Primary this required writing approximately 345,000 vote totals.*

Once the numbers had been called and checked, the votes were tabulated using desktop printing calculators. When the Ward Tally Sheets had been tabulated, Commission personnel then wrote each candidate's vote total from the ward sheets onto a Citywide or District Tally Sheet. In the 1999

Primary, this required another 9,636 transcriptions. These sheets were also tabulated using the desktop printing calculators.

The EVS eliminated the manual writing and tabulating.

The City Commissioners begin its' Official Canvass on the Friday following the election by re-reading the memory cartridge from every EVM in a public hearing at the Central Tabulation & Computation Center (CTCC). City Commissioners civil service personnel conduct the Official Canvass returns by rereading all the memory cartridges during a public hearing, with civil service personnel operating the central tabulation system.

<u>Guardian software does not permit manual over writing of any election results obtained by electronic reading of the Memory Cartridges. Once a Memory Cartridge has been read by the system no one, not even county election personnel, can change the results in the Central workstation for that machine.</u>

The last process of the Canvass, about one and a half weeks after an election is to perform the mandated 2% audit. About eight civil service employees are sent from the Delaware Ave office to our warehouse to randomly select two machines per Ward and run a machine "dump" which is a printout of the election results stored in each of the machines three tables. The vote totals on these paper machine dumps are then used to conduct an audit of three different sets of numbers: 1).the votes recorded in the Central tabulation database for each specific machine; 2) the votes printed and certified by polling place official signatures at the polls on election night; and 3) the votes in the three tables in the voting machines as represented on the machine dump tapes.

Commission personnel also perform random audits of the precinct returns on the Official Returns reports and the Unofficial reports produced on election night.

The Official Canvass will adjourn until the Monday following the election, when the Commission, at a public hearing, will continue with a canvass of alternative ballots, tabulation write-in votes, and provide for requests from candidates.

5.d   Certification
Once all audits have been completed, the totals for each candidate are typed on a hard copy Certification, signed by the Commissioners and forwarded to the Secretary of the Commonwealth or the County Board of Elections.

The EVS has enabled the City Commissioners to announce the Official Computation of Election Returns no later than eight (8) days after an election. This provides the ability for Certification of the returns to the Secretary of the Commonwealth 13 or 14 days after an election, well within the mandated 20-day requirement.

Certification under the current manual system can take as long as 20 or 27 days.

The EVS has enabled the City Commissioners to eliminate the manual processes and replace them with proven, yet current technology for accurate and efficient electronic tabulation of votes. In the 1999 Primary, the EVS would have eliminated the writing up to 3,841,394 numbers, manual data entry of 205,082 vote totals, and thousands of manual tabulations.

This substantially <u>reduces known</u> risks associated with inaccurate vote returns from manual tabulations.

The EVS and EVMs will enable the City Commissioners to provide Philadelphians an efficient and reliable process for insuring that Official Election Returns accurately and securely reflect the selections made by voters at the polling place.

5.e   Hard Copy and Electronic Backups
Hard copies of the results, by precinct are produced and secured during each phase of the Unofficial tabulation, Official Canvass, and after the audits. Backups of the election database are made during

various stages of the election preparation.

6.   **Ballot Secrecy**

6.a   DRE EVM Construction
The EVM is durably constructed, fully comprehensive, self-contained, and sets up as an enclosed voting booth, much like mechanical lever machines. A large curtain extends from the top of the EVM to several inches below the ballot face. Once a voter is inside, the curtain falls closed with a 4-inch overlap providing secrecy.

6.b   DRE EVM Results Table Secrecy
Votes recorded on the EVM are not accessible while it's in POLLS OPEN status. Results can only be obtained after the polls have closed. It is not possible to program the memory chip in the MC to earlier states; it is a one-way operation. Once the status moves from "polls ready to open" to "polls open" and finally to "polls closed" the EVM refuses to "back track" to an earlier status.

Once the polls are closed on the EVM, the machine will recognize this fact and refuse to "regress" to an earlier condition, i.e. permit the re-opening of the polls on any given MC and allow the continued recording of voter choice sets. The EVM will not let anyone add votes to an MC that has been closed.

There are no telecommunication lines linking the EVMs to the tabulating workstations at RTCs, CTCC, or BTCC. Election night vote tallies can only be obtained after the polls have closed, the MCs transported to the RTC by the Philadelphia Police Department, read on the RTC workstations, and transmitted to the CTCC.

6.c   EVM Audit Trail Secrecy
The EVM retains an electronic image of the each ballot position selected by each voter. After   an election, City Commissioners' personnel can print the ballot images from the EVM, in random   order to prevent tracking any single ballot image to any specific voter. ***This provides a paper   audit trail that details all selections by each individual voter in a manner that preserves the   secrecy of the ballot.***

7.   **Ease Of Use for Voters**

7.a   Uniform Ballot Countywide
The City currently uses four different models of mechanical voting machines, presenting two different ballot configurations. ***The EVS, using a single DRE EVM model will provide for a uniform ballot configuration for each election in all 1,681 election districts***.

7.b   View of Ballot
The use of the DRE EVMs will result in little deviation from the way in which voters currently cast a ballot. Our current mechanical lever machines contain 400 - 500 candidate positions and provide that a voter can view and select from all candidates and issues on the ballot without the need to turn or scroll through numerous pages or screens.

The DRE EVM has a full face ballot containing 504 candidate/issue positions which provides that a voter can view and select from all candidates and issues on the ballot without the need to turn or scroll through numerous pages or screens. ***This avoids potential voter confusion of smaller scrolling systems where candidates for a single office could be spread across several screens or pages, as evidenced in Duval County, Florida this past November.***

7.c   Caption Font Size
The EVS provides flexibility in setting font size for office, issue or candidate information on the ballot face. The font size available in the smallest possible ballot position is equal to, or larger, than that provided on our current lever machines.

7.d   Selection Indicator
An LED light will turn on for each candidate selected. The lights, and the full face ballot, will enable voters to quickly review all of their selections prior to pressing the VOTE button, casting their ballot.

7.e   Accessibility

The EVM ballot face can be lowered 12" by polling place officials to provide accessibility for wheelchair users. The buttons are pressure sensitive, rather than touch sensitive. The top row of the mechanical lever machines was often too high to read or reach for some voters. The ballot face is more centrally positioned, eliminating the need to bend down to select positions at the bottom of the ballot.

7.f   Voting

There are three events that will be different for voters. First, voters will push a pressure sensitive button to select a candidate instead of pulling down a lever. *A light will go on in each candidate position selected by the voter*. *This provides a voter the opportunity to quickly review and verify all of their selections prior to executing their ballot*.

Second, after a voter completes candidate selection, the ballot is executed and recorded by pressing a "VOTE" button instead of pulling the curtain rod, or pushing the curtain button. Finally, the "VOTE" button does not open the booth curtains, but rather the booth lights turn off and the voter exits by walking through the curtain opening.

7.g   Overvotes

Overvotes occur when voters cast a ballot for more candidates for a specific office than permitted. *The DRE EVMs, incorporate lockout, or lockin, provisions, like our current lever machines, which eliminate overvotes.*

7.h   Undervotes

The DRE EVM provides an LED light in each office or issue caption position to indicate to the voter that he or she may select additional candidates within that office. When a voter has selected the maximum number of candidates permitted for an office the candidate lights stay on, but the office caption light turns off.

7.i   No paper ballots

Voter selections are recorded directly into the EVM results memory tables. Prior to pressing the VOTE button, voters can select or de-select candidates as often as necessary, unlike paper systems that require the voter to ask officials for another ballot when they make mistakes. *Unlike Optical Scan or Punch Card systems, there are no risks associated with paper ballots that may be spoiled, incorrectly positioned or marked, lost, damaged, altered, or destroyed.*

8.   Operational Risks

Based upon usage in other jurisdictions, the DRE EVMs will substantially reduce Election Day machine malfunctions.

C.   *Questionable Value of Ballot "Receipts"*

1.   Intent of the Voter

The Danaher and Sequoia full face DRE voting devices, like their technological predecessor, the mechanical lever voting machine, do not require paper ballots or receipts to determine the intent of the voter. Voters enter their selections directly into the machine, where the ballots are stored in numerous memory tables. These DRE voting devices maintain separate electronic images of each elector's ballot selections, in random order, for subsequent printing of a paper audit trail, if necessary. The majority of uncounted or rejected ballots in the November 2000 election Florida election were due to overvotes on punchcard or optical scan systems. DRE voting devices do not allow voters to select more candidates for an office than are permitted.

Another major factor in uncounted or rejected ballots was undervotes. Undervotes recorded by punchcard systems was due to chad that was not fully punched by the voter and only dimpled, slightly perforated, and/or hanging. Undervotes on optical scan paper ballots occurred where voters used the wrong writing instrument or circled the oval, placed a check or x inside the oval instead of completely

filling it. The full face DRE voting devices do not allow for such deviance in how a voter can select their candidates. Voters simply press a button and an indicator light for the selected candidate turns on.

As currently configured, programmed and used, existing full face DRE voting devices eliminate 100% of the problems experienced in Florida relating to determining voter intent. ***Ballot receipts are not necessary to address these problems found in paper based punchcard and optical scan systems, as DRE voting devices, like mechanical lever machines, limit the manner of selection and accurately record and store the selections entered by the voter.***

2.   Alleged Potential for Tampering / Meaningless receipts

Proponents are not suggesting these receipts to address the ***known*** voter-intent problems with paper based systems in Florida. Rather they claim the receipts are needed to prevent the unknown, the fear for hidden codes that could be introduced into the voting device that would alter voter selections. For example, a voter selects candidate A, the light for candidate A goes on, but when the voter presses the vote button, the device firmware alters the voter selection and records or reports a vote for candidate B.

It is claimed that the receipts will assure voters of their selections and could be used in a recount to verify that the votes recorded and reported by the DRE match those printed on the receipts and reviewed by the voter. There are fallacies with these assertions.

2.a   *Value of receipts to Individuals*
There is no voting device, or system, in existence and use that can verify to the voter, through issuance of a ballot receipt, that their ballot will be accurately counted and reported.

Optical Scan, Punch Card, and Mechanical Lever voting systems do not provide a printed receipt to the voter to verify that the actual tabulating device, or mechanism, has correctly recorded and tabulated the voter's candidate or issue selections. Voters cannot view the counters advancing in the rear of a mechanical machine, nor can they be certain that ***computerized*** optical scan and punch card tabulating equipment is not altering their selections after they insert their ballot.

Paper ballot systems provide voters no assurance that the persons manually counting their ballot, along with thousands of others, will do so without error.

Proponents claim there is absolutely nothing to ensure that the vote that registers on the DRE ballot screen is the vote that gets recorded on the cartridge, or that the vote that is recorded on the cartridge is the vote that prints out on paper. One individual has claimed that "Unless the voter sees that paper trail, how do they know. I could teach a 12 year old to write a program that shows one thing on the screen and another thing on the printout."

If a person could program the device to indicate that candidate position display lights conform with the voters selections, yet the device records votes for candidates not selected, then it logically follows that one could also program, or teach a 12 year old to program the device to print a receipt and display candidate position lights that both conform to the voters selections, yet the device record and report altered returns.

The proponents own claim that programs could be altered to show anything, evidences that the receipts are meaningless as a valid verification to individual voters that their individual ballot selections were accurately recorded and/or will be accurately reported.

2.b.   *Incomplete Receipts*
Most proposed implementations of the voter receipt provide a printout listing only the candidates a voter has selected. In contests for offices where the voter is permitted to vote for more than one candidate, yet selects only one, the receipt does not show the remaining candidates with zeros next to their name. Philadelphia often lists offices where voters may vote for 10 or 15 candidates out of 30 or 40 on the ballot. If a voter only selects 1 candidate, what assurance does the voter have that the system is not crediting votes for any of the other 9 or 14 candidates if all candidate names do not appear on the ballot.

2.c   *Value of "Receipts" in Recounts*

Jurisdictions only conduct recounts when election margins are close, within a specific low percentage range, or when a petition for a recount or contest has been filed with the appropriate authority. Even if vote switching were possible, persons intent on programming devices to fraudulently switch voter selections could simply attempt to avoid the possibility of a recount, or review of the receipts, by switching a sufficient percentage of votes to provide for a sufficient margin of victory.

If there is no recount, or contest, then there would be no comparison of electronic and printed paper results with the individual ballot receipts.

If proponents suggest that the counties use the receipt to verify results after each election, then that is equivalent to returning to the 1800's and using a manually counted paper ballot. In the late 19th century, and early 20th century many jurisdictions switched to mechanical lever voting machines to eliminate the nuisance, problems and widespread fraud that existed under paper balloting systems.

Paper based processes do not provide for acceptable accuracy, efficiency, or security in casting, storing, and counting ballots in large jurisdictions where 100,000 - 500,000 votes may be cast.

D.   *Pragmatic Issues Related to Ballot receipts*

The proponents of ballot receipts have provided very little detail as to how they would be implemented in an electronic voting device. There are some pragmatic issues that cast serious doubt about the feasibility of this feature in an electronic device. This issue isn't as simple as the three to five inch receipt you take from your ATM machine mounted in a wall or kiosk.

1.   Vote Buying / Secrecy of the Ballot

Any device that provides a voter receipt listing the names of the candidates for whom a voter cast a ballot, facilitates bribery and vote buying. A voter could simply take the receipt to any person intent on buying an election and request payment.   Voters should not be provided a receipt that they could take outside the polling place after voting.

If the receipts are to be deposited in a locked box by the voters there is no guarantee that each and every voter will deposit their receipt. Some voters may simply place them in their pocket, and others may simply refuse to turn them in, resulting incomplete and inaccurate documentation.

If the receipts are collected by polling place officials as the voters leave, then secrecy of the ballot is comprised as officials would be able to view each individual voter's selections.

The above concerns would also rule out secondary printing device. Separate printing devices would not be a feasible option as the voter would not be permitted to view the receipt while in the voting compartment, without handling by polling place officials. The Sequoia and Danaher full face DRE voting devices are fully self-contained and can be rolled into place and setup in 5 - 10 minutes.   In addition to compromising ballot secrecy, secondary devices would require polling place officials to connect cables between the printing devices and the DRE voting devices and require additional county expenditures.

It is has been suggested by these proponents that these receipts be viewed through a "window" in the device and remain in the voting device after viewing to avoid these bribery and secrecy problems. Assuming the receipt is to remain within the machine, we have attempted to determine characteristics and functionality.

2.   Logistical Problems

2.a   Ballot Size

Proponents of the receipt have apparently not given due consideration to the potential size of a ballot. The ballot for the 1983 Democratic Primary in Philadelphia contained 180 candidates. The typical DRE paper results tape prints 6 lines per inch, without spacing, to provide a readable font size. If the candidates were listed in a single column, this would have required a "view window" sized 3 x 36 inches. If the candidates were printed in two columns, the required window size would be a minimum of 6" x 18".

That is equivalent to consuming three ballot position columns on existing full ballot face DRE, or the loss of 126 positions.

2.b   Paper Roll Length
If we use the above example, each voter receipt would consume approximate 1.5 to 3 feet of paper. Most precincts may have up to 1200 registered voters and some may have even more, counting Inactive voters. If we assume a precinct has 1500 registered voters and three voting devices, or 500 voters per machine, the paper roll would have to be a minimum of 750 feet to provide 2 column receipts and 1500 feet to provide single column receipts.

Provision of such lengths of paper will require extremely large paper rolls or constant changing of paper rolls during the voting process.

The paper roll for printing single column zero reports and precinct election results on the Danaher 1242 DRE is approximately 50 - 100 feet in length. The diameter of a typical 150 ft. roll measures 2-1/4 inches, or 1.5 inches per 100 feet. A paper roll for two columns (6-inch width) of 750 feet in length could have a diameter of 8-12 inches. A single paper roll for a single column (3 inch width) of 1500 feet could have a diameter of 16-23 inches.

Assuming the "window" would be within the enclosed voting compartment, on the ballot face, the proposed DRE device ballot face portion would have to have a depth of approximately 18" - 20" for double column receipts and 29" - 31" for single column receipts. The ballot face portion of the Sequoia and Danaher DRE's is approximately 8 inches in depth. This increase in required depth may not be feasible.

If we cannot use a single roll to provide all the paper necessary for providing the receipts to every potential voter, who is going to be available in 1,681 precincts in Philadelphia to change the paper roll 5 or ten times during the voting process? Do we want, or can we expect, our polling place officials to open the service compartments of voting device to change paper rolls?

2.c   Depository for Receipts
Again, assuming we would not allow voters or poll workers to have the receipts, we must also provide for a secure depository within the machine for the receipts once voters have viewed them.

·   *Return Spoil*
    The most efficient way to do this would seem to be the use of a return spoil that would re-roll the receipts onto a spindle. This would require a second 12 or 23 inch spoil which would then enlarge the height of the ballot face component. If we have stationary two spoils, each requiring from 12 to 23 inches in space for the roll alone, the minimum height of the ballot face becomes approximately 5 foot. The Sequoia and Danaher DRE ballot face height dimensions are probably less than 3 feet.

    If we provide for two movable spoils to reduce the height requirements we have added another moving mechanical operation to the electronic device that could malfunction during the voting process.

    A third more serious concern with a return spoil would be the fact that the receipts would be returned to the spoil uncut, and wound in the exact sequence of the voters appearance for that machine. ***The paper audit trail would not be in random order.*** In precincts using only one voting device, it would be possible to determine exactly for which candidates whom each and every single voter selected by referring to the Number Two Book which records the sequence in which voters appear to vote.   Even precincts with two voting devices may not be enough to prevent attempts at reconstructing the vote.

· *Receipt Depository*
Another method would be for the device to cut the receipt at the end of each voter's ballot and have it drop into the bottom of the device after viewing. While this would provide for random deposit of receipts, the fact that they would be loose would require more space for storage. If the receipts don't fall flatly to the bottom of the depository and it fills before the close of the polls, piled up receipts could interfere with printer or paper spoil operations, much as unevenly piled chads could have interfered with perforating certain candidate positions on punchcard devices in Florida.

E.   *Impact on the Voting Process*

1.   Malfunctioning or Jammed Printers

Assuming we have overcome the paper supply and receipt depository concerns, we also have to question whether we want to chance having an impact or thermal printer operate properly before, or after, each and every vote is cast, perhaps 300 - 500 times per device each Election Day.
The most ideal electronic voting system would be one without any moving parts. A comprise is made in existing DRE's to provide for a paper zero count report and a paper copy of election returns that polling place officials certify on Election Day. But even at that, we are only operating the printer twice on Election Day, once prior to opening the polls and once after the polls close. The proposed receipt would require that the printer on each device operate up to 500 times during the voting process. The more times we require the printer to operate, the higher the incidence of jammed or malfunctioning printers, or paper spoil mechanisms.

The potential of countywide problems with malfunctioning or jammed voting devices during heavy turnout elections would result in serious delays in voting and potential disenfranchisement. If the two DRE voting devices in a typical precinct both jammed, or malfunctioned at the same time, then that precinct would effectively be closed for 30 - 45 minutes to provide technicians travel and repair time.
The County could never provide enough technicians to quickly repair or clear the printers.

2.   Delays in Voting

Assuming that efficient logistics for receipts could be provided, another serious concern would be the time spent by voters peering through a "window" to review the paper receipt.

On the Danaher and Sequoia full-face DRE devices, a light goes on in the candidate's ballot position whenever a voter has selected a candidate by pressing the button within that position. This indicates to the voter that the DRE voting device will record a vote for all candidates whose lights are on and provides the voter the opportunity to quickly review their selections before executing their ballot by pressing the vote button.

The addition of an unnecessary printed paper receipt appearing before, or after, the voter presses the vote button will result in voters spending more time in the voting compartment. The review of the paper receipt will undoubtedly take more time than the review of the candidate lights. *The accumulated effect of every voter taking the time to read the entire receipt will be longer lines at the polls.*

Imagine the impact if every shopper in dozens of long Supermarket checkout lines, a day or two before a forecast 1 - 2 foot snow blizzard, stopped to read each of a hundred entries on their cash register receipt before they paid the cashier and exited the checkout lane. The problem for election personnel is while people accept such delays at Supermarkets because they need the food, they do not accept waiting in long lines to vote for any reason.

Jurisdictions that have referendum voting have experienced delays and long lines as voters wait until they get into the voting compartment before reading the ballot issues. Some jurisdictions report waits of more than an hour or two when there is heavy turnout with a large ballot that includes ballot questions.

Nothing more discourages voter participation than requiring voters to wait in long lines, or go through complex procedures before being permitted to vote. The most common complaint amongst voters nationwide is delays in voting. *In an NVRA implementation report issued in March 1998, the*

> *FEC reported that the serious nature of significant delays in voting cannot be overemphasized. Significant delays stress polling place officials, test the patience and fortitude of the voters, and discourage voter participation.*

3.   Machine Accessibility and Polling Place Availability

Increasing the overall size of existing full face DRE voting devices to provide for the viewing window, paper supply and depository for receipts would have a detrimental impact upon machine accessibility and polling place availability in major urban areas like Philadelphia.

A 5-foot ballot face, centrally positioned would result in voters having to bend over, or reach up to make candidate selections. The large height will also present problems for wheel chair users. We are moving to our selected DRE device because it is 75% lighter and, when closed approximately 60% smaller than our mechanical lever machines.

This compact size provides for easy storage within polling places before and after elections. Increasing the size of the DRE could eliminate this advantage.

F.   *Decentralized Voting Systems*

The Florida controversy has highlighted the fact that voter registration and the conduct of elections in our nation is administered for the most part at the County level. Many have used the problems with inadequate voting systems and standards to call for uniform ballots and voting devices throughout the state, or nation.   While it is true that elections can be become troublesome when jurisdictions are not provided sufficient resources and technologies for administering elections, we may all be forgetting the true value of decentralized election systems.

The proponents of the ballot receipt have often questioned the security of computerized voting systems. There have been claims that hackers can bypass security measures, change a program or two and weak havoc, and possibly steal elections, even the Presidency.

These receipt proponents fail to recognize, or mention, the fact that decentralized administration of Elections results in more than 3,000 different entities administering elections and certifying vote returns. These 3,000 entities, consisting of more than 150,000 election districts, conduct elections through a wide range of election laws, procedures, voting devices, and ballot programming and tabulation software. States position candidate names by various methods such as alphabetically, or by lottery, while others rotate candidate names. This decentralization makes the theft of a national or even statewide election not feasible in practice.

Pennsylvania takes decentralization to the election district level requiring the voting device to report election returns for certification by precinct polling place officials at the close of the polls.
Decentralization of election administration at the county level and vote certification at the precinct level is far more secure than providing the opportunity for fraud by a few individuals in control of a centralized, uniform election system.

G.   *Alternative use of Optical Scan Systems*

2001 - In addition, since there is no existing DRE voting system that provides voters a receipt, proponents have recommend that jurisdictions refrain from procuring any system until one can be developed, tested, and marketed. On other occasions receipt proponents have also asserted that jurisdictions would be wiser to use Optical Scan voting devices because the paper ballot used by voters to make selections serves as the paper audit trail to conduct recounts.

H.   *Conclusion*

> *The existing full face DRE voting devices have been adequately tested, extensively used, and have proven through years of use to be durable, reliable, accurate and efficient in recording, storing, and reporting votes*

as cast by electors.

The full-face DRE voting devices provide for storing and printing an electronic ballot image of each elector's ballot selections in random order. This provides for a sufficient paper audit trail without comprising the secrecy of the ballot.

Introduction of ballot "receipts" to manually count results would relegate the process to those used before the invention of the voting machine and would negate all the advantages provided by electronic voting devices.

Assurance that electronic voting devices accurately and securely record and report voter selections is accomplished through adherence to the following:
· extensive developmental testing by the manufacturer;
· FEC compliance testing by a designated Independent Testing Authorities;
· examination and approval for use by State election equipment examining authorities;
· adequate post production testing by the manufacturer;
· adequate and extensive conditional and final acceptance testing by procuring jurisdictions;
· adequate scheduled maintenance by county election personnel;
· pre-election testing of every device to be used in an election, using the actual election ballot;
· post-election testing using the actual election ballot.

Secrecy and Security of the ballots is enhanced by:
· a self contained, standalone device with an enclosed voting compartment;
· restricted access to the system and voting devices;
· redundant results memory, including random electronic ballot images;
· internal CPU battery power supply;
· 16 hour backup power supply for voting device;
· electronic and paper results certified by election district officials at the polling place;
· decentralized (county level) certification of results;
· escrowed source code - unavailable for public inspection;
· encrypted files and unofficial election results transmissions; and
· centralized re-reading of DRE voting device vote results cartridges, during Official Canvasses.

The list of secrecy and security features that existing full face DRE voting devices provide could go on and on as detailed in previous sections.

THE BALLOT RECEIPTS WILL NOT PROVIDE THE PROPONENTS DESIRED EFFECT OF VALID ASSURANCE TO VOTERS, AT THE TIME OF VOTING, THAT THEIR BALLOT SELECTIONS ARE BEING ACCURATELY RECORDED AND COUNTED.

THESE RECEIPTS ARE UNNECSSARY, NOT EASILY OR EFFICIENTLY IMPLEMENTED IN ELECTRONIC DEVICES, AND THEIR USE WILL HAVE A DETRIMENTAL IMPACT UPON THE VOTING PROCESS.

H.   *Delay Procurement / Alternative use of Optical Scan Systems*

In March 2001, when the City signed it's contract to procure new electronic voting machines there were no existing full-face DRE voting system that provided voters a receipt. Proponents of these voter receipts recommended at that time that jurisdictions refrain from procuring any system until one can be developed, tested, and marketed.

On other occasions these receipt proponents have also asserted that jurisdictions would be wiser to use Optical Scan voting devices because the paper ballot used by voters to make selections serves as the paper audit trail to conduct recounts.

Everything we have heard since Florida about companies developing new systems is simply speculation at this point. The development, factory testing, independent testing, examination and approval, and proven usage in sufficient numbers result in long incubation periods for new voting systems.

County election personnel and appropriating authorities are justifiably reluctant to chance the use of a new voting system that has not been proven as acceptable though use in conducting elections in smaller or similar sized jurisdictions. Philadelphia would not have selected or used a voting system that hadn't been successfully tested by a designated Independent Testing Authority for compliance with Federal Election Commission standards for voting systems. Pennsylvania law prohibited the use of any system not certified by the Secretary of the Commonwealth. ***In March 2001, there were no electronic voting machines certified by the Secretary for use in Pennsylvania that provided an audio device for accessibility for the visually impaired, nor did any certified system provide "voter receipts". That is still true as of the date of this revised report.***

Philadelphia also wanted an electronic voting machine that had a proven track record of use in conducting over a number of years. Electronic voting machines providing accessibility for the visually impaired have now been used in some jurisdictions for a couple of years. Systems with "voter receipts" have not been proven in use at all.

If independent ballot verification is eventually determined as necessary then the ideal electronic voting system would be one that included independent electronic ballot verification, without the need for troublesome paper receipts. It could take another 5 - 10 years for such potential new systems to be designed, tested, produced and proven in use. A new procurement process could add another 2 to 3 years, with implementation consuming another year.

Furthermore, the recent events in Florida highlighted the numerous problems and risks associated with paper-based punchcard and optical scan systems in accurately determining and reporting voter intent. These voter intent problems, along with the nuisance, problems and potential for fraud have rendered these paper based systems unacceptable in Philadelphia. The old mechanical lever machines also presented Philadelphia with numerous problems in election setup, hauling, manual vote counting, replacement parts, and repair

Again, the existing full face DRE voting devices have been adequately tested, extensively used in other jurisdictions, and have proven through the years to be durable, reliable, accurate and efficient in recording, storing, and reporting votes as cast by electors.

In November 1998 Philadelphians voted overwhelmingly to approve the use of an electronic voting system to conduct elections. They deserve no less.

There was no reason or need for Philadelphia to delay its procurement, implementation and use of the selected system.

Philadelphia has used the Danaher Controls ELECTronic 1242 voting machines for two years. The transition to the machines by pollworkers and voters was successful and we have eliminated real, known problems with errors in manually transcribing and tabulating votes.