Report on Secretary of State
Testing of Diebold PCM 500 Units

April 19, 2004

From April 10 through April 14, 2004, staff of the Secretary of State's Election Division conducted tests to identify the causes of the problems with the Diebold Precinct Control Module (PCM) 500 reported during the March 2, 2004 election. The PCM is a device used with the Diebold AccuVote-TS and TSx voting systems to encode the cards that voters insert into touch screen voting machines to allow the voters to cast their ballots. The information encoded on the card tells the machine which ballot type to display on the screen. Voters can cast their ballots only if the cards are properly encoded.

This report describes the problems experienced with PCMs at the March 2, 2004 election, the causes of those problems, and the testing conducted by the Secretary of State staff to identify those causes.

1. Desktop Screen

Description of Problem: The PCM 500 appears to have two default or start-up modes, Windows CE and PCM. On Election Day, it was reported that the unit often entered Windows CE mode rather than the expected PCM mode, creating uncertainty for pollworkers as to how to begin the process of encoding cards for voter to use with the touch screen machines.

Causes Identified: Secretary of State staff testing identified three causes of the PCM unit entering Windows CE mode: (1) a "cold boot," (2) an on/off switch boot when the unit was previously in Windows CE mode, or (3) a reset boot with AC power not attached. Only the first two of these causes were identified in Diebold reports issued following the election.[1]

The first cause was a "cold boot" of the system. A "cold boot" is a condition that causes the system's settings to be reset to those settings that are permanent to the unit's internal flash memory. Secretary of State testing verified that if a "cold boot" occurred, the unit would start up in Windows CE mode regardless of whether the unit had AC power, what mode the unit was previously in or the level of the battery charge.

According to the Diebold reports, the primary cause of the "cold boot" (starting in Windows CE rather than the expected PCM mode) was a slow loss of battery charge due to the unit being in "suspend" mode when turned off. Secretary of State testing did verify that the battery would lose charge when turned off and that a complete loss of battery power would cause the system to "cold boot." Due to the limited amount of time available, however, the testing could not verify a

[1] "Preliminary Report on PCM-500 Issues Experienced in March 2, 2004 Primary Election in Alameda County" and "Report on PCM-500 Issues Experienced on March 2, 2004 in San Diego County."

slow loss of charge when the unit was turned off, leading to a complete loss of battery power and causing a "cold boot."

According to the Diebold report, this slow loss of battery charge was the sole cause of the units entering Windows CE mode in Alameda and the primary cause of the units entering Windows CE mode in San Diego.

The second cause of the system entering Windows CE mode instead of the expected PCM mode was the unit being turned off when it was in Windows CE mode. Secretary of State testing verified this would occur regardless of whether the unit had AC power or the level of battery charge. According to the Diebold report, this occurred occasionally in San Diego.

The third cause of the system entering Windows CE mode identified by Secretary of State testing was an operator manually resetting the unit by pressing a button on the top of the device while AC power was not attached. This resetting without AC power would force the unit into Windows CE mode regardless of what mode the unit was previously in and regardless of battery charge level. The Diebold reports did not identify this resetting of the unit without AC power as a source of problems on Election Day.

Finally, the Secretary of State staff reviewed the poll worker manuals from Alameda and San Diego counties, as well as the manual provided by the vendor. Staff found that the manuals did not identify the PCM booting to Windows CE error as a potential problem, and therefore did not provide instructions to resolve it.

Tests Conducted:

Tests were conducted to identify potential variables that would affect whether the PCM unit would enter the PCM mode or Windows CE mode. These tests focused on the boot method, power source, the previous mode the unit was in and the battery charge level.

Test #1

The first set of tests included four different variables.
Variable 1: How the unit was turned on (on/off switch; resetting the system; or a "cold boot.")
Variable 2: Power source (AC or battery power)
Variable 3: Previous operating mode (Windows CE or PCM mode)
Variable 4: Level of battery charge (tests were conducted at 10% intervals of battery charge from 100% to 0%)

The result was a series of 12 tests conducted at each of 11 different power levels.

The results of those tests are reported below.

Boot Method	Power Source	Previous Mode	Power Level										
			100%	*90%*	*80%*	*70%*	*60%*	*50%*	*40%*	*30%*	*20%*	*10%*	*0%*
"Cold"	AC	PCM	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
"Cold"	AC	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
"Cold"	Battery	PCM	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	N/A
"Cold"	Battery	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	N/A
On/Off	AC	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM
On/Off	AC	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
On/Off	Battery	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	N/A
On/Off	Battery	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	N/A
Reset	AC	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM
Reset	AC	CE	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM	PCM
Reset	Battery	PCM	CE*	CE*	CE*	CE*	CE*	CE*	CE*	CE*	CE*	CE*	N/A
Reset	Battery	CE	CE*	CE*	CE*	CE*	CE*	CE*	CE*	CE*	CE*	CE*	N/A

** Booted to Windows CE with error message "WARNING: Battery power may not be sufficient to run your PC card. Some PC cards, such as modem cards, require AC power. Do you want to use this PC card on battery power?"*

Three causes of the unit entering Windows CE mode were identified through Secretary of State staff testing: (1) a "cold boot," (2) an on/off switch boot when the unit was previously in Windows CE mode, or (3) a reset boot with AC power not attached.

Test #2

The second set of tests focused on potential causes of a "cold boot."

Secretary of State testing was able to replicate a "cold boot" in two ways:

- Simulating a complete drain of the battery charge. Removing the battery from the unit for several minutes indeed resulted in a "cold boot."
- Manually triggering a "cold boot" by pushing a small button under the rear panel of the unit.

Due to the limited amount of time available, testing could not be conducted to completely drain the battery through a slow loss of charge while the unit was turned off. Therefore, the slow loss of charge resulting in a "cold boot" described in the Diebold reports could not be replicated.

Test #3

The third set of tests focused on whether a slow loss of battery charge occurred when the PCM unit was turned off.

A fully charged unit was removed from AC power and then left in the "off" position for 36 hours. After 36 hours, it was reconnected to AC power and rebooted. The battery charge had dropped to 98%.

Thus, Secretary of State testing was able to verify that the units did suffer from a slow loss of charge while the unit was turned off. Due to the limited amount of time and units available, however, that rate of loss could not be fully quantified.

2. Frozen Screen

Description of Problem: Occasionally the screen on the PCM unit would freeze. The unit would then need to be rebooted before it could be used.

Causes of Problem: The Diebold reports did not identify any specific cause of screen freezes. The Diebold reports did discuss a possible correlation between that problem, and problems experienced during encoding the cards that voters insert into touch screen voting machines.

During Secretary of State testing, this problem was replicated on one occasion when the card was removed prematurely during the card activation process.

Tests Conducted: No tests were conducted specifically to identify causes of frozen screens.

3. Compact Flash Error Messages

Description of Problem: Error messages would be displayed when the flash memory card on the top of the unit was not properly inserted.

Causes of Problem: The Diebold reports concluded that the cause of error message displays was an operator's improper insertion of the flash memory card during programming. Secretary of State testing confirmed this conclusion. Based on their testing, Secretary of State staff also concluded this improper insertion of the flash memory card would sometimes cause the unit to enter Windows CE mode.

Tests Conducted:

Test #1

The first set of tests was designed to identify whether a properly inserted memory card could be removed without deliberately depressing the plunger designed to eject the card. Shaking of the unit did not cause this to occur.

In addition, attempts to depress the eject plunger for the card while the protective rubber cover did not succeed in ejecting the card.

Thus, Secretary of State testing confirmed that a properly inserted memory card is not easily removed during normal operation.

Test #2

The second set of tests was designed to determine what would happen if a flash memory card was removed, regardless of whether the unit either on or off.

Secretary of State testing was able to verify many of the error messages contained in the Diebold reports including "A Native Exception Occurred" and "=Serious Error Message Error: Could not find resource assembly. Could not find resource assembly."

Secretary of State additionally identified that removing the flash memory card using the eject plunger would sometimes cause the unit to revert to the Windows CE mode. Also, if the unit was turned off and on, or was manually reset before the memory card was reinserted, it would enter Windows CE mode. Even after the memory card was reinserted the unit would remain in Windows CE mode unless the unit was reset or the PCM mode was manually selected.

These additional errors resulting from the removal of the flash memory card were not identified in the Diebold report.

4. Voter Access Card Messages

Description of Problem: Error messages were generated during the process of encoding the voter access card.

Causes of Problem: The Diebold report concluded that the cause of these problems was the premature removal of the voter access card before completion of the encoding process. Secretary of State testing was able to replicate this finding.

In addition to the error messages reported in the Diebold report, Secretary of State testing also found that on one occasion premature removal of the voter access card before completion of the encoding process caused a frozen screen error.

Finally, Secretary of State found that the occurrence of error messages during the encoding process was not correlated with other variables, particularly party type, ballot style and battery charge level. This was not a focus in the Diebold reports.

Tests Conducted:

The test consisted of three variables:

1: The party of the card being activated (11 different parties);
2: Font of ballot (normal or large font)
3: The level of battery charge (11 different intervals as discussed previously).

If the voter access card was removed prematurely, one of two error messages would be generated ("No resource file: IOException Error Code=8" or "No resource file: IOException Error Code=15"). These were the same error messages identified in the Diebold reports.

These errors could be replicated for each combination of party, font size and battery charge and thus was not found to be correlated to any of these variables.

If the voter access card was reinserted, one of three things would occur: 1) the card would be successfully activated (which occurred in most situations); 2) the unit would continue to prompt that it was activating the card without completing the process (removing the card and reinserting it would rectify this); or 3) the unit froze and required resetting (this occurred only once).

5. Power

Description of Problem: The power on the unit would drain due to a lack of AC power.

Causes of Problem: The Diebold report identified that the causes of the problem as either a poor connection to the AC, lack of power at the polling place, the power bar being in the "off" position, or a failure in the power supply in the base of the unit. No Secretary of State tests were conducted to verify these problems.

Tests Conducted: No tests were conducted.

6. PCM at Login

Description of Problem: Poll workers did not know how to login into the PCM program (by entering a user ID and password), which resulted in them not being able to start encoding voter access cards.

Cause of Problem: The cause of this problem is poll worker training.

Tests Conducted: No tests were required.