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# TEST REPORT

## CHANGE RELEASE REPORT OF THE EDGE MODELS I & II DRE VOTING MACHINES, VERIVOTE PRINTER, CARD ACTIVATOR, AND ADA AUDIO ADAPTER PERIPHERALS (FIRMWARE VERSION 5.0.21)

For  
 Sequoia Voting Systems  
 7677 Oakport St. Suite 800  
 Oakland, CA 94621

STATE OF ALABAMA }  
 COUNTY OF MADISON }

Robert D. Hardy, being duly sworn, deposes and says: The information contained in this report is the result of complete and carefully conducted testing and is to the best of his knowledge true and correct in all respects.

*Robert Hardy*

SUBSCRIBED and sworn to before me this 17 day of March 2006

*Ardelean Stabbin*  
 Notary Public in and for the State of Alabama at Large

My Commission expires March 3, 2007

Wyle shall have no liability for damages of any kind to person or property, including special or consequential damages, resulting from Wyle's providing the services covered by this report.

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 W. Owens, Project Engineer Date

APPROVED BY: *[Signature]* 17 MAR 06  
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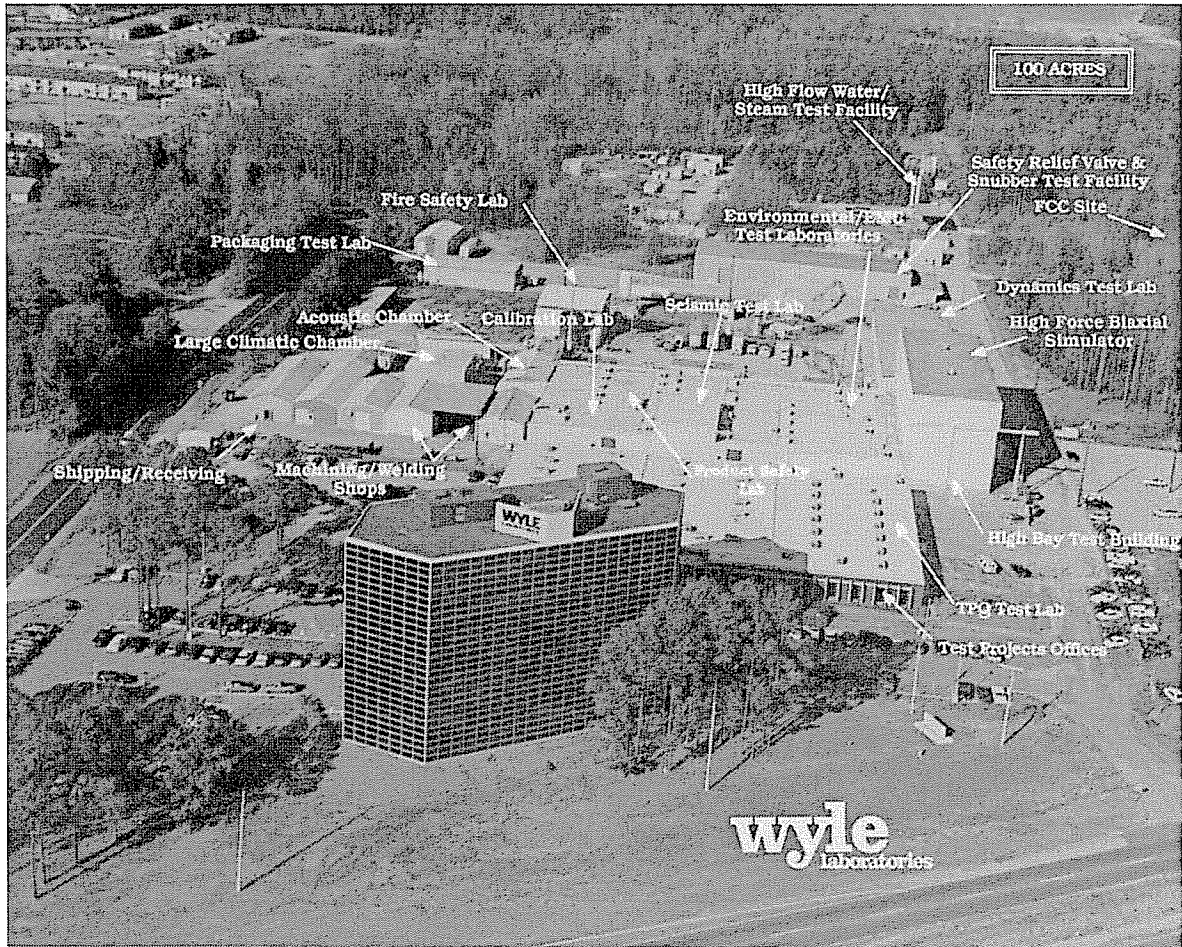
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AERIAL VIEW OF WYLE/HUNTSVILLE

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**1.0 INTRODUCTION**

**1.1 Scope**

This report presents the test results for Hardware Qualification Testing of the Sequoia Edge Models I and II Direct Record Electronic (DRE) Voting Machines, VeriVote Printer, Card Activator, and ADA Audio Adapter Peripherals.

**1.2 Objective**

The objective of this test program was to ensure that the Edge DRE Voting Machines, Firmware Release 5.0.21, continued to comply with the guidelines of the Federal Election Commission (FEC) Voting System Standards, April 2002, under which it was originally qualified.

**1.3 Summary**

A change release to the Edge firmware was implemented, requiring a review of the source code and follow-up regression testing to ensure continued compliance with the requirements of the Federal Election Commission (FEC) Voting System Standards, April 2002, under which it was originally qualified.

The regression testing (in-depth source code review and functional tests) was limited to the resident machine firmware and hardware used at the precinct level and did not include any election management software, which typically resides on a personal computer and is used for ballot definition, absentee, and report canvassing activities. Testing of the election management software including end-to-end system level testing will be performed by a Software ITA which will issue the results of such testing under a separate report.

It was demonstrated, that the Edge DRE Voting Machines, using firmware release 5.0.21, successfully met the qualification test requirements of the Federal Election Commission Voting System Standards, April 2002.

**Due to the varying requirements of individual jurisdictions, it is recommended by the Voting Systems Standards that local jurisdictions perform pre-election logic and accuracy tests on all systems prior to their use in an election within their jurisdiction.**

## 2.0 REFERENCES

- Sequoia Purchase Order No. 10006806
- Sequoia Voting Systems AVC Edge Test & Verification Specification, Version 1.02, Part Number 096051202, dated December 2005
- FEC April 2002 Voting System Standards, Volume I, "Performance Standards", and Volume II, "Test Standards"
- Wyle Laboratories' Report No. 51884-03, "Hardware Qualification Testing of the Edge Models I & II DRE Voting Machines, VeriVote Printer, Card Activator, and ADA Audio Adapter Peripherals (Firmware Version 5.0.14)", dated March 16, 2006
- Wyle Laboratories' Quality Assurance Program Manual, Revision 2
- MIL-STD-45662A, "Calibration System Requirements"
- ANSI/NCSL Z540-1, "Calibration Laboratories and Measuring and Test Equipment, General Requirements"
- ISO 10012-1, "Quality Assurance Requirements for Measuring Equipment"

## 3.0 CUSTOMER

Sequoia Voting Systems  
7677 Oakport St. Suite 800  
Oakland, CA 94621

## 4.0 TEST HARDWARE/SOFTWARE DESCRIPTION

### 4.1 Hardware

The following hardware descriptions were provided by Sequoia.

#### 4.1.1 Edge

The AVC Edge is a Direct-Record Electronic (DRE) voting device which uses a color Liquid Crystal Display (LCD) with an integrated touchscreen, a control panel for use by election poll workers, appropriate electronic circuitry and processing devices for performing specific system functions, internal memory for storing ballot data and voting records, a removable Results Cartridge with non-volatile memory, protective and public counters, and integrated voter privacy panels.

The AVC Edge provides a large format LCD and associated touchscreen to present the ballot and allow the voter to make their selections. Offices and issues can be set up in multiple formats allowing election administrators flexibility in the presentation of the ballots.

#### 4.0 TEST HARDWARE/SOFTWARE DESCRIPTION (Continued)

#### 4.1 Hardware (Continued)

##### 4.1.1 Edge (Continued)

The AVC Edge is modular in design and is available with options that allow the customer to configure it to their specific needs. The AVC Edge is a stand-alone system, i.e.; it does not require any networking to a central system in order to function. All processing from loading the ballot to recording votes is done on individual units. Loading ballots and accumulating tallies from the machines is accomplished via a Results Cartridge. Consolidation of votes from individual machines located within the same precinct can also be performed.

The Results Cartridge is designed so that it can be inserted into the voting machine, record voting results, be removed from the machine at the closing of the polls and be transferred to a central location and read by the Sequoia Voting System WINEDS election management software.

The Results Cartridge stores:

- An electronic representation of the ballot
- Ballot logic to enable the voter to make those selections to which they are lawfully entitled
- The aggregated vote totals
- A randomized record of all individual ballots cast
- A chronological log of significant machine operations, including error conditions

There are two models of the AVC Edge available. Both models were subjected to all tests. The difference in the models is limited to the location of the PCMCIA cartridge slots and the serial number nomenclature. On Edge I models, the PCMCIA slots are located just below the poll worker display and the serial numbers are less than 22000. On Edge II models, the PCMCIA slots are located behind the touch screen and the serial numbers are greater than 21999. Reference Photographs 2 and 3 for further details.

The AVC Edge is a suitcase shaped device measuring 10" by 17" by 26" and weighing approximately 45 pounds. It is portable and has a handle to allow for ease in carrying. For common carrier transport a protective fiberboard shipping carton is provided. An optional nylon carrying case is also available for additional protection of the Edge during transit between a storage facility and polling precinct.

The AVC Edge is powered via nominal 115 VAC/60 Hz power and includes internal battery backup power.

##### 4.1.2 VeriVote VVPAT Printer

The VeriVote printer is a thermal-type side-mounted printer which attaches to the AVC Edge via a slide rail located to the left of the touchscreen display housing. The VeriVote is used to produce a paper record that can be reviewed by the Voter during voting.

**4.0 TEST HARDWARE/SOFTWARE DESCRIPTION (Continued)**

**4.1 Hardware (Continued)**

**4.1.2 VeriVote VVPAT Printer (Continued)**

The VeriVote printer includes the following:

- Privacy panel/drape which allows the printout to be seen only by the Voter
- Provision for putting a seal on the printer ensuring that the housing containing the receipt paper cannot be disturbed without recognition
- Provision for putting a lock on the slide rail to which the printer is attached, preventing its removal from the AVC Edge
- The Printer also includes the poll's opening and closing reports

The VeriVote measures approximately 16" by 6" by 6" and weighs 7.4 pounds. It includes a nylon canvas carrying case. It is powered and receives data directly from the AVC Edge via a stand-alone power connector and a DB-25 plug.

The VeriVote uses a 300' length thermal paper roll.

As tested using the AVC Edge Firmware Release 5.0.21, the VeriVote printer was configured to suppress, (does not print out) any associated Serial Number data to which the printed roll can be traced back to the specific machine from which the voter receipts were printed. Additionally, there were no provisional voter ID tags printed, just a statement denoting "provisional voter."

**4.1.3 Card Activator**

The Card Activator is an optional device designed to activate Voter Cards, which enables the voter to access the AVC Edge voting machine upon card insertion into the AVC Edge. If a Card Activator is not used, a polling official must be present to manually activate the AVC Edge for each voter. After identifying the voter, the poll worker inserts a Voter Card into the Card Activator. The Card Activator prompts the poll worker for the ballot style to which the voter is allowed to vote based upon the voter's geographic location of residence. The Card Activator then transfers the poll worker responses to the voter's Voter Card. After the transfer is complete, the Card Activator ejects the activated card. The poll worker hands the activated Voter Card to the voter, who will use the activated Voter Card to access the AVC Edge voting machine. The Card Activator is comprised of a Central Processing Unit (CPU)/Printed Circuit Board, power conditioning, keypad, and its firmware. The Card Activator uses a 486CORE Module, i.e., embedded PC.

The Card Activator measures approximately 4" by 6" by 12" and can be operated from 115 VAC/60 Hz power or internal battery. It includes a nylon canvas carrying case.



#### 4.0 TEST HARDWARE/SOFTWARE DESCRIPTION (Continued)

#### 4.1 Hardware (Continued)

##### 4.1.4 ADA Handset

The ADA Handset is an optional Audio Voting accessory used for audio voting with the AVC Edge voting machine. The ADA Handset measures approximately 3.5" by 5.5" by 1.5" and is powered through a data cable attached to the AVC Edge. The ADA Handset utilizes 8-bit serial data, which is passed from the AVC Edge to a 20-PIC microprocessor in the handset. In the PIC microprocessor, a 10-bit pulse-switch modulator converts serial-audio voting data into a pulse-width modulated data stream, which is then passed through a 4 kHz low-pass filter where it is amplified and then sent to the stereo jack on the handset. It includes a nylon canvas carrying case.

#### 4.2 Firmware

The following hardware descriptions were provided by Sequoia.

##### 4.2.1 EDGE Firmware

The AVC Edge firmware is totally self-contained. It does not use an off-the-shelf operating system. A periodic interrupt routing is used to monitor hardware events, such as switch closures. The AVC Edge firmware includes purchased components for its file system (ERTFS) and graphics (Menuet and Metagraphics). These components all include source code, which the vendor has brought to compliance with the 2002 VSS. A separate real-mode BIOS is also part of the system, which is used during power up only.

Edge Version 5.0 firmware includes a dual-printer operational mode as a configuration option that is controlled from WinEDS. This mode prints to the Seiko DPU-414 printer when polls are not open (before and after) but to the VVPAT during voting. This allows for secure voter receipts while not limiting the ability for tear-off results and other reports, such as when the results are required to be posted at the polling place. When the dual-printer mode is active, the AVC Edge will inform the operator if the proper printer type for a given operation is not present. This will be via enhanced text in the "Printer Not Responding" alert message that indicates to check that the proper printer is installed. The dual-printer operational mode was tested during the required functional testing.

In-depth discussion of the Software System Concepts are documented in the Sequoia Voting Systems AVC Edge Software Technical Description, Release 5.0.

##### 4.2.2 Card Activator Firmware

The Card Activator uses an AMD Elan 486 processor. The software is compiled and linked as a single object module approximately 110K in size using C language. The source is compiled using Borland C/C++ compiler, and the executable is loaded into the Card Activator using a PCMCIA card. The resulting module runs on the MS-DOS operating system. In-depth discussion of the Software System Concepts are documented in the Sequoia Voting Systems Card Activator Software Specification, Release 5.0.

**5.0 MATERIALS REQUIRED FOR TESTING**

**5.1 Equipment**

Sequoia provided a sufficient number of Edge machines to ensure that parallel testing where feasible could be performed.

**5.2 Test Materials**

Sequoia provided all ancillary support material required during the course of the ITA Hardware Qualification Testing.

**5.3 Deliverable Materials**

Sequoia provided the latest versions of all hardware and software specifications and poll-worker hardware and software user/maintenance manuals. All user manuals have an identifiable Version Number or Document Control Number or Release Date. Reference Paragraph 2.0 for a listing and version of the applicable documentation.

**6.0 TEST SPECIFICATIONS**

**6.1 Functional Qualification Tests**

The Edge was subjected to a series of tests to simulate Election Day activities at the precinct level. These tests were performed to ensure compatibility of voting machine functions at the precinct level using the 5.0.21 firmware.

These included activities to simulate:

- (a) verification of hardware status via diagnostic reports prior to election
- (b) performing procedures required to prepare hardware for election operations
- (c) obtaining 'zero' machine report printouts on all contest fields
- (d) performing procedures to open the polling place and enable ballot counting
- (e) casting of ballots to demonstrate proper processing, error handling, and generation of audit data
- (f) performing hardware operations required to disable ballot counting and closing the polls
- (g) obtaining machine reports and verifying correctness
- (h) obtaining machine generated audit logs and verifying correctness

**6.0 TEST SPECIFICATIONS (Continued)**

**6.1 Functional Qualification Tests (Continued)**

**6.1.1 Source Change Specific Functional Tests**

Functional tests were performed to verify source specific changes associated with Release 5.0.21. This was done to ensure proper implementation of the changes. The changes associated with the 5.0.21 Firmware Release added functional enhancements, improvements in the overall structure, maintainability, and readability of the code as well as addressing any bugs identified during actual use or as a result of introduction through a previous step release while still in development. Additionally, some changes were imbedded in overall system operation and not specific to a singular functional attribute.

Source specific functional testing was performed to verify specific functional changes.

The following synopsis lists the changes between Edge Version 5.0.14 (the previously qualified version) and the revised Version 5.0.21:

- VVPAT font size available as an election configuration parameter
- Audio Box Rev. C includes controls for speeding up and slowing down the audio and "sip & puff" inputs
- Corrected printer management issues
- Improvements made to VVPAT special character mapping table to allow all possible Spanish characters to be printed
- Rank choice voting support extended to allow for write-in candidates
- Increased button size on both the selection code numeric entry screen and the 12-button screen
- Corrected condition of results files' digital signatures not being properly stored upon closing of polls
- Fixed logic flaw when validating write-in name record CRCs
- Corrected Audit Trail Transfer error where the cartridge would sometimes not be recognized
- Corrected occurrence of the 12<sup>th</sup> selection code on the 12-button screen not being displayed
- Corrected formatting of provisional IDs when in manual activate mode
- Correction of error when running the included vote simulation on the "IL Ballot"
- Corrected occurrence of lock mode not being properly entered when voting multiple Early Voting sessions
- Corrected instance of consolidation cartridge verifying with errors in vote consolidation

## 6.0 TEST SPECIFICATIONS (Continued)

### 6.2 Software Design and Coding

The precinct-level AccuVote-TSx AccuView Printer Module (AVPM) machine level software was subjected to a source code review. The source code was reviewed to ensure it followed the recommended programming guidelines as contained in the FEC standards. This included a review for:

- **Simplicity:** the straightforwardness of the design, such as avoidance of complex structure and obscure algorithms.
- **Understandability:** the ease with which the intent and function of the code can be ascertained and verified.
- **Testability:** the construction of code so as to incorporate implicit or explicit points or features to the flow of data and control within modules and at module interfaces.
- **Robustness:** a property of software design that is enhanced by editing and range specification, by the incorporation of controls or traps for immediate detection of errors to prevent their propagation throughout the rest of the code, and by providing a means of recovery without loss of control or data.
- **Security:** the inclusion of provisions to prevent unauthorized access, or to detect and control it, should it be attempted.
- **Usability:** the ability of the Voting Machine to be operated without recourse to excessive or obscure control procedures (e.g., text messages rather than numerical error codes that require the user to consult a table).
- **Installability:** the ease with which a Voting Machine can be made fully operational after delivery.
- **Maintainability:** the ease with which defects can be identified, corrected, and validated in the field.
- **Modifiability:** the ease with which new features can be incorporated into existing software.

Attachment A contains the firmware version 5.0.21 source code review reports.

## **7.0 TEST EQUIPMENT AND INSTRUMENTATION**

All instrumentation, measuring, and test equipment used in the performance of this test program were calibrated in accordance with Wyle Laboratories' Quality Assurance Program, which complies with the requirements of ANSI/NCSL 2540-11 ISO 10012-11 and Military Specification MIL-STD-45662A. Standards used in performing all calibrations are traceable to the National Institute of Standards and Technology (NIST), by report number and date. When no national standards exist, the standards are traceable to international standards or the basis for calibration is otherwise documented.

## **8.0 WYLE QUALITY ASSURANCE**

All work performed on this program was completed in accordance with Wyle Laboratories' Quality Assurance Program Manual, Revision 2.

Wyle Laboratories is accredited (Certificate No.: 845.01) by the American Association for Laboratory Accreditation (A2LA) and the results shown in this test report have been determined in accordance with Wyle's scope of accreditation unless otherwise stated in the report.

**Pages 14 through A-26 of the 3/16/06 Wyle Report No. 51884-04 have been redacted because they contain trade secrets of Sequoia including proprietary source code and related materials.**