



Federal Voting Assistance Program (FVAP)  
Operation VOTE

*16 September 2011*



# Operation VOTE

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16 September 2011

This report prepared for the Federal Voting Assistance Program by CALIBRE Systems, Inc.

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## Executive Summary

As part of a broad initiative to evaluate potential systems for remote voting electronic pilot projects, Federal Voting Assistance Program (FVAP) coordinated with the Office of Wounded Warrior Care and Transition Policy (WWCTP) and the U.S. Election Assistance Commission (EAC) to address the voting related needs of Wounded Warriors by assessing the usability, accessibility, and privacy of electronic voting systems.

This report details the results of this assessment, and includes:

- an evaluation of Wounded Warrior needs for electronic voting systems,
- recommendations to improve both Internet Voting Systems (IVSs) and Electronic Ballot Delivery Systems (EBDSs),
- recommendations to enhance the usability and accessibility portions of the EAC's UOCAVA Pilot Program Testing Requirements (UPPTR), and
- recommendations for future testing efforts.

Testing participants were very enthusiastic about both IVS and EBDS electronic voting systems, finding them to be easier and quicker to use than traditional postal mail absentee ballots. In particular, participants were impressed with the systems' abilities to prevent user errors, and the reliability of electronic systems in comparison to postal mail. Users displayed a slight preference for IVS versus EBDS systems, as these did not require the return of a voted ballot via postal mail.

Wounded Warriors reported needing systems with clear instructions, usable accessibility features, a simple log-in process, clear warnings about potential errors, a minimum of scrolling, and the ability to easily fix mistakes noticed on the verification screen. Additionally, participants requested systems which allowed the dual submission of electronic and hard-copy ballots.

Report recommendations for system usability and accessibility improvements included plain language instructions for using accessibility features, labeled icons to facilitate ballot navigation and display feature adjustments, built in audio ballots and touch screen functionality, the simplification of log-in procedures, architecture that displays only one race per screen to minimize scrolling, plain language warnings regarding over and under-voting, and designs that allow "jumping" between the verification screen and individual contests.

This report also contains a series of recommendations designed to clarify, clearly organize, and enhance the content of the UPPTR. These include suggestions for consistent numbering, condensing redundant requirements, separating out distinct requirements, and adding additional requirements for voting system features that assist users with cognitive disabilities.

The final set of recommendations in this report describes additional testing recommended for electronic voting technology. Following vendor and federal agency assessments of this report, it is recommended that the systems undergo more rigorous testing in both certified voting system test laboratory and operational testing environments.

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## 1 Introduction

The Federal Voting Assistance Program (FVAP) provides U.S. citizens worldwide with a broad range of non-partisan information and assistance to facilitate their participation in the voting process, regardless of where they live or work. FVAP specifically assists military and overseas voters in exercising their right to vote, supports state and local election officials in complying with federal requirements to provide equal voting opportunities for military and overseas voters, and works with key stakeholders to protect military and overseas voting rights.

The Director of FVAP administers the federal responsibilities of the Secretary of Defense under the Uniformed and Overseas Citizens Absentee Voting Act of 1986 (UOCAVA). This legislation requires states and territories to allow certain U.S. citizens (commonly referred to as UOCAVA voters) to register and vote absentee in elections for federal office. These groups include:

- Members of the Uniformed Services (including Army, Navy, Air Force, Marine Corps, Coast Guard, and Merchant Marine) and their voting age dependents;
- Commissioned Corps of the Public Health Service, and Commissioned Corps of the National Oceanic and Atmospheric Administration;
- U.S. citizens employed by the federal government residing outside the U.S.; and
- All other private U.S. citizens residing outside of the U.S.

UOCAVA was modified by the Fiscal Year 2002, 2005, and 2010 National Defense Authorization Acts, which imposed additional requirements upon the Department of Defense (DoD) on behalf of absentee voters. The 2002 Act required FVAP to carry out an electronic voting demonstration project in which uniformed service members could cast ballots in a regularly scheduled election. The 2005 Act allowed FVAP to wait for the U.S. Election Assistance Commission (EAC) to certify guidelines for such a project. The 2010 Act included the Military and Overseas Voter Empowerment (MOVE) Act, which authorized FVAP to conduct electronic voting pilot programs to test the feasibility of new election technology, and reiterated that the EAC should provide guidelines for pilot project systems, as noted in the 2002 and 2005 Acts. The MOVE Act also established provisions for states to transmit all general election information, voter registration and absentee ballot applications, and blank absentee ballots electronically to UOCAVA voters as part of a legislative approach for protecting the voting franchise for military and overseas voters. Additionally, the Act required FVAP to take necessary and practicable actions to ensure that UOCAVA voters at DoD facilities have the ability to vote privately and independently.

FVAP's obligations under UOCAVA also apply to injured service members (Wounded Warriors) who are repatriated from active engagements to military treatment facilities. To ensure that Wounded Warriors have the same opportunities for access and participation (including privacy and independence) as other voters, and to assess potential electronic voting systems that could be used for the Congressionally-mandated electronic voting demonstration or pilot projects, FVAP coordinated with the Office of Wounded Warrior Care and Transition Policy (WWCTP) and the EAC to engage in a comprehensive testing and research effort of the Wounded Warrior voting environment.



The testing effort described in this report assessed the accessibility, usability, and privacy of six electronic voting systems via a mock election process, using volunteer Wounded Warrior participants. This project was dubbed Voting Operations Testing and Evaluation, or Operation VOTE. Two of the project goals were assessment of Wounded Warrior requirements for electronic voting systems, and identification of current accessibility, usability, or privacy deficiencies in the tested systems. Data collection methods for this effort involved direct observation during the voting sessions, and qualitative post-voting interviews with participants.

Observer checklists and interview questions were also designed to make all practicable effort to examine system compliance with Section 3 of the UOCAVA Pilot Program Testing Requirements (UPPTR). Adopted in August 25, 2010 by the EAC, these requirements describe voluntary<sup>1</sup> guidelines for kiosk-based<sup>2</sup> remote electronic pilot systems submitted for EAC certification.<sup>3</sup> Section 3 of the UPPTR (see [Appendix A](#)) describes usability, accessibility and privacy issues related to voting systems. The requirements in this section address a broad range of usability and accessibility factors including physical abilities, language skills, and technology experience across various disabilities, including cognitive, vision, hearing, dexterity, and mobility challenges. The third goal of Operation VOTE was the creation of meaningful recommendations for the EAC, enabling improvements to Section 3 of the UPPTR with regard to persons with disabilities generally, and Wounded Warriors specifically.

Although the tested systems were designed and built before the advent of UPPTR, and the naturalistic setting of Operation VOTE prevented a full review of compliance, it was felt that at least a partial assessment of UPPTR compliance and requirements was necessary, because these guidelines are the latest to be issued by the EAC, and are the only guiding principles specifically formulated to apply to a kiosk environment. As any pilot or demonstration project is likely to take place in such a kiosk environment, there is a need to assess both the quality of the guidelines and the ability of current technology to meet them. The Operation VOTE assessment identified several recommended changes to Section 3 of the UPPTR.

This report begins with an overview of Operation VOTE, followed by an explanation of the project methodology in Chapter [3](#), describing inclusions, exclusions, a characterization of tested systems, and a profile of the participants. Chapter [4](#) provides a summary of the results, including both positive and negative feedback received from Operation VOTE participants. Chapter [5](#) discusses the UPPTR guidelines in terms of system compliance and recommended changes to the UPPTR. Wounded Warrior requirements for electronic voting systems are summarized in Chapter [6](#), while Chapter [7](#) contains recommendations pertaining to the systems, the UPPTR, and future testing.

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<sup>1</sup> The guidelines are considered voluntary in that states can decide whether to require the voting systems used in pilot programs in their state to have an EAC certification.

<sup>2</sup> The EAC defines internet-based kiosks as varying from “non-specific mobile computing devices” such as laptops and personal computers to more elaborate “remote electronic absentee voting systems implemented as a manned kiosk with printable paper ballots for audit capability.”

<sup>3</sup> U.S. Election Assistance Commission. 2010. UOCAVA Pilot Program Testing Requirements August 25<sup>th</sup>, 2010 Retrieved from:

[http://www.eac.gov/assets/1/Documents/UOCAVA\\_Pilot\\_Program\\_Testing%20Requirements%20August%208%202010.pdf](http://www.eac.gov/assets/1/Documents/UOCAVA_Pilot_Program_Testing%20Requirements%20August%208%202010.pdf)

## 2 Project Overview

As previously described, Operation VOTE was a targeted accessibility, usability, and privacy test of six electronic voting systems, using Wounded Warrior participants as testers, and as practicable, assessing Section 3 of the UOCAVA Pilot Program Testing Requirements (UPPTR). This was the first exercise of its kind performed by FVAP, and the first evaluation of the UPPTR to use voters with disabilities in a mock election process. At its highest level, Operation VOTE served as a demonstration project to show that such a test is feasible. The objectives of this testing were to assess both Internet Voting Systems (IVSs) and Electronic Ballot Delivery Systems (EBDSs) in a potential kiosk environment, in order to identify:

- Wounded Warrior needs;
- usability, accessibility, and privacy deficiencies in the platforms; and
- deficiencies in the UPPTR.

Operation VOTE was not intended as an end-to-end test of any systems, nor as an assessment against all of Section 3 of the UPPTR. A full test against Section 3 of the UPPTR would require the resources of a test lab, as well as much larger time and energy commitments on the part of the Wounded Warriors. Cost and human resources made such testing impractical and unnecessary to achieve the objectives of the project.

Operation VOTE was designed to be a two-day process, evaluating the IVS platform on Day 1, and the EBDS platform on Day 2. Three systems from three different vendors were selected to represent each type of platform being tested. Operation VOTE was not planned as a test of any of the individual systems, but rather as an assessment of the usability, accessibility, and privacy features of each of the platforms. Some system features were more accessible or user friendly than others, but if any one IVS or EBDS system met an UPPTR requirement, that requirement was considered observed for the platform.

After consideration for Wounded Warrior population size and diversity of injuries, Operation VOTE was held at the Okubo Barracks at Brooke Army Medical Center in San Antonio, TX.

Operation VOTE data was collected both through direct observation during voting, and structured post-voting interviews of each participant in the test. The data collection methodology is further described in [Section 3](#) of this document. See [Appendix B](#) for the observation checklist and [Appendix C](#) for the interview protocol.

### 3 Methodology

Operation VOTE reflected a potential kiosk environment as much as possible, while allowing volunteer participants to be observed in a manner that could provide insight into the usability, accessibility, and privacy of the voting platforms. All vendors were provided a standard ballot for use during the exercise (see [Appendix D](#) for the sample ballot). All volunteers gave informed consent prior to participating in Operation VOTE, and the data collection was carried out in accordance with Department of Defense policies, under the Washington Headquarters Service Report Control Symbol DD-P&R (OT)-2483.

Operation VOTE took place as follows:

Upon arrival at the Okubo Barracks, participants were welcomed by FVAP representatives, read the consent form, and were handed a unique number that would allow for their voting experience and system to be documented while maintaining their anonymity. Vendor representatives then showed the participants a 3-5 minute overview demonstration of the voting system that they would be using during the voting process, giving an overview and specifying any accessibility features. At the conclusion of the demonstration, each participant was escorted to the voting machine where they completed their ballot. If needed, a “poll worker” (voting system vendor representative) was available to assist the participants during the voting process, just as a poll worker would offer help in an actual voting environment. See [Appendix E](#) for a detailed picture of the layout of the Okubo Barracks day room during Operation VOTE.

Each participant was observed advancing through the voting process by a trained member of the project team. Participants were instructed to ignore these observers in their latter assessments of the privacy of the systems. Observers recorded their evaluations of the participants’ voting experiences on an observer checklist (see [Appendix B](#)). The checklist was used by the observers to assess issues relating to usability, accessibility, and privacy as well as the effectiveness and efficiency of the voting process for the participants.

Upon completion of the voting process, the participants were interviewed to assess their satisfaction with the particular voting system that they used (see [Appendix C](#) for the interview protocol). Questions dealt with the accessibility, usability, and privacy features of the voting system, including physical system configuration, visual display settings, audio features, tactile controls, instructions, navigation, voting selection, help features, error messages, ballot summary, and ballot submission. Participants were also asked about their previous voting experiences and their medical situation, including current difficulties with vision, hearing, mobility, dexterity, cognition, and emotion.

#### 3.1 Inclusions

Section 3 of the UOCAVA Pilot Program Testing Requirements (UPPTR) provides specific guidelines related to the usability, accessibility, and privacy of voting systems (see [Appendix A](#)). However, not all aspects of the requirements apply to the IVS and EBDS voting systems, and many of the requirements were not testable outside of a lab environment. For the purposes of this project, only aspects of the Section 3 UPPTR that were clearly testable and could be observed in a simulated voting environment

were included in this evaluation.<sup>4</sup> These aspects are summarized in the sections below, and a full requirement-by-requirement listing of can be found in [Appendix G](#).

### 3.1.1 Usability

The following table summarizes Section 3 usability requirements (including privacy) observable during Operation VOTE.

**Figure 1: Observerable UPPTR Usability Requirements**

Section 3.2: Usability			
3.2.1	Privacy	.1 a & b	The ability of the voting system to prevent people other than the voter from determining the content of the ballot during the voting process.
		.1 c	The audio interface is audible to only the voter.
		.1 d	Any alerts and/or warnings given by the voting system preserve the privacy of the voter.
		.1 e	The vote capture device does not issue a receipt to the voter that would provide proof to another of how the voter voted.
3.2.2	Cognitive Issues	a	The voting system includes valid instructions for all operations.
		b	The voting system provides a means for the voter to get help directly from the system.
		d	The voting system supports a process that does not introduce a bias for or against any ballot choices.
		e	There is a capability to design a ballot with a high level of clarity and comprehensibility.
		f	Any use of color agrees with common conventions.
		g	When an icon is used to convey information, indicate an action, or prompt a response, it is accompanied by a corresponding linguistic label.
3.2.3	Perceptual Issues	b	System performs an automatic reset to standard default settings upon completion of individual voting session.
		c	System contains a mechanism to allow the voter to reset all settings to default values while preserving current votes.
		e	The voting system is capable of showing all information in at least two defined font sizes.
		g	Reading assistance is provided for any paper verification records.
		j	The system supports correct perception by voters with color blindness.
		k	Color coding is not used as the sole means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.
3.2.4	Interaction Issues	a	No page scrolling is required by voters.
		b	There is unambiguous feedback regarding the voter's selection.

### 3.1.2 Accessibility

The following figure details Section 3 accessibility requirements observable during Operation VOTE.

<sup>4</sup> Some portions of the UPPTR Section 3 were not tested due to unclear language.

**Figure 2: Observable UPPTR Accessibility Requirements**

Section 3.3: Accessibility			
3.3.1	General	b	When the provision of accessibility for the voting system involves an alternative format for ballot presentation, then all information presented to non-disabled voters, including instructions, warnings, error and other messages, and contest choices are presented in the alternative format.
		c	The support provided to voters with disabilities is intrinsic to the voting system and it is not necessary for the voting system to be connected to any personal assistive device of the voter in order for the voter to operate it correctly.
3.3.2	Low Vision	a	Black text on white background and white text on black background are provided as display options.
		b	Buttons and controls on the voting station are distinguishable by both shape and color.
		c	Synchronized audio output is available to convey any information displayed on screen; there is a means by which the voter can disable either the audio or video output; and the system allows the voter to switch among the three modes throughout the voting session while preserving current votes.
3.3.3	Blindness	a	There is an audio-tactile interface that supports the full functionality of the visual ballot interface.
		b	Voting stations that provide audio presentation of the ballot do so in a usable way.
		c	If voting system supports ballot activation for non-blind voters, then it also provides features that enable voters who are blind to perform this activation.
		d	The support of ballot submission or vote verification for non-blind voters is also provided for voters who are blind.
		e	Mechanically operated controls or keys, or any other hardware interface on the voting system available to the voter is tactilely discernible without activating those controls or keys.
		f	The status of all locking or toggle controls or keys for voting system are visually discernible, and also discernible through either touch or sound.
3.3.4	Dexterity	a	There is a mechanism to enable non-manual input that is functionally equivalent to tactile input.
		b	Features are provided that enable voters who lack fine motor control to perform ballot submission and/or vote verification.
		c	Keys, controls, and other manual operations operable with one hand without requiring tight grasping, pinching, or twisting of the wrist.
		d	The system does not require direct bodily contact or the body to be a part of any electrical circuit.
3.3.5	Mobility	c	Labels, displays, controls, keys, audio jacks, and other parts of the voting system necessary to operate the voting system are legible and visible to a voter in a wheelchair with normal eyesight.
3.3.8	English Proficiency	a	There are features designed to assist voters who lack proficiency in reading English.

### 3.2 Exclusions

Voting system features and functionality that do not impact voting usability, accessibility, and privacy were not evaluated during Operation VOTE testing. No portions of UPPTR Sections 2, 4, 5, 6, 7, 8, or 9 were evaluated in this exercise. Furthermore, portions of the UPPTR Section 3 that were not easily observable during a simulated election process, that were not applicable to IVS and EBDS voting

systems, or that were ambiguously worded were not evaluated. The usability of the ballot design was also not evaluated during Operation VOTE.

### 3.3 Systems Tested

Six voting systems from six different voting system vendors were tested during Operation VOTE. Three IVS systems were tested on Day 1 and three EBDS systems were tested on Day 2. IVS and EBDS systems were chosen for this exercise because these platforms can be used on any PC or laptop, have the capability to display an unlimited number of different ballots, and are potential candidates for use in an overseas kiosk voting environment. Figure 3 summarizes the voting systems and vendors who participated in Operation VOTE. These particular systems were chosen based either on vendor experience in real-world elections, or prior participation in FVAP's Electronic Voting Support Wizard (EVSU) program.<sup>5</sup> Direct Recording Electronic (DRE), optical scan, digital scan, Ballot Marking Devices (BMDs) and other voting technologies were not included in this voting system evaluation.

**Figure 3: Voting System Manufacturers**

Type	Manufacturer	System Name	Selection Criteria
IVS	Dominion Voting Systems <a href="http://www.dominionvoting.com">www.dominionvoting.com</a>	Democracy Suite IVS	Dominion Voting is the second largest election vendor in the U.S.* and its IVS solution has been used in Canada.
IVS	Everyone Counts <a href="http://www.everyonecounts.com">www.everyonecounts.com</a>	eLect Platform	Everyone Counts participated in FVAP's EVSU program and has deployed internet voting technology around the world.
IVS	Scytl <a href="http://www.scytl.com">www.scytl.com</a>	Scytl Pynx	Scytl participated in FVAP's EVSU program and has deployed internet voting technology around the world.**
EBDS	Democracy Live <a href="http://www.democracylive.com">www.democracylive.com</a>	LiveBallot	Democracy Live participated in FVAP's EVSU program.
EBDS	Konnech <a href="http://www.konnech.com">www.konnech.com</a>	Konnech EVSU	Konnech participated in FVAP's EVSU program.
EBDS	Credence <a href="http://www.credence-llc.com">www.credence-llc.com</a>	Credence EVSU	Credence participated in FVAP's EVSU program.

\*Election Systems & Software (ES&S) is the largest.

\*\*Scytl is now in a marketing arrangement with ES&S to market Scytl's technology in the United States.

The following paragraphs contain more detailed descriptions of each of the systems as they were configured for Operation VOTE. It should be noted that other configurations of these systems may be possible, including configurations that allow election officials to set pop-up versus verification screen warnings, and configurations for some EBDS systems to electronically cast the ballots. However, only the configurations specified here were assessed during Operation VOTE.

<sup>5</sup> The EVSU program was an FVAP funded and managed EBDS tool employed in collaboration with state election officials on a pilot basis during the 2010 election.

**Democracy Suite IVS**

The Democracy Suite IVS is an interactive internet voting solution developed by Dominion Voting, and provides a web-based voting interface that allows voters to electronically receive, complete, and cast their ballots. The system presented the Operation VOTE ballot as one race per screen. Voters were notified of any over or under-votes on a verification screen after the last race. The system allowed voters to make changes from the verification screen before casting their ballots, but a security and privacy implementation required them to restart a blank ballot from the beginning to allow the changes to be made.

**eLect Platform IVS**

The eLect Platform IVS is an interactive internet voting solution developed by Everyone Counts, and provides a web-based voting interface that allows voters to electronically receive, complete, and cast their ballots. The system presented the Operation VOTE ballot as one race per screen. Voters were notified of under-votes on a verification screen after the last race. The system prevented over-votes on each race by requiring participants to deselect their choices prior to selecting new candidates. The system allowed voters to make changes from the verification screen before casting their ballots, and provided a “change selection” link under each choice that would take the voter directly back to each individual contest needing correction, such that voters did not have to restart the ballot.

**Pnyx IVS**

The Pnyx IVS is an interactive internet voting solution developed by Scytl, and provides a web-based voting interface that allows voters to electronically receive, complete, and cast their ballots. The system presented the Operation VOTE ballot as one race per screen. Voters were notified of under and over-votes by an immediate pop-up message. The system allowed voters to make changes from the verification screen before casting their ballots, but returned the voter to the first race and required them to click through the ballot from the beginning to make changes (voter selections were preserved).

**LiveBallot EBDS**

The LiveBallot EBDS is an interactive electronic ballot delivery system developed by Democracy Live, and provides a web-based voting interface that allows voters to receive, complete, and print the ballot for postal mailing. Voters could choose whether the Operation VOTE ballot would present as one race per screen or all races on one screen. Voters were notified of over-votes by an immediate pop-up message on the screen, while under-votes did not receive an error message until the verification screen after the last race. The system allowed voters to make changes from the verification screen before printing their ballots, and the verification screen provided links to take voters directly to the individual contests needing correction, such that voters did not have to restart the ballot. Voters followed on-screen instructions to print the ballot and then secured it in an envelope to be mailed for tabulation.

**Konnech EBDS**

The Konnech EBDS is an interactive electronic ballot delivery system, and provides a web-based voting interface that allows voters to receive, complete, and print the ballot for postal mailing. The system displayed all Operation VOTE races on one screen. Voters were notified of under-votes by a pop-up



message at the bottom of the screen, which stated that not all selections had been completely voted, but did not specify in which race. The use of radio buttons prevented over-voting in races where voters could choose only one candidate.<sup>6</sup> After completing the ballot, the voter converted the ballot to a PDF file. The voter then printed the PDF file and secured it in an envelope to be mailed for tabulation. After printing the ballot, a new browser window appeared confirming the votes cast. If voters found an error, they were required to restart the process with a blank ballot to correct the error.

### Credence EBDS

The Credence EBDS is a web-based electronic ballot delivery system, which delivers the PDF ballot and allows it to be electronically filled and printed for postal mailing. The system delivered all Operation VOTE races on one screen, as the entire ballot was one PDF file. The use of the PDF interface meant that the system did not provide notifications or warning messages about under or over-votes, and did not provide a verification screen. However, the use of radio buttons prevented over-voting in races where voters could choose only one candidate. Voters used the Adobe Acrobat interface to print their ballot and then secured it in an envelope to be mailed for tabulation.

## 3.4 Participants

Participants in Operation VOTE consisted of volunteer Wounded Warriors and Warrior in Transition Unit staff stationed at Brooke Army Medical Center (BAMC). Based on previous research evaluating Wounded Warrior voting challenges,<sup>7</sup> Wounded Warriors with vision, hearing, mobility, dexterity, cognitive, and emotional impairments were asked to participate in the exercise. Staff members who regularly work with the Wounded Warriors were also invited to volunteer to ensure the broadest possible testing of system accessibility features. See [Appendix F](#) for a January 2011 sample of the BAMC Wounded Warrior population.

A total of 127 people participated in Operation VOTE. Figure 4 below represents the breakdown of voters by platform and participant type.

**Figure 4: Participant Numbers by Platform**

Platform	Participant Type	Number
IVS	Wounded Warrior	61
	Staff	6
EBDS	Wounded Warrior	39
	Staff	21

A robust number of Warriors with a variety of injuries and illnesses participated in Operation VOTE. The following figure demonstrates the variety of injuries and illnesses reported by the Wounded Warrior

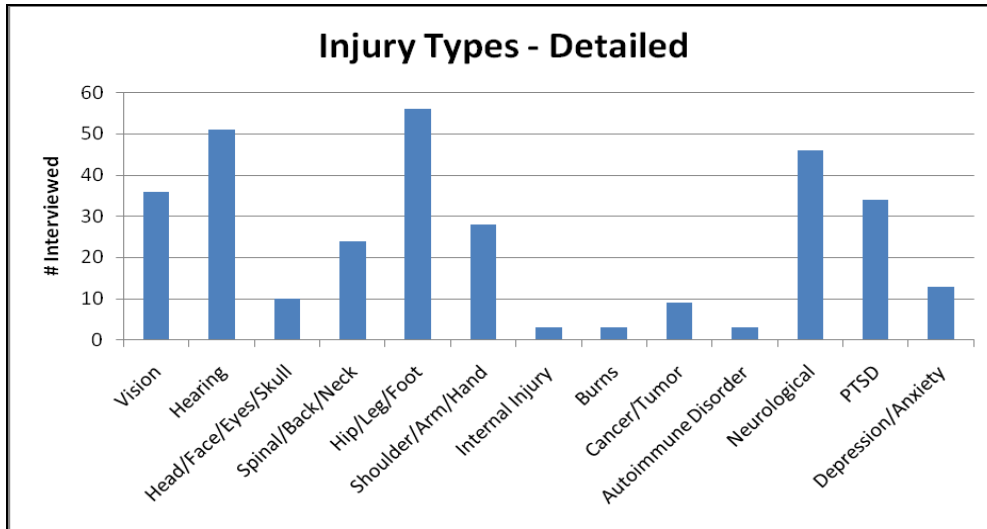
<sup>6</sup> Radio buttons, also called option buttons, are a type of graphical user interface that allow the user to only choose one option from a predefined set.

<sup>7</sup> Department of Defense. Federal Voting Assistance Program. CALIBRE Systems, Inc. 2011. Combat-Related Disabilities and Voting Challenges.



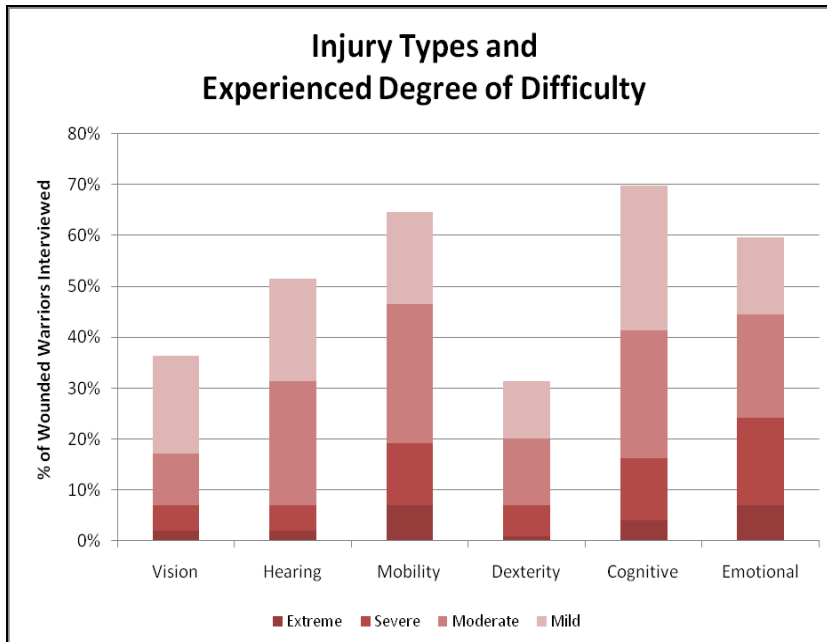
participants in Operation VOTE. It should be noted that this figure represents only the injuries of personnel interviewed during Operation VOTE, and should not be generalized to all Wounded Warriors.

**Figure 5: Detailed Injuries of Operation VOTE Participants**



The detailed injuries above were classified into six domains: vision, hearing, mobility, dexterity, cognitive, and emotional. The following figure shows that most interviewed Wounded Warriors reported difficulties in multiple domains, with over 60% reporting mobility and cognitive impairments, and over 50% reporting hearing and emotional impairments. When asked about the degree of difficulty they experienced in each domain, Wounded Warriors generally reported mild or moderate difficulties, although significant percentages also experienced severe or extreme difficulties, especially in mobility, cognitive, and emotional areas.

**Figure 6: Injury Types and Degree of Difficulty Experienced by Operation VOTE Participants**



Previous FVAP research has shown that injured service members may have special voting-related requirements related to reading forms and instructions, completing forms and ballots, and travelling to their local polling place and voting in-person. This research suggested the following accommodations relevant to electronic voting systems:

- access to voting assistance online;
- simplified forms and written instructions with a large type;
- voting website assistance and tools that are compatible with screen readers;
- the ability to magnify information;
- dual auditory and visual versions of registration and ballot materials;
- availability of headphones with adjustable volume for audio; and
- voting technology that is accessible and compatible with assistive devices for dexterity impairments.<sup>8</sup>

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<sup>8</sup> Department of Defense. Federal Voting Assistance Program. CALIBRE Systems, Inc. 2011. Combat-Related Disabilities and Voting Challenges.

## 4 Results

Feedback from Operation VOTE participants regarding both the IVS and EBDS platforms was overwhelmingly positive. Four common themes were reiterated by almost all participants:

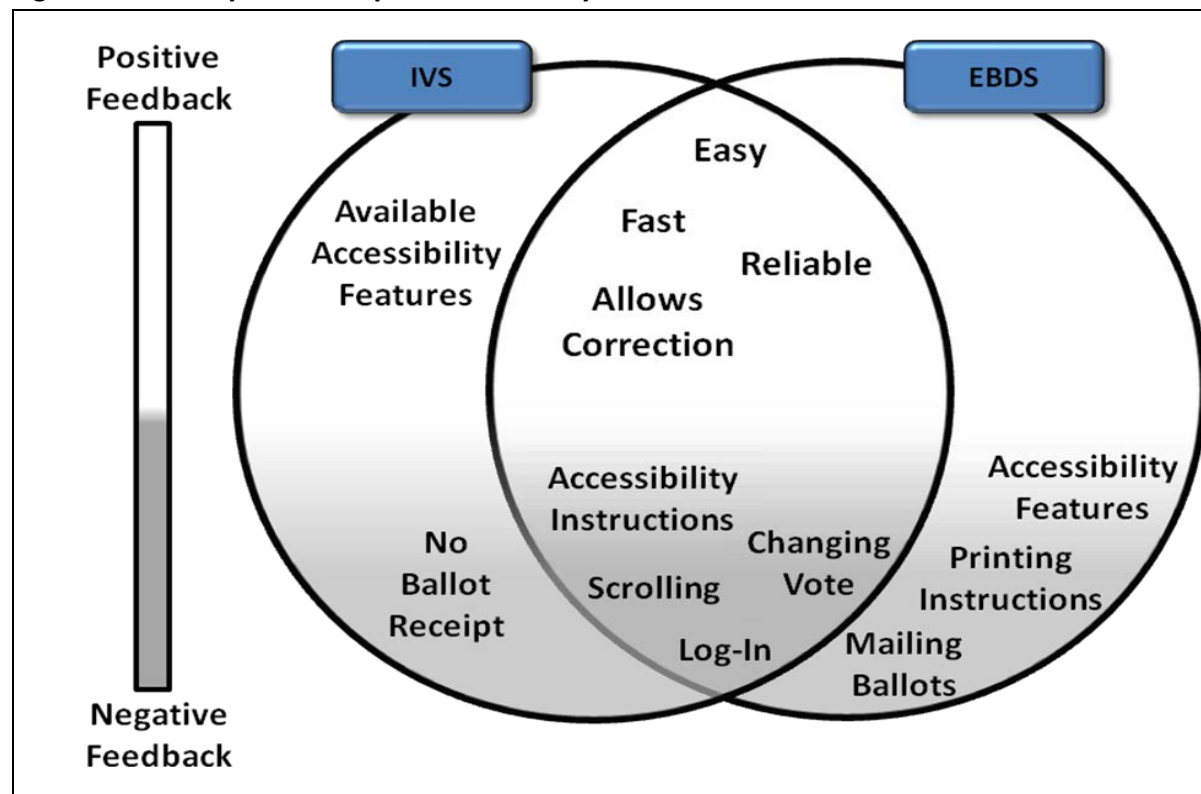
- the ease of use and convenience of the systems;
- the quickness of the voting process;
- the fact that both platforms caught user errors and prevented mistakes; and
- the reliability of the systems to electronically deliver (and in the case of IVS, return) ballots, especially to overseas locations where postal mail service is frequently undependable.

When asked about negative aspects of the systems, participants were less uniform in their responses, but some participants reported accessibility and usability difficulties related to four domains:

- the length of the log-in process;
- a lack of clear instructions for resizing fonts, activating accessibility features, and printing ballots;
- navigation issues after attempting to change a vote; and
- issues with excessive scrolling.

The following figure summarizes these common positive and negative feedback themes, as well as the issues unique to each of the platforms. Note that the positive and negative feedback themes listed in the middle of the figure relate to both the IVS and EBDS platforms.

**Figure 7: Summary of Usability and Accessibility Interview Results**



In addition to the above usability and accessibility concerns, a minority of participants also voiced:

- security concerns related to hacking or computer errors, and
- logistical concerns due to unreliable internet connectivity (and in the case of EBDS, postal system problems) overseas.

The following sections explain each of these themes in detail.

#### 4.1 Overall Voting Experience

Both Wounded Warrior and staff participants reported positive voting experiences using the IVS and EBDS platforms. In particular, the terms “easy,” “simple,” “intuitive,” and “straight-forward” were used repeatedly during the post-voting interviews. Many Wounded Warriors echoed the words of this soldier, who stated that the IVS system he used was “clear, concise, and user-friendly.” Similarly, an EBDS user stated, “It was very easy. I did not have to write anything in. [It was] very convenient just to read it and click on a name.” Several participants reported that their familiarity with computers made the electronic voting systems particularly easy to use. For example, a Wounded Warrior stated the IVS system was “almost the same set-up as an online survey...so it’s familiar.” Another participant echoed this, saying, “Everything is real, real easy to do. Like I said, if you have any... e-mail experience or anything, it shouldn’t take anyone barely a minute.” Participants deemed the electronic voting systems easier to use than traditional paper absentee ballots, with one voter saying: “It’s the easiest I have ever seen voting...outside the States.”

Another common theme mentioned during the post-voting interviews was the quickness of the voting process when using both IVS and EBDS systems. Without factoring in the approximately five minutes of instruction, participants took an average of four and half minutes to use the IVS systems, and close to six minutes to use the EBDS systems. The maximum time taken by a participant to vote was 14 minutes on an EBDS system. Participants were highly satisfied with amount of time they spent voting, describing both IVS and EBDS systems as “quick,” “fast,” “speedy,” and “timely.” Participants reported that using the electronic voting systems was faster than completing traditional absentee ballots, with the added benefit that “everything is legible, and you don’t have to worry about handwriting.”

Both IVS and EBDS systems were also judged to be superior to traditional absentee ballots because of built-in features to summarize voting selections, catch mistakes, and make changes to the voted ballot. Users of both platforms reported high levels of satisfaction with the vote verification screens, echoing the sentiments of this participant, who said the screen was useful, because, “It gave you a chance to review. If you want to go back and start over again, it gives you the opportunity to do so.” Other participants stated that they liked the pop-up or red system warnings, which “prevented you from making a mistake.”

Many participants using the IVS systems commented on the reliability of electronic ballots, especially in comparison to paper ballots mailed from overseas. As one Wounded Warrior stated, “I spent seven years overseas, so voting is more of a pain than anything. It may take three or four months for you to get the paperwork, and then once you fill it out, there’s no guarantee that it’s going to end up where you wanted it to... I mean, if you do it in Iraq, you have to worry about whether the... ballot boxes themselves are going to get blown up, wet, lost, trashed.” Another soldier echoed these thoughts, saying, “It was so

much easier. I voted since...I was 19, and I've been in the military all that time, so I'm always doing absentee votes. And...I never know if my vote makes it, you know? I put it in the mail, and that's the end of it. So I have more of a sense of satisfaction, knowing that if it's digital, I can see the end result...my vote is going to make a difference.” Despite the need for mailing the ballot, the EBDS systems were also judged to be more secure than traditionally completed mail ballots because of the perception that “with paper...somebody can go back in and cross (your vote) out and then handwrite in whatever. If it was all electronic, then they couldn't.”<sup>9</sup>

To summarize, Operation VOTE participants reported four key positive themes when describing their experiences using both IVS and EBDS systems in comparison to traditional mail-based voting: greater ease of use, greater speed, more ability to catch and fix mistakes, and a greater chance that the ballot would arrive on-time and as voted.

## 4.2 Instructions/Icons

On the whole, Operation VOTE participants were pleased with both IVS and EBDS system designs. For example, when asked about positive system features, an IVS user stated, “The font, colors, the shape of the boxes on the ballot, everything was just very straightforward, very simple. Good visual feedback when you clicked. [I had] no problems at all, and it was intuitive.” An EBDS user similarly said, “It's very easy. I'm pretty sure my little brother could do it. It's very clear... it's easily fixable if you want to change something when you make an error.”

However, both platforms received some negative comments in regard to instructions for various accessibility features. In particular, both IVS and EBDS users found some issues with font readability, font sizes, and font resizing. One IVS user stated that the “typeface was not big enough for me to see it well,” while another had the opposite complaint, saying that “the screen, the words were too big on it, and the screen was too close to me.” A third IVS user summarized both points of view, saying that he wanted “an option in there to increase or decrease the font size.” An EBDS user also reported that “the font could have been a little bit bigger. It was pretty small.” It is significant that both IVS and EBDS platforms included options for font resizing to increase readability, but that these features were not clearly labeled or identified for users, and sometimes involved using browser-based controls. If participants did not ask poll workers how to increase or decrease the font size, they were generally unable to change these settings by themselves. This lack of instructions constituted one accessibility issue for both IVS and EBDS platforms.

Instructions were also lacking for various other accessibility features, including audio features. Neither IVS nor EBDS systems provided documentation or instructions on how to access or use these features. Some, but not all voters were shown how to turn on accessibility features of the systems by the poll workers. As one participant stated regarding the audio features, “If I needed it, I didn't see where I could have – like there was nothing that would have prompted me. And the same thing with the visuals, there wasn't a prompt to say ‘click this’ or ‘go here’ to make the audio or visual assistance function.”

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<sup>9</sup> It should be noted that despite voter perceptions, a cyber attack could change a vote on an electronic ballot.

Some EBDS users also reported difficulties with system instructions regarding the printing process. For example, one Wounded Warrior stated, “Unless somebody was there to explain it, I don’t know how well someone could get through it on their own. And I don’t know if the soldiers overseas would be able to figure all that out on their own.” The primary difficulty encountered by these users occurred when they finished voting their ballot. Two of the EBDS systems lacked clear Print icons, instead relying on Adobe Acrobat controls or confusing instructions for this function. In one of these systems, users were offered no instructions about printing, and had to know to use the Adobe Acrobat interface to print. In the other system, after clicking Print, voters saw a pop-up window at the bottom of the screen, offering three options: Open, Save, or Cancel. Printing was not mentioned in this window, leading to user confusion. Participants were required to click Open, which opened the document in a PDF format, from which participants could print using the Adobe Acrobat controls. One Wounded Warrior described the pop-up window as “a block that could easily be missed on (Internet) Explorer.” Another participant was also confused, saying, “It just came up: Open, Save, or Cancel – it didn’t say to print, it didn’t have a simple Print icon.”

To summarize, IVS and EBDS systems were generally rated quite positively on their display features, although Wounded Warriors would have preferred clearer, more usable icons and instructions to resize fonts, activate accessibility features, and print ballots.

### **4.3 Accessibility Features and Devices**

One clear contrast between the IVS and EBDS systems had to do with accessible devices and features. Although FVAP did not specifically request it for Operation VOTE, IVS vendors brought a variety of assistive devices for use with their systems, including screen readers, sip and puff devices, touch screens, keypads, headsticks, and a hands-free mouse using an optical tracking camera. One EBDS vendor did bring a screen reader, but none of the other devices provided by IVS vendors. With the exception of the touch screens, Wounded Warriors generally did not opt to use these devices, but approved of them being available. For example, one IVS user referred to the accessible keypad, stating, “Everything was set up really good. In fact, I had larger, way more obvious ways of telling which numbers were which instead of the little black and white keys...it was helpful.”

The touch screens were the most used accessibility feature of the IVS systems, and garnered several positive reviews. For example, when asked about the tactile controls, one Wounded Warrior stated, “I liked the touch screen – I didn’t have to mess with any buttons or anything like that, [or] look down from the screen.” When touch screens were not an option, Wounded Warrior participants commented on their absence, with one participant saying, “You know, the only thing I’d recommend, for some folks it might be more convenient to have a touch screen.” Another Wounded Warrior described his accessibility problems when his dominant arm was broken, saying, “When I was casted, I would have had to use a reverse mouse, so touch screens would probably be the best interface for the system, because it’s ambidextrous.”

To summarize, Operation VOTE participants commented positively on the number of assistive devices and accessible features of IVS systems, in particular favorably singling out touch screens, which were lacking in the EBDS systems.

## 4.4 Log-In

Both IVS and EBDS users experienced some difficulties with the logging in process. In the case of the IVS systems, several participants reported difficulties with the CAPTCHA feature.<sup>10</sup> For example, one participant stated, “It took me three attempts to figure out what the word actually was.” Another Wounded Warrior said he did not mind typing in the login and password, but thought that the CAPTCHA feature was excessive, because “if you have an ID, extensive long ID and extensive PIN, I don’t think there should be [a CAPTCHA] as well.” In the case of the EBDS systems, participants generally reported log-in concerns based on the length of the process. For example, when asked about the usability of the EBDS system he tested, one participant stated, “It was okay except for when it asked me to re-enter my email address.” Another Wounded Warrior reported a similar issue, saying: “Just going through all the different steps, which – I mean, it’s – it makes sense the way it works on asking you who you are and everything, but maybe if they had like a number given to that person instead of [the question-based log-in process] – that way, they knew automatically that person was who they said [they were].”

To summarize, Operation VOTE participants made several negative comments about the usability of the log-in process: some participants disliked the CAPTCHA feature on the IVS systems, and others felt that the EBDS systems required too many steps to log-in.

## 4.5 Ballot Navigation and Fixing Mistakes

Users experienced issues related to over and under-vote warnings with all of the EBDS systems and one of the IVS systems. The IVS system presented no warnings until the verification screen. One of the EBDS systems gave no warnings about under and over-voting at all, whereas another of the EBDS systems did not implement under-vote warnings until the final verification screen. In the case of the third EBDS, the system did not tell the voter which race was under-voted, instead merely stating “Not all selections have been completely voted.” Operation VOTE participants found these warnings confusing, as described by this Wounded Warrior, “I intentionally tried to miss a bubble, and instead of saying ‘come back’ or highlighting [that race] in red...it just said ‘you missed something.’ And it forced you to go back and try to look all over instead of highlighting what we missed in red.”

In addition to the warning message challenges experienced by voters, participants using both IVS and EBDS systems had usability problems when attempting to change their vote after viewing the verification screen. Across the board, participants stated that they wanted a system which took them directly to the race that needed changing, and then directly back to the verification screen. Instead, some IVS and EBDS systems implemented features which required the participants to either begin with a new, blank ballot, or to click through the ballot from the beginning. One Wounded Warrior described his confusion with this implementation, saying: “If I did want to make a change, my initial thought was to...click on the name I wanted to change...but that wasn’t it. I had to scroll down to the bottom, and then it...brought me back to the very beginning. And I had to go next, next, next, next to find the one I wanted to change. And then

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<sup>10</sup> CAPTCHA is an acronym for “Completely Automated Public Turing test to tell Computers and Humans Apart.” A common type of CAPTCHA requires the user to type letters or digits from a distorted image that appears on the screen.



once I made the change, I had to go next, next, next, next, next to get all the way back to the end. So that was the only thing that could possibly make it a little easier, a little more user-friendly, was literally just clicking on the name, making the change, and then have an option to go right back to the validation page.”

To summarize, Operation VOTE participants preferred navigation features that decreased confusion and increased usability, including:

- clear under and over-vote warnings implemented both immediately and on the verification screen, and
- at the verification screen, the ability to easily jump to the race where the mistake occurred, followed by the ability to jump back to the verification screen.

## 4.6 Scrolling

All three IVS systems implemented the Operation VOTE ballot to minimize scrolling, so that with the exception of the verification screen, only one race was displayed per page. However, in several instances the very small size of the laptop screens, in combination with a long amendment, required participants to scroll down to click the button to proceed to the next screen. This caused some confusion for voters, who had grown used to seeing earlier screens where the ballot information and the forward/next button did not necessitate scrolling. One Wounded Warrior stated, “I don’t particularly like having to scroll down... except at the end where you scroll down to review everything, I would expect that, but otherwise it would be nice if everything was on the same screen.” Other participants would have preferred even the verification screen to be designed to avoid scrolling. For example, when asked about the verification screen that summarized his selections, one Wounded Warrior said: “Oh, you kind of had to scroll down a little bit. Perhaps if you made them smaller to fit on one page, because some people might not know to scroll. I would have liked to have seen it all on one page versus having to keep scrolling down.” A third participant had just this issue, calling the final verification screen “a little confusing” because “you go from one screen to the next, each individual ballot, but the last one, they didn’t tell you it’s the last one. I had to have someone tell me, ‘Okay. This is where you scroll down to find the Submit button.’”

In contrast to the IVS systems, the EBDS systems generally implemented the entire ballot on one screen,<sup>11</sup> necessitating the voters to scroll significantly in order to mark their votes and cast the ballot. Participants found this implementation confusing. For example, when asked about negative aspects of the system he tested, one Wounded Warrior stated, “The only thing I could think of was on the mouse control, scrolling down. I kind of got lost scrolling down a few times.” Another participant echoed this thinking, saying, “Having to scroll down is kind of – it’s always easier for me to see it all in one screen shot than to have to scroll back up and scroll back down.” A third participant specifically requested a one-race-per-screen implementation, saying he wanted something that “goes from one section to the next section and you don’t have to scroll up and down.”

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<sup>11</sup> With the exception of one vendor, who offered both a one race per screen option and the entire ballot on one screen option.



## 4.7 Ballot Mailing and Receipts

Operation VOTE participants expressed concerns regarding the ballot submission process for both IVS and EBDS systems.

In the case of IVS systems, the concerns centered on the receipt and processing of the ballots. “What happens with the ballot after the submission?” asked one Wounded Warrior. Another IVS user said he wanted proof of ballot submission, such as an emailed receipt or a webpage he could visit. A third participant suggested a “confirmation number, so you could track your vote and make sure it was...that you could look it up on the internet...to make sure your vote was actually recorded someplace.”

In the case of the EBDS systems, the user concerns related to printing and mailing the ballots, especially from overseas locations with unreliable postal delivery systems. As one Wounded Warrior said, “In a real-world environment, the only problem [is] going through the mail...I’d probably do like email.” Other soldiers had similar concerns, saying, “You would have to go back to a base camp before you were sure it was going to make it anywhere,” and “You don’t know if your vote will reach its destination or not.” When asked if he would be confident using the system in a real election, another EBDS user stated, “I would be confident if they have both options to submit electronically and print off and mail.”

To summarize, Operation VOTE participants who used IVS systems would have preferred some sort of email or physical receipt that their ballot was correctly submitted, while participants who used the EBDS systems would have preferred an option to submit their ballots electronically as well as via printing and mailing.

## 4.8 Logistical and Security Concerns

Despite generally positive feedback from a majority of the participants, a minority of IVS and EBDS users reported logistical and security concerns related to electronic voting systems. Several participants described generalized unease due to the “mysterious nature of the internet,” and because computers “mess up all the time.” Other participants were more concerned with the concrete issue of voter fraud. For example, an IVS user stated that “dealing with electronic stuff, there is always a risk that it could crash or that somebody could hack and steal stuff.” Another Wounded Warrior was concerned with password privacy, stating that “the problem with the military is that everything is everybody’s knowledge...there could be an issue with that if somebody found out your information and voted twice.” An EBDS user stated he was concerned that his information could be “intercepted or viewed” because “there was nothing that made me feel like I knew it was safe, kind of like those little bank emblems...the little secured lock thing that is encrypted.”

In addition to such security concerns, several participants voiced worries related to the logistical deployment of IVS and EBDS systems overseas. In regard to IVS systems, internet availability and connectivity issues were the primary concerns. For example, one Wounded Warrior stated, “once it gets overseas then that’s when we get all the errors and the quirks in the system. We never really get the type of signal that we need there.” Another participant concurred, saying “I know that when we’re in Afghanistan, there’s a lot of times that we’re in areas that...you don’t get internet access.” In regard to

the EBDS systems, participants were more concerned with the logistics related to postal service. One Wounded Warrior stated, “I spent 10 years stationed in Europe, three in deployed environments, and I’m not sure my mail would always get where it needed to go on time. I’ve had so many mail trucks blown up that I’m not sure my mail would actually get where it’s supposed to go.”

Several IVS and EBDS users explained that for both types of platforms, they would like the option of electronic *and* postal mail delivery of ballots to overcome logistical and security concerns. As one voter explained, “have dual [options]...that way, you could match...the electronic system and a hard copy.”

## 5 UPPTR Compliance and Assessment

Operation VOTE was not intended to assess full system compliance with Section 3 of the UPPTR, as this would be impossible in the simulated election environment in which the exercise took place. Instead, Operation VOTE was intended as an initial, qualitative assessment, both of current IVS and EBDS system compliance levels, and of the contents and presentation of the UPPTR. Previous Voting System Test Laboratory (VSTL) reports have emphasized that well presented requirements remove ambiguity and reduce the time and cost of a certification,<sup>12</sup> and it was felt that initial evaluation of both the systems and Section 3 of the UPPTR before potential VSTL testing might provide significant benefits for the vendors, VSTLs, and federal government agencies involved. It should be noted that the participating systems were designed and built before the advent of UPPTR, and thus were not expected to demonstrate full compliance during Operation VOTE.

The following sections summarize system and UPPTR results and recommendations. A detailed, requirement-by-requirement explanation is contained in [Appendix G](#).

### 5.1 IVS vs. EBDS Compliance

As Operation VOTE was not a full compliance test against the UPPTR, the research team chose not to use the terms “Pass” and “Fail” when assessing whether each of the platforms complied with UPPTR requirements. Instead, the following definitions were used:

- Observed – At least one of the three systems within a platform was observed meeting the requirement.
- Not Observed – None of the three systems within a platform were observed meeting the requirement.
- Not Tested – The requirement was outside the scope of Operation VOTE, or was ambiguously phrased, and was thus not assessed.
- Not Applicable – The requirement was not applicable to either the platforms being assessed, or to the Operation VOTE environment.

Some variances in UPPTR compliance were seen between the IVS and EBDS platforms during Operation VOTE. As demonstrated in the table below, IVS systems were observed meeting more requirements than EBDS systems.

**Figure 8: IVS vs. EBDS UPPTR Compliance**

	Observed	Not Observed	Not Tested	Not Applicable
IVS	32%	6%	36%	25%
EBDS	24%	13%	42%	22%

<sup>12</sup> Department of Defense. Federal Voting Assistance Program. CALIBRE Systems, Inc. 2011. Voting System Testing Report.

The discordance in UPPTTR compliance can be attributed to several factors. FVAP invited but did not specifically require vendors to provide assistive devices during Operation VOTE. IVS vendors brought a variety of such devices, including screen readers, sip and puff devices, touch screens, keypads, headsticks, and a hands-free mouse using an optical tracking camera. EBDS vendors generally did not bring such assistive devices, with the exception of one EBDS vendor, who brought a screen reader. Due to time constraints and the constant stream of voters on Day 2, the research team could not test this screen reader, contributing to the somewhat higher not tested rate for EBDS systems. The greater availability of assistive devices on Day 1 contributed to the higher rate of IVS UPPTTR compliance seen in Figure 8. Additionally, IVS systems were used for electronic submission of ballots, such that no printing was required. In contrast, the EBDS systems required users to print ballots for mailing. Various UPPTTR requirements related to printed materials were thus not applicable to the IVS systems, but were applicable and not observed for the EBDS systems.

More uniform and standardized testing in a VSTL environment will be necessary to determine full system compliance with the UPPTTR. Observations from Operation VOTE are intended only as an initial, qualitative view of the current state of electronic voting technology.

## 5.2 UPPTTR Presentation and Contents

In addition to being used to assess compliance, the UPPTTR requirements were reviewed from the viewpoint of a testing laboratory, assessing organization, applicability, completeness.

### 5.2.1 UPPTTR Organization and Layout

The requirements are currently organized into a hierarchical scheme in which higher order titles and general requirements are supported by more specific, lower-level requirements nested into several levels. When the nesting hierarchy reaches four levels (i.e., 1.1.1.1), further nested requirements are designated with fifth-level lowercase letters and sixth-level Roman numerals in order to be traceable by a distinct reference. These fifth and sixth level requirements contain a majority of the specific prescriptive language (the words SHALL and SHALL NOT) to indicate mandatory conformance aspects of the requirements.

There are two issues with this hierarchical organization. First, in order to avoid vagueness and redundancy, VSTLs prefer that higher-order requirements not contain prescriptive language. For example, Section 3 has three second level titles (3.1 Overview, 3.2 General Usability, and 3.3 Accessibility Requirements). These titles should not contain introductory text with the terms SHALL or SHALL NOT, as each of the second level requirements should be met when all of their nested requirements (which go up to the sixth level) are fulfilled. However, as the requirements are currently written, there is text under the title 3.2 General Usability, which states:

The voting system SHALL support voters in the task of effectively and accurately casting their ballots. The features of the voting system SHALL NOT contribute to the commission of voter error within the voting session.

The above sentences are so vague as to be not testable, and the use of proscriptive terms is not necessary, as there are many specific, testable requirements within that section. Once the VSTL shows that a system meets the testable requirements, Sub-Section 3.2 can be considered met. **It is recommended that the terms SHALL and SHALL NOT in all higher order requirements be changed to “should” and “should not” to avoid this confusion.**

The second issue with the UPPTR hierarchical scheme is a lack of consistency within Section 3. Section 3 has three second level titles (3.1 Overview, 3.2 General Usability, and 3.3 Accessibility Requirements). Within each of the second level titles, general third level requirements highlight particular topic areas (e.g., 3.2.1 Privacy, 3.2.2 Cognitive Issues, 3.2.3 Perceptual Issues, etc). The inconsistency is introduced at the fourth, fifth, and sixth levels. Some of the third level requirements are followed by fourth level titles (e.g., 3.2.1 Privacy is divided into 3.2.1.1 Privacy at Kiosk Locations and 3.2.1.2 No Recording of Alternative Format Usage), whereas other third level requirements are immediately followed by fifth level lowercase letters listing prescriptive requirements (i.e., 3.2.2 Cognitive Issues, is followed by seven lettered requirements providing very specific normative language for conformance). This inconsistency in outlining the UPPTR makes it more difficult for testers to identify normative versus informative text, and to provide clean, understandable summaries of their results. **It is recommended that Section 3 be renumbered with consistent titling at the third and fourth levels, and prescriptive language only at the fifth and sixth levels. It is possible that the most expeditious solution is the elimination of fourth level titles where they appear, such that lowercase letters become fourth level requirements, and Roman numerals become fifth level requirements.**

In addition to the two organizing issues described, the research team found several problems with the organization of prescriptive requirements in certain portions of Section 3. VSTLs prefer to explicitly reference particular enumerated requirements. Practically, this means that each individual SHALL or SHALL NOT statement should have its own unique number/letter sequence. However, in multiple places in Section 3, one numbered requirement contains up to three separate SHALL or SHALL NOT statements. For example, requirement 3.3.4-c states:

Keys, controls, and other manual operations on the accessible voting station SHALL be operable with one hand and SHALL not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls and keys SHALL be no greater than 5 lbs.

As these are actually three separate and testable requirements, each should be enumerated using a fifth level lowercase letter. **It is recommended that any requirement containing more than one unique SHALL or SHALL NOT statement be divided into separate requirements.**

In addition to portions of Section 3 with multiple requirements which should be separated, there were also portions with multiple requirements which should be condensed due to redundancy. For example, requirement 3.2.3-j(ii) states:

No information presented to the voter SHALL be in the form of colored text on a colored background. Either the text or the background SHALL be black or white.

The first sentence above is providing informative text to clarify the requirement, and the first SHALL statement should be changed to “should” in order to eliminate redundancy. **It is recommended that any requirement containing redundant SHALL or SHALL NOT statements be changed to contain one or more clarifying “should” statements and one prescriptive SHALL or SHALL NOT statement.**

A final issue noted by the research team was the presence of fifth and sixth level requirements without the SHALL or SHALL NOT prescriptive language. For example, requirement 3.2.3-f states:

Text should be presented in a sans serif font.

While there may be good reasons that these particular requirements do not use the prescriptive SHALL statement, these reasons are not explained in either the Overview or Section 3 of the UPPTR. Additionally, the requirements without SHALL statements are intermixed with requirements using SHALL statements. This creates a level of confusion for the tester, as it is not evident whether conformance with these requirements is necessary for certification. **It is recommended that all non-prescriptive requirements be grouped together at the end of lists of prescriptive requirements, and that explicit language be added specifying why these requirements are not prescriptive.**

## 5.2.2 UPTTR Applicability and Completeness

A review of Section 3 of the UPPTR found these requirements to be generally robust, comprehensive, and applicable to either the IVS or EBDS systems. However, three deficiencies in the requirements were noted.

Several Wounded Warriors who tested the systems explained that while accessibility features were present in the systems, they had no way of knowing how to access or operate these features without poll worker assistance. There is currently no specific language in Section 3 of the UPPTR which describes a requirement for prominent, understandable instructions about how to operate accessibility features (i.e., increasing or decreasing the font size, changing the contrast on the screen, using audio or tactile assistive devices, etc.). Requirement 3.2.2-a does state:

The vote capture device SHALL provide instructions for all its valid operations.

However, it is not clear from the context whether accessibility features or adjustable aspects of the vote capture device are specifically included in the words “valid operations.” Such specific language could be added to the above requirement, or to a new, additional requirement. This additional requirement could be placed in multiple portions of Section 3, as appropriate. For example, requirement 3.2.3-a describes characteristics of the electronic display screen, and requirement 3.2.3-b deals with the automatic reset of all adjustable features (including font size, color, contrast, audio volume, and rate of speech). It would be appropriate to add another requirement between 3.2.3-a and 3.2.3-b, which states “Any aspect of the vote capture device that can be adjusted by the voter, including font size, color, contrast, audio volume, and rate of speech, SHALL be accompanied by instructions detailing how the voter can make that adjustment. **It is recommended that either requirement 3.2.2-a be modified to specifically mention accessibility**

**features as valid system operations that require instructions, or that an additional requirement discussing this topic be added to the UPPTR.**

Another deficiency in Section 3 of the UPPTR relates to requirement 3.3.7-a, which states:

The accessible voting station should provide support to voters with cognitive disabilities.

This requirement is not prescriptive, presumably because this section does not describe any specific, testable features of the accessible voting station that could assist voters with cognitive disabilities. However, guidelines for such assistance are present in many prominent usability and accessibility-related resources, including the Web Content Accessibility Guidelines (WCAG) and the Illinois Center for Information Technology Accessibility (iCITA) HTML Best Practices. **It is recommended that specific, testable requirements be adapted from available resources and added to section 3.3.7 of the UPPTR. These requirements may detail features such as:**

- **consistent navigation (placement, display, and functionality);**
- **avoidance of unnecessary time-outs or short time limits;**
- **confirmation features for correct ballot submission; and**
- **alerts for users to errors or possible errors.**

In addition to the modifications discussed above, it was found that requirement 3.2.2-e(ii) refers to ballot design, which is regulated by election officials, not system vendors. This requirement states:

The ballot SHALL clearly indicate the maximum number of candidates for which one can vote within a single contest.

**It is recommended that requirement 3.2.2-e(ii) be deleted from Section 3 of the UPPTR.**

## 6 Wounded Warrior Requirements

In general the Wounded Warriors that participated in Operation VOTE were very enthusiastic about electronic voting systems. Participants found the systems to be user-friendly, especially because they were already familiar with web-based computer applications. Said one participant, “Instead of focusing on the system...you're able to adjust with ease and concentrate mentally on the person you're voting for. You don't have to think of the system.” Participants also stated that the systems were quick to use, and allowed for the review of ballots and correction of mistakes. These features are critical to creating systems that are accessible for Wounded Warriors.

However, as described in [Chapter 4](#), observer and interview data from Operation VOTE indicates that Wounded Warriors did experience some challenges when using the IVS and EBDS platforms. The sections below summarize Wounded Warrior requirements based both on Operation VOTE data and the UPPTTR guidelines described in [Chapter 5](#) and [Appendix G](#).

### 6.1 Instructions

Because cognitive and psychological injuries are common in recent conflicts, the most critical Wounded Warrior needs for voting systems center around simple, clear, and jargon-free instructions.

#### 6.1.1 Instructions for Using the System – Online Help

UPPTTR requirement 3.2.2-b states, “The vote capture device SHALL provide a means for the voter to get help directly from the system at any time during the voting session.” Neither the IVS nor EBDS systems provided this type of help from the system. Instead, during Operation VOTE the vendor representatives provided voters with a five minute orientation to the systems, and served as poll workers to answer questions as needed.

A number of voters commented on the appreciation they felt for the orientation that they received prior to testing the systems. Said one voter, “The good thing about actually having the practice station – everyone [can] get familiar with [the system] before they cast their actual vote.” When asked how he would have felt without an orientation, another voter stated, “I would have had problems.” However, this type of help would likely not be available in an overseas kiosk setting or at the voter’s home, making intuitive system design critical. Since completely intuitive design is not possible, the online help for all of the systems should be further developed to describe how to use the system. These instructions should be worded using plain English guidelines and simple syntax to best facilitate Wounded Warrior understanding.

Online system instructions are especially critical for accessibility features which may not be immediately apparent to voters. UPPTTR requirement 3.2.2-a (Cognitive Issues) states that “The vote capture device SHALL provide instructions for all its valid operations.” Further, requirement 3.3.1 (General Accessibility Requirements) states that “The Acc-VS (accessible voting station) SHALL be integrated into the manufacturer’s complete voting system so as to support accessibility for disabled voters throughout the voting session.” That section further states that “The manufacturer SHALL supply



documentation describing 1) recommended procedures that fully implement accessibility for voters with disabilities; and 2) how the Acc-VS supports those procedures.” What UPPTTR does not clearly state is that the systems themselves should contain instructions for users on how to access or turn on the accessibility features.

It is critical that the systems contain a clear explanation regarding how to use accessibility features. A number of voters with sight impairments struggled to adjust the font size, and many users were not aware that an audio version was available for some of the systems. None of the systems tested provided documentation or instructions on how to access or use their accessibility features. Some, but not all voters, were shown by the poll workers how to adjust the font size or turn on accessibility features of the systems. Building this feature into the system makes it consistently available to a wider cross section of users who need this type of assistance.

### **6.1.2 Instructions Using Icons**

UPPTTR requirement 3.2.2-g addresses the use of icons stating, “When an icon is used to convey information, indicate an action, or prompt a response, it SHALL be accompanied by a corresponding linguistic label.” What the requirements do not clearly do is encourage the use of icons as a way of simplifying the system interface and reinforcing important instructions.

The use of icons and simple words can assist voters in understanding the functions of the system, although they are best presented together. Icons without clarifying text can lead to some ambiguity, as in the case of one Wounded Warrior, who was confused because the Next button did not have text stating “Click here to continue.” Likewise, the use of words without icons can confuse voters, as in the case of EBDS systems which did not feature Print icons.

Wounded Warriors require a combination of words and icons to reinforce instructions and makes the systems easier to use. In particular, font resizing and printing icons and instructions were requested by Operation VOTE participants.

## **6.2 Accessible Devices and Features**

Although Wounded Warriors did not opt to use all of the assistive devices made available during Operation VOTE, the single IVS system which incorporated the optional use of touch screens received very favorable feedback from voters. Service members with dexterity and cognitive injuries both supported the use of touch screens, because this technology reduces the need for typing and dividing attention between the screen and the keyboard.

To meet UPPTTR requirements, systems designed for accessibility must include intrinsic assistive devices or features to support voters with disabilities. Additionally, the systems should have the capability for voters to use their own assistive devices. For example, UPPTTR requirement 3.3.3-b states that “Voting stations that provide audio presentation of the ballot SHALL do so in a usable way, as detailed in the following sub-requirements.” The sub-requirements describe an industry standard headphone jack, comprehensible verbal information, and an adjustable rate of speech.

Operation VOTE systems that supported audio capabilities relied on screen readers, which can be very confusing for novice users, as they read every element on the screen, including unlabelled icons and irrelevant browser features. For example, the screen readers may narrate the content of all toolbars at the top of every browser window, as well as coding information that is invisible to sighted users but that exists within web pages. Because of the nature of their injuries, all Wounded Warriors with visual impairments can be considered novice users of accessible technology such as screen readers. Therefore, Wounded Warriors have a need for specially created audio ballots which contain only relevant information, as described by this voter, “Make...an audible ballot for everyone.”

### 6.3 Log-in

Although certain log-in questions, passwords, or CAPTCHAs<sup>13</sup> may be necessary for voter verification, Wounded Warrior injuries require that such security measures be kept to a minimum. These features are confusing for those with cognitive injuries, and represent obstacles for those with dexterity, vision, and hearing injuries. Difficult CAPTCHAs in particular were singled out by Operation VOTE participants as needlessly creating obstacles in the voting process. These CAPTCHAs should be simplified as much as security requirements allow.

### 6.4 Ballot Navigation and Fixing Mistakes

Although there is no UPPTTR requirement for systems to provide user feedback about voting mistakes, such a feature was present in almost all systems tested during Operation VOTE. The ability to review and fix potential mistakes was very positively received by Wounded Warriors, but the presentation of this information varied considerably by system, with some systems presenting the feedback in more user-friendly ways than others. The most highly rated systems provided immediate warning when a voter over or under-voted, and also clearly reminded the voter of any unfixed errors on the verification screen. The lowest-rated systems did not provide warnings, or provided an unclear message stating that not all selections had been completely voted. Users were required to search the entire ballot to find the race in which they had made a mistake. Such ambiguous warning messages at the end of voting are not user-friendly for Wounded Warriors in general, and service members with cognitive and emotional injuries in particular. To meet Wounded Warrior needs, systems should provide immediate, clearly worded feedback about voting mistakes (e.g., under-voting and over-voting) as well as feedback at the end of the voting process on a verification screen.

Ballot navigation to fix a mistake is another area which varied by system. The higher rated systems allowed a voter to click on the race needing correction, which took the voter directly to the screen for that race. Once the voter corrected the error, they were able to click on a link to return to the verification screen. Lower rated systems forced the users to click through the ballot from the beginning, or invalidated all selections on the ballot and forced users to start over. This type of implementation does not meet the needs of Wounded Warriors with cognitive and emotional injuries, as many such individuals

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<sup>13</sup> CAPTCHA is an acronym for "Completely Automated Public Turing test to tell Computers and Humans Apart." A common type of CAPTCHA requires the user to type letters or digits from a distorted image that appears on the screen.

may abandon the process when forced to start over. A user should be able to return directly to a race to fix an error, without the system erasing prior selections or forcing the user to click through unnecessary pages. The system should then allow the voter to return to the verification screen to complete the vote submission process.

## 6.5 Plain Language

UPPTR requirement 3.2.2-c(iii) states that “The vote capture device should use familiar, common words and avoid technical or specialized words that voters are not likely to understand.”

Several Operation VOTE participants reported problems related to language in the ballots, the system instructions, or the system warnings. Wounded Warriors may be challenged by election-related jargon and complex terminology for two reasons. First, physical and psychological injuries often affect cognitive processing, limiting the service members’ abilities to understand unfamiliar words and long sentences. Second, many Wounded Warriors are under the age of 25, and are less experienced with the voting process in general. Less-experienced voters are more likely to be confused by technical or complicated terminology related to elections. For example, many of the voters were confused by warnings using the terms ‘under vote’ and ‘over vote’ when they voted for too many or too few candidates.

To meet Wounded Warrior needs, instructions and warning messages should use short words and simple syntax to convey meaning. For example, instead of warnings about over-voting, the system should provide a message that states: “You have voted for too many candidates. Please select only one.”

## 6.6 Scrolling

UPPTR requirement 3.2.4 states that “The vote capture devices SHALL not require page scrolling by the voter.” Operation VOTE participants echoed this requirement, stating that they preferred screens which eliminated the need to scroll. In general, the Wounded Warriors experienced less difficulty with systems that presented one race per screen such that scrolling was not required to view pertinent information or to proceed to the next screen.

To meet Wounded Warrior needs in this domain, systems should implement ballots which show only one race per screen. Additionally, screens and monitors should be maximized to eliminate the need for scrolling as much as possible. In cases such as the verification screen where scrolling may be required, systems should incorporate a clear icon that allows the voter to zoom out. This icon could be the same as the font resizing icon suggested in [Section 6.1.2](#).

## 6.7 Ballot Submission

The majority of Operation VOTE participants reported that they would feel very confident using electronic voting systems in a real world setting. However, IVS users stated concerns about the lack of a ballot receipt when they submitted their ballots, while EBDS users expressed worries about the reliability

of the mailing process. There are multiple ways to address these concerns. A simple pop-up window confirming the completion of the voting process would help to assure IVS voters that they have successfully cast their ballot. Additionally, many electronic voting systems provide an email confirmation upon completion of the voting process. Finally, the systems could provide a paper record for the purpose of allowing voters to verify their votes.<sup>14</sup> Dual submission of electronic and hard copy ballots could also reassure EBDS voters concerned about mail delivery.

## 6.8 Security and Logistics

Operation VOTE participants who were not confident about using electronic voting systems in a real world election cited two primary concerns.

The first concern centered around unreliable internet connectivity overseas. There is little that can be done by system manufacturers to address this issue.

The second concern related to cyber-security. Said one voter, “I’m concerned with bugs and potential tampering. It’s a safety/security concern.” Clearer explanations of security implementation may address some of these issues. As one participant noted, he felt more comfortable using bank websites which clearly indicated that they were secure. Such emblems on electronic voting websites could help reassure voters anxious about hacking or privacy issues.

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<sup>14</sup> If this is done, then an alternative format must also be presented for voter verification as UPPTTR requirement 3.3.1-e states that “If the Acc-VS generates a paper record... for the purpose of allowing voters to verify their votes, then the system SHALL provide a means to ensure that the verification record is accessible to all voters with disabilities...”

## 7 Recommendations

### 7.1 Usability, Accessibility, and Privacy

Based on Operation VOTE participant feedback and observer comments, as well as an assessment of the UPPTTR Section 3 requirements, the following recommendations apply to both IVS and EBDS systems:

- Instructions should be written using plain language guidelines, and should include information on using the system generally, as well as on using accessibility features (plugging in assistive devices, changing font sizes, etc.).
- Labeled icons should be used to clarify instructions, especially for changing display features, navigating the ballot, and submitting the ballot.
- Systems should be built with certain accessibility features, including the ability to resize fonts, change the contrast on the screen, the capability for a touch screen, and the capability for an all audio version of the ballot.
- Assistive devices (special keypads, headphones, etc) should be intrinsically incorporated into system architecture to the greatest extent possible. Systems should also have features (e.g., industry standard headphone jacks) to help voters use their own assistive devices.
- To the greatest extent practicable for security purposes, log-in procedures should minimize typing and the need to decipher complicated CAPTCHAs.
- Over and under-vote warnings should utilize plain language and avoid jargon, and should appear both immediately and during the verification process.
- When a user detects a mistake during the verification process, the system should enable the voter to return to the race with the mistake, and then return directly to the verification screen.
- Systems should implement one race per screen to eliminate user scrolling wherever possible. When this is impossible, users should have the option to decrease the font size or zoom out to view all information on a screen at one time.
- Systems should implement visible security features similar to those available for online banking to give users greater confidence in the privacy and security of their ballots.
- To ease logistical and security concerns, systems should allow users the option of submitting their ballot both electronically and by postal mail.

In addition to the above recommendations, IVS systems should ensure that users receive a receipt after they submit their ballots, verifying that their vote has been cast. EBDS systems should also implement clear instructions at the conclusion of the ballot, clarifying to voters how they may print, fold and mail the ballot.

## 7.2 UOCAVA Pilot Program Guidelines

Operation VOTE was an initial, qualitative assessment of IVS and EBDS systems against Section 3 of the UPPTTR. Rigorous, quantitative testing in a VSTL environment will be necessary in the future, but the UPPTTR should first be revised to remove ambiguity and maximize testing efficiency and efficacy.

The following recommendations apply to the organization and presentation of Section 3 of the UPPTTR.

- It is recommended that the terms SHALL and SHALL NOT in all higher order requirements be changed to “should” and “should not.”
- It is recommended that Section 3 be renumbered with consistent titling at the third and fourth levels, and prescriptive language only at the fifth and sixth levels. It is possible that the most expeditious solution is the elimination of fourth level titles, such that lowercase letters become fourth level requirements, and Roman numerals become fifth level requirements.
- It is recommended that any requirement containing more than one unique SHALL or SHALL NOT statement be divided into separate requirements.
- It is recommended that any requirement containing redundant SHALL or SHALL NOT statements be changed to contain one clarifying “should” statement and one prescriptive SHALL or SHALL NOT statement.
- It is recommended that all non-prescriptive requirements be grouped together at the end of lists of prescriptive requirements, and that explicit language be added specifying why these requirements are not prescriptive.

The following recommendations apply to the contents of Section 3 of the UPPTTR.

- It is recommended that either requirement 3.2.2-a be modified to specifically mention accessibility features as valid system operations that require instructions, or that an additional requirement discussing this topic be added to the UPPTTR.
- It is recommended that specific, testable requirements be adapted from available resources and added to subsection 3.3.7 of the UPPTTR. These requirements may detail features such as:
  - consistent navigation (placement, display, and functionality);
  - avoidance of unnecessary time-outs or short time limits;
  - confirmation features for correctly casting the ballot; and
  - alerts for users to errors or possible errors.
- It is recommended that requirement 3.2.2-e(ii) be deleted from Section 3 of the UPPTTR.

## 7.3 Additional Testing

Operation VOTE was an initial, qualitative assessment of the usability, accessibility, and privacy of electronic voting systems that could be used in future pilot or demonstration projects mandated by Congress. Operation VOTE demonstrated that such field tests of electronic voting systems can be successfully performed in a military environment, and yield results helpful to system manufacturers and

government agencies. However, before these voting systems can be used in FVAP's Congressionally-mandated remote electronic voting demonstration project, further rigorous testing will be required in a VSTL environment, followed by thorough operational testing at multiple locations in the common environments found throughout the DoD (i.e., shipboard, hostile areas, CONUS and OCONUS). It is recommended that systems vendors, the EAC, and FVAP assess the results of Operation VOTE, make recommended changes to system features and the UPPTTR guidelines, and then conduct further testing in conjunction with certified VSTLs and operational test scripts.

Electronic voting technology is typically developed in an iterative process of improvements and testing. As the currently available technology matures and approaches EAC certification, it is likely that new technologies will be developed. As these new technologies become available, qualitative assessments such as Operation VOTE will be necessary to ensure that these technologies are accessible and usable for the UOCAVA population.

[Appendix H](#) contains a detailed After Action Report for Operation VOTE. It is recommended that subsequent testers assess the lessons learned from this project to improve future testing efforts. Key recommendations include:

- Cooperative advance planning with vendor representatives and potential military testing hosts.
- A realistic voting experience without system orientations for the testing participants.
- The incorporation of specific test cases so that participants can effectively test the limits of the systems and provide more specific data on usability and accessibility. For example, users could be directed to purposefully over-vote, under vote or skip races.
- Rigorous training for test observers, including practice runs to demonstrate possible system issues.

## Appendix A: UPPTR Section 3

### Section 3: Usability, Accessibility, and Privacy Requirements

#### 3.1 Overview

The importance of usability and accessibility in the design of voting systems has become increasingly apparent. It is not sufficient that the internal operation of these systems be correct; in addition, voters and kiosk workers must be able to use them effectively. There are some particular considerations for the design of usable and accessible voting systems:

The voting task itself can be fairly complex; the voter may have to navigate an electronic ballot, choose multiple candidates in a single contest, or decide on abstrusely worded referenda

Pilot projects by definition are implementing new kinds of voting systems, so there is limited opportunity for voters and kiosk workers to gain familiarity with the process

Usability and accessibility requirements include a broad range of factors, including physical abilities, language skills, and technology experience

#### 3.1.1 Purpose

The challenge, then, is to provide a voting system that voters can use comfortably, efficiently, and with confidence that they have cast their votes correctly. The requirements within this section are intended to serve that goal. Three broad principles motivate this section:

1. All eligible UOCAVA voters SHALL have access to the voting process without discrimination.

The voting process SHALL be accessible to individuals with disabilities. The voting process includes access to the kiosk site, instructions on how to vote, initiating the voting session, making ballot selections, review of the ballot and the paper record, final submission of the ballot, depositing the paper record in a secure receptacle, and getting help when needed.

2. Each cast ballot SHALL accurately capture the selections made by the voter.

The ballot SHALL be presented to the voter in a manner that is clear and usable. Voters should encounter no difficulty or confusion regarding the process for recording their selections.

3. The voting process SHALL preserve the secrecy of the ballot.

The voting process SHALL preclude anyone else from determining the content of a voter's ballot, without the voter's cooperation. If such a determination is made against the wishes of the voter, then his or her



privacy has been violated. All the requirements in this section have the purpose of improving the quality of interaction between voters and voting systems.

Note that these principles refer to the entire voting process. The UOCAVA Pilot Program Testing Requirements apply only to voting systems; other aspects of the process (such as administrative rules and procedures) are outside the scope of EAC certification, but are nonetheless crucial for the full achievement of the principles.

### **3.1.2 Special terminology**

The following terms are used frequently in this chapter; they are defined in the Glossary in Appendix A:

- Alert time
- Audio-Tactile Interface (ATI)
- Common Industry Format (CIF)
- Completed system response time
- Initial system response time
- Voter inactivity time

## **3.2 General Usability**

The voting system SHALL support voters in the task of effectively and accurately casting their ballots. The features of the voting system SHALL not contribute to the commission of voter error within the voting session.

### **3.2.1 Privacy**

The voting process must preclude anyone else from determining the content of a voter's ballot without the voter's cooperation. Privacy ensures that the voter can cast votes based solely on his or her own preferences without intimidation or inhibition.

#### **3.2.1.1 Privacy at the kiosk locations**

- a) The vote capture device SHALL prevent others from determining the contents of a ballot.
- b) The vote capture device SHALL support ballot privacy during the voting session and ballot submission.
- c) During the voting session, if an audio interface to the vote capture device is provided, it SHALL be audible only to the voter.
- d) The vote capture device SHALL issue all warnings in a way that preserves the privacy of the voter and the confidentiality of the ballot.

- e) The vote capture device SHALL not issue a receipt to the voter that would provide proof to another of how the voter voted.

### 3.2.1.2 No recording of alternative format usage

When voters use non-typical ballot interfaces, such as large print or alternative languages, their anonymity may be vulnerable. To the extent possible, only the logical contents of their ballots should be recorded, not the special formats in which they were rendered.

- a) No information SHALL be kept within an electronic cast voter record that identifies any alternative language feature(s) used by a voter.
- b) No information SHALL be kept within an electronic cast voter record that identifies any accessibility feature(s) used by a voter.

### 3.2.2 Cognitive issues

The features specified in this section are intended to minimize cognitive difficulties for voters. They should always be able to operate the vote capture device and understand the effect of their actions.

- a) The vote capture device SHALL provide instructions for all its valid operations.
- b) The vote capture device SHALL provide a means for the voter to get help directly from the system at any time during the voting session.
- c) Instructional material for the voter SHALL conform to norms and best practices for plain language.
  - i. Warnings and alerts issued by the vote capture device SHALL be distinguishable from other information and should clearly state:
    - The nature of the problem;
    - Whether the voter has performed or attempted an invalid operation or whether the vote capture device itself has malfunctioned in some way; and
    - The set of responses available to the voter.
  - ii. When an instruction is based on a condition, the condition should be stated first, and then the action to be performed.
  - iii. The vote capture device should use familiar, common words and avoid technical or specialized words that voters are not likely to understand.
  - iv. Each distinct instruction should be separated spatially from other instructions for visual or tactile interfaces, and temporally for auditory interfaces.
  - v. The vote capture device should issue instructions on the correct way to perform actions, rather than telling voters what not to do.

- vi. The instructions should address the voter directly rather than use passive voice constructions.
  - vii. The vote capture device should avoid the use of gender-based pronouns.
- d) Consistent with election law, the voting application SHALL support a process that does not introduce bias for or against any of the contest choices to be presented to the voter. In both visual and aural formats, the choices SHALL be presented in an equivalent manner.
- e) The voting system SHALL provide the capability to design a ballot with a high level of clarity and comprehensibility.
- i. The vote capture device should not visually present a single contest spread over two pages or two columns.
  - ii. The ballot SHALL clearly indicate the maximum number of candidates for which one can vote within a single contest.
  - iii. The relationship between the name of a candidate and the mechanism used to vote for that candidate SHALL be consistent throughout the ballot.
  - iv. The vote capture device should present instructions near to where they are needed.
- f) The use of color SHALL agree with common conventions: (a) green, blue or white is used for general information or as a normal status indicator; (b) amber or yellow is used to indicate warnings or a marginal status; (c) red is used to indicate error conditions or a problem requiring immediate attention.
- g) When an icon is used to convey information, indicate an action, or prompt a response, it SHALL be accompanied by a corresponding linguistic label.

### 3.2.3 Perceptual issues

The requirements of this section are designed to minimize perceptual difficulties for the voter. Some of these requirements are designed to assist voters with poor reading vision. These are voters who might have some difficulty in reading normal text, but are not typically classified as having a visual disability.

- a) The electronic display screen of the vote capture device SHALL have the following characteristics:
- Flicker frequency NOT between 2 Hz and 55 Hz.
  - Minimum display brightness: 130 cd/m<sup>2</sup>
  - Minimum display darkroom 7×7 checkerboard contrast: 150:1
  - Minimum display pixel pitch: 85 pixels/inch (0.3 mm/pixel)
  - Minimum display area 700 cm<sup>2</sup>
  - Antiglare screen surface that shows no distinct virtual image of a light source

- Minimum uniform diffuse ambient contrast for 500 lx illuminance: 10:1
- b) Any aspect of the vote capture device that is adjustable by either the voter or kiosk worker, including font size, color, contrast, audio volume, or rate of speech, SHALL automatically reset to a standard default value upon completion of that voter's session.
- c) If any aspect of a vote capture device is adjustable by either the voter or kiosk worker, there SHALL be a mechanism to allow the voter to reset all such aspects to their default values while preserving the current votes.
- d) For all text the vote capture device SHALL provide a font with the following characteristics
- Height of capital letters at least: 3.0 mm
  - x-height of a least: 70% of cap height
  - Stroke width at least: 0.35 mm.
- e) The vote capture device electronic image display SHALL be capable of showing all information in at least two font sizes:
- 3.0-4.0 mm cap height, with a corresponding x-height at least 70% of the cap height and a minimum stroke width of 0.35 mm;
  - 6.3-9.0 mm cap height, with a corresponding x-height at least 70% of the cap height and a minimum stroke width of 0.7 mm; under control of the voter. The device SHALL allow the voter to adjust font size throughout the voting session while preserving the current votes.
- f) Text should be presented in a sans serif font.
- g) Vote capture devices providing paper verification records SHALL provide features that assist in the reading of such records by voters with poor reading vision.
- i. The vote capture device may achieve legibility of paper records by supporting the printing of those records in at least two font sizes, 3.0-4.0mm and 6.3-9.0mm.
  - ii. The vote capture device may achieve legibility of paper records by supporting magnification of those records. This magnification may be done by optical or electronic devices. The manufacturer may either: 1) provide the magnifier itself as part of the system, or 2) provide the make and model number of readily available magnifiers that are compatible with the system.
- h) The minimum figure-to-ground ambient contrast ratio for all text and informational graphics (including icons) SHALL be 10:1. For paper records, contrast is measured based on ambient lighting of at least 300 lx.
- i) The electronic display screen of the vote capture device SHALL be capable of showing all information in high contrast either by default or under the control of the voter. If the device allows the voter to adjust contrast during the voting session it SHALL preserve the current votes.

High contrast is a figure-to-ground ambient contrast ratio for text and informational graphics of at least 50:1.

- j) The default color coding SHALL support correct perception by voters with color blindness.
  - i. Ordinary information presented to the voter should be in the form of black text on a white background. The use of color should be reserved for special cases, such as warnings or alerts.
  - ii. No information presented to the voter SHALL be in the form of colored text on a colored background. Either the text or background SHALL be black or white.
  - iii. If text is colored other than black or white:
    - 1. The background SHALL be black or white.
    - 2. The text SHALL be presented in a bold font (minimum 0.6 mm stroke width).
    - 3. If the background is black, the text color SHALL be yellow or light cyan.
    - 4. If the background is white, the text color SHALL be dark enough to maintain a 10:1 contrast ratio.
  - iv. If the background is colored other than black or white, the presentation SHALL follow these guidelines:
    - 1. The text color SHALL be black.
    - 2. The background color SHALL be yellow or light cyan.
- k) Color coding SHALL not be used as the sole means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.

### 3.2.4 Interaction issues

The requirements of this section are designed to minimize interaction difficulties for the voter.

- a) The vote capture device SHALL not require page scrolling by the voter.
- b) The vote capture device SHALL provide unambiguous feedback regarding the voter's selection, such as displaying a checkmark beside the selected option or conspicuously changing its appearance.
- c) Vote capture device input mechanisms SHALL be designed to prevent accidental activation.
  - i. On touch screens, the sensitive touch areas SHALL have a minimum height of 0.5 inches and minimum width of 0.7 inches. The vertical distance between the centers of adjacent areas SHALL be at least 0.6 inches, and the horizontal distance at least 0.8 inches. Touch areas SHALL not overlap.

### 3.2.4.1 Timing issues

These requirements address how long the system and voter wait for each other to interact.

- a) The initial system response time of the vote capture device SHALL be no greater than 0.5 seconds.
- b) When the voter performs an action to record a single vote, the completed system response time of the vote capture device SHALL be no greater than one second in the case of a visual response, and no greater than five seconds in the case of an audio response.
- c) The completed system response time of the vote capture device SHALL be no greater than 10 seconds.
- d) If the vote capture device has not completed its visual response within one second, it SHALL present to the voter, within 0.5 seconds of the voter's action, some indication that it is preparing its response.
- e) If the vote capture device requires a response by a voter within a specific period of time, it SHALL issue an alert at least 20 seconds before this time period has expired and provide a means by which the voter may receive additional time.

### 3.2.5 Alternative languages

HAVA Section 301 (a)(4) states that the voting system SHALL provide alternative language accessibility pursuant to the requirements of Section 203 of the Voting Rights Act of 1965 (42 U.S.C. 1973aa-1a). Ideally every voter would be able to vote independently and privately, regardless of language. As a practical matter, alternative language access is mandated under the Voting Rights Act of 1975, subject to certain thresholds (e.g., if the language group exceeds 5% of the voting age population). Thus, election officials must ensure that the pilot voting system is capable of handling the languages meeting the legal threshold within their districts.

- a) The voting system SHALL be capable of presenting the ballot, contest choices, review screens, paper verification records, and voting instructions in any language declared by the manufacturer to be supported by the system.

### 3.2.6 Usability for kiosk workers

Voting systems are used not only by voters to record their votes, but also by kiosk workers who are responsible for kiosk site set-up, light maintenance, and kiosk site closing. Because of the variety of possible implementations, it is impossible to specify detailed design requirements for these functions. The requirements below describe general capabilities that all pilot systems must support.

- a) Messages generated by the vote capture device for kiosk workers in support of the set up, maintenance, or safety of the system SHALL adhere to the requirements for clarity in Section 3.2.4 "Cognitive issues".

### 3.2.6.1 Operation

Kiosk workers are responsible for opening the kiosk locations each day of the voting period, keeping them running smoothly during voting hours, closing the kiosk locations at the end of each day of the voting period, and shutting down the kiosks at the end of the voting period.

Operations may be categorized in three phases: initial system set up, daily set up and operation, and shutting down the system at the end of the voting period.

Initial setup includes all the steps necessary to remove the system from its shipping crate, physically set up and configure the vote capture devices and peripherals, verify the integrity of the software, load and check out the software, initiate and check out the communications links. .

Daily operation of the kiosk location includes such functions as:

- voter identification and authorization;
- provision of smartcard to voter to initiate the voting session ;
- assistance to voters who need help;
- system recovery in the case of voters who abandon the voting session without having cast a ballot; and
- routine supplies replenishment, such as adding paper to the printer.

Daily shutdown includes all the steps necessary to take the vote capture device from the state in which it is ready to record votes to its overnight storage state.

- a) The procedures for voting system setup, polling, and shutdown, as documented by the manufacturer, SHALL be reasonably easy for the typical poll worker to learn, understand, and perform.
- b) The manufacturer SHALL provide clear, complete, and detailed instructions and messages for kiosk location setup, daily operation, and shutdown.
  - i. The documentation SHALL be presented at a level appropriate for kiosk workers who are not experts in voting system and computer technology.
  - ii. The documentation SHALL be in a format suitable for use in the kiosk location.
  - iii. The instructions and messages SHALL enable the kiosk worker to verify that the vote capture device, peripherals, and communications links
    - Has been set up correctly;
    - Is in correct working order to record votes; and
    - Has been shut down correctly.

### 3.2.6.2 Safety

All voting systems and their components must be designed so as to eliminate hazards to personnel or to the equipment itself. Hazards include, but are not limited to:

- Fire hazards;
- Electrical hazards;
- Potential for equipment tip-over (stability);
- Potential for cuts and scrapes (e.g., sharp edges);
- Potential for pinching (e.g., tight, spring-loaded closures); and
- Potential for hair or clothing entanglement.

Devices associated with the voting system SHALL be certified in accordance with the requirements of UL 60950-1, Information Technology Equipment – Safety – Part 1 by a certification organization accredited by the Department of Labor, Occupational Safety and Health Administration’s Nationally Recognized Testing Laboratory program. The certification organization’s scope of accreditation SHALL include IEC/UL 60950-1.

IEC/UL 60950 is a comprehensive standard for IT equipment and addresses all the hazards discussed above under Safety.

### 3.3 Accessibility requirements

The voting process is to be accessible to voters with disabilities through the use of a specially equipped voting station. A machine so equipped is referred to herein as an accessible voting station (Acc-VS).

The requirements in this section are intended to address this HAVA mandate. Ideally, every voter would be able to vote independently and privately. As a practical matter, there may be some number of voters who, because of the nature of their disabilities, will need personal assistance with any system. Nonetheless, these requirements are meant to make the voting system independently accessible to as many voters as possible. This includes access across all voting processes: capabilities to generate, verify and cast an official ballot must be provided.

This section is organized according to the type of disability being addressed. For each type, certain appropriate design features are specified. Note, however, that a feature intended primarily to address one kind of disability may very well assist voters with other kinds. Moreover, this organization in no way implies that the various sets of requirements are optional or mutually exclusive. In order to conform, an Accessible Voting Station must fulfill all the requirements of all the sub-sections of Chapter 3.3.

There are many other requirements, such as the general usability requirements, that apply to the Acc-VS besides those in this section. Please see Section 3.1.3 “Interaction of usability and accessibility requirements” for a full explanation.



### 3.3.1 General

The requirements of this section are relevant to a wide variety of disabilities.

- a) The Acc-VS SHALL be integrated into the manufacturer's complete voting system so as to support accessibility for disabled voters throughout the voting session.
  - i. The manufacturer SHALL supply documentation describing 1) recommended procedures that fully implement accessibility for voters with disabilities and 2) how the Acc-VS supports those procedures.
- b) When the provision of accessibility for Acc-VS involves an alternative format for ballot presentation, then all information presented to non-disabled voters, including instructions, warnings, error and other messages, and contest choices, SHALL be presented in that alternative format.
- c) The support provided to voters with disabilities SHALL be intrinsic to the accessible voting station. It SHALL not be necessary for the accessible voting station to be connected to any personal assistive device of the voter in order for the voter to operate it correctly.
- d) If a voting system provides for voter identification or authentication by using biometric measures that require a voter to possess particular biological characteristics, then Acc-VS SHALL provide a secondary means that does not depend on those characteristics.
- e) If the Acc-VS generates a paper record (or some other durable, human-readable record) for the purpose of allowing voters to verify their votes, then the system SHALL provide a means to ensure that the verification record is accessible to all voters with disabilities, as identified in 3.3 "Accessibility requirements".
  - i. If the Acc-VS generates a paper record (or some other durable, human-readable record) for the purpose of allowing voters to verify their votes, then the system SHALL provide a mechanism that can read that record and generate an audio representation of its contents.

### 3.3.2 Low vision

These requirements specify the features of the accessible voting station designed to assist voters with low vision.

In general, low vision is defined as having a visual acuity worse than 20/70. Low (or partial) vision also includes dimness of vision, haziness, film over the eye, foggy vision, extreme near-sightedness or far-sightedness, distortion of vision, color distortion or blindness, visual field defects, spots before the eyes, tunnel vision, lack of peripheral vision, abnormal sensitivity to light or glare and night blindness.

People with tunnel vision can see only a small part of the ballot at one time. For these users it is helpful to have letters at the lower end of the font size range in order to allow them to see more letters at the same time. Thus, there is a need to provide font sizes at both ends of the range.

People with low vision or color blindness benefit from high contrast and from a selection of color combinations appropriate for their needs. Between 7% and 10% of all men have color vision deficiencies. Certain color combinations in particular cause problems. Therefore, use of color combinations with good contrast is required. Note also the general Requirement 3.2.5 j.

However, some users are very sensitive to very bright displays and cannot use them for long. An overly bright background causes a visual white-out that makes these users unable to distinguish individual letters. Thus, use of non-saturated color options is an advantage for some people.

It is important to note that some of the requirements in 3.2.5 "Perceptual issues" also provide support for voters with certain kinds of vision problems.

- a) An accessible voting station with a color electronic image display SHALL allow the voter to adjust the color saturation throughout the voting session while preserving the current votes. Two options SHALL be available: 1) black text on white background and 2) white text on black background.
- b) Buttons and controls on accessible voting stations SHALL be distinguishable by both shape and color. This applies to buttons and controls implemented either "on-screen" or in hardware. This requirement does not apply to sizeable groups of keys, such as a conventional 4x3 telephone keypad or a full alphabetic keyboard.
- c) The Acc-VS SHALL provide synchronized audio output to convey the same information as that which is displayed on the screen. There SHALL be a means by which the voter can disable either the audio or the video output, resulting in a video-only or audio-only presentation, respectively. The system SHALL allow the voter to switch among the three modes (synchronized audio/video, video-only, or audio-only) throughout the voting session while preserving the current votes.

### **3.3.3 Blindness**

These requirements specify the features of the accessible voting station designed to assist voters who are blind.

- a) The accessible voting station SHALL provide an audio-tactile interface (ATI) that supports the full functionality of the visual ballot interface.
  - i. The ATI of VEBD-A of the accessible voting station SHALL provide the same capabilities to vote and cast a ballot as are provided by its visual interface.
  - ii. The ATI SHALL allow the voter to have any information provided by the voting system repeated.
  - iii. The ATI SHALL allow the voter to pause and resume the audio presentation.
  - iv. The ATI SHALL allow the voter to skip to the next contest or return to previous contests.

- v. The ATI SHALL allow the voter to skip over the reading of a referendum so as to be able to vote on it immediately.
- b) Voting stations that provide audio presentation of the ballot SHALL do so in a usable way, as detailed in the following sub-requirements.
- i. The ATI SHALL provide its audio signal through an industry standard connector for private listening using a 3.5mm stereo headphone jack to allow voters to use their own audio assistive devices.
  - ii. When VEBD-A utilizes a telephone style handset or headphone to provide audio information, it SHALL provide a wireless T-Coil coupling for assistive hearing devices so as to provide access to that information for voters with partial hearing. That coupling SHALL achieve at least a category T4 rating as defined by [ANSI01] American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19.
  - iii. A sanitized headphone or handset SHALL be made available to each voter.
  - iv. VEBD-A SHALL set the initial volume for each voting session between 40 and 50 dB SPL.
  - v. The audio system SHALL allow the voter to control the volume throughout the voting session while preserving the current votes. The volume SHALL be adjustable from a minimum of 20dB SPL up to a maximum of 100 dB SPL, in increments no greater than 10 dB.
  - vi. The audio system SHALL be able to reproduce frequencies over the audible speech range of 315 Hz to 10 KHz.
  - vii. The audio presentation for VEBD-A of verbal information should be readily comprehensible by voters who have normal hearing and are proficient in the language. This includes such characteristics as proper enunciation, normal intonation, appropriate rate of speech, and low background noise. Candidate names should be pronounced as the candidate intends.
  - viii. The audio system SHALL allow the voter to control the rate of speech throughout the voting session while preserving the current votes. The range of speeds supported SHALL include 75% to 200% of the nominal rate. Adjusting the rate of speech SHALL not affect the pitch of the voice.
- c) If Acc-VS supports ballot activation for non-blind voters, then it SHALL also provide features that enable voters who are blind to perform this activation.
- d) If Acc-VS supports ballot submission or vote verification for non-blind voters, then it SHALL also provide features that enable voters who are blind to perform these actions.
- e) Mechanically operated controls or keys, or any other hardware interface on Acc-VS available to the voter SHALL be tactilely discernible without activating those controls or keys.

- f) The status of all locking or toggle controls or keys (such as the "shift" key) for Acc-VS SHALL be visually discernible, and also discernible through either touch or sound.

### **3.3.4 Dexterity**

These requirements specify the features of the accessible voting station designed to assist voters who lack fine motor control or use of their hands.

- a) The accessible voting station SHALL provide a mechanism to enable non-manual input that is functionally equivalent to tactile input. All the functionality of the accessible voting station (e.g., straight party voting, write-in candidates) that is available through the conventional forms of input, such as tactile, SHALL also be available through the non-manual input mechanism.
- b) If Acc-VS supports ballot submission or vote verification for non-disabled voters, then it SHALL also provide features that enable voters who lack fine motor control or the use of their hands to perform these actions.
- c) Keys, controls, and other manual operations on the accessible voting station SHALL be operable with one hand and SHALL not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls and keys SHALL be no greater than 5 lbs. (22.2 N).
- d) The accessible voting station controls SHALL not require direct bodily contact or for the body to be part of any electrical circuit.

### **3.3.5 Mobility**

These requirements specify the features of the accessible voting station designed to assist voters who use mobility aids, including wheelchairs. Many of the requirements of this section are based on the ADA Accessibility Guidelines for Buildings and Facilities (ADAAG).

- a) The accessible voting station SHALL provide a clear floor space of 30 inches minimum by 48 inches minimum for a stationary mobility aid. The clear floor space SHALL be designed for a forward approach or a parallel approach.
- b) When deployed according to the installation instructions provided by the manufacturer, Acc-VS SHALL allow adequate room for an assistant to the voter. This includes clearance for entry to and exit from the area of the voting station.
- c) Labels, displays, controls, keys, audio jacks, and any other part of the accessible voting station necessary for the voter to operate the voting system SHALL be legible and visible to a voter in a wheelchair with normal eyesight (no worse than 20/40, corrected) who is in an appropriate position and orientation with respect to the accessible voting station.

#### **3.3.5.1 Controls within reach**

The requirements of this section ensure that the controls, keys, audio jacks and any other part of the accessible voting station necessary for its operation are within easy reach. Note that these requirements

have meaningful application mainly to controls in a fixed location. A hand-held tethered control panel is another acceptable way of providing reachable controls.

- a) If the accessible voting station has a forward approach with no forward reach obstruction then the high reach SHALL be 48 inches maximum and the low reach SHALL be 15 inches minimum. See Part 1: Figure 3-1.
- b) If the accessible voting station has a forward approach with a forward reach obstruction, the following sub-requirements SHALL apply. (See Part 1: Figure 3-2).
  - i. The forward obstruction for Acc-VS SHALL be no greater than 25 inches in depth, its top no higher than 34 inches and its bottom surface no lower than 27 inches.
  - ii. If the obstruction for Acc-VS is no more than 20 inches in depth, then the maximum high reach SHALL be 48 inches, otherwise it SHALL be 44 inches.
  - iii. Space under the obstruction between the finish floor or ground and 9 inches above the finish floor or ground SHALL be considered toe clearance and SHALL comply with the following provisions for Acc-VS:
    1. Toe clearance depth SHALL extend 25 inches maximum under the obstruction;
    2. The minimum toe clearance depth under the obstruction SHALL be either 17 inches or the depth required to reach over the obstruction to operate the accessible voting station, whichever is greater; and
    3. Toe clearance width SHALL be 30 inches minimum.
  - iv. Space under the obstruction between 9 inches and 27 inches above the finish floor or ground SHALL be considered knee clearance and SHALL comply with the following provisions:
    1. Knee clearance depth SHALL extend 25 inches maximum under the obstruction at 9 inches above the finish floor or ground;
    2. The minimum knee clearance depth at 9 inches above the finish floor or ground SHALL be either 11 inches or 6 inches less than the toe clearance, whichever is greater;
    3. Between 9 inches and 27 inches above the finish floor or ground, the knee clearance depth SHALL be permitted to reduce at a rate of 1 inch in depth for each 6 inches in height. (It follows that the minimum knee clearance at 27 inches above the finish floor or ground SHALL be 3 inches less than the minimum knee clearance at 9 inches above the floor.); and
    4. Knee clearance width SHALL be 30 inches minimum.
- c) If the accessible voting station has a parallel approach with no side reach obstruction then the maximum high reach SHALL be 48 inches and the minimum low reach SHALL be 15 inches. See Part 1: Figure 3-3.

- d) If the accessible voting station has a parallel approach with a side reach obstruction, the following sub-requirements SHALL apply. See Figure 3-1.
  - i. The side obstruction for Acc-VS SHALL be no greater than 24 inches in depth and its top no higher than 34 inches.
  - ii. If the obstruction is no more than 10 inches in depth, then the maximum high reach SHALL be 48 inches, otherwise it SHALL be 46 inches.

**Figure 3-1 Unobstructed reach measurements**

Dimensions shown in inches above the line, SI units (in millimeters) below the line

<p>Figure 1: Unobstructed forward reach</p>	<p>Figure 2: Obstructed forward reach (a) for an obstruction depth of up to 20 inches (b) for an obstruction depth of up to 25 inches</p>
<p>Figure 3: Unobstructed side reach with an allowable obstruction less than 10 inches deep</p>	<p>Figure 4: Obstructed side reach (a) for an obstruction depth of up to 10 inches (b) for an obstruction depth of up to 24 inches</p>

### **3.3.6 Hearing**

These requirements specify the features of the accessible voting station designed to assist voters with hearing disabilities.

- a) The accessible voting station SHALL incorporate the features listed under Requirement 3.3.3-C for voting systems that provide audio presentation of the ballot.
- b) If the accessible voting system provides sound cues as a method to alert the voter, the tone SHALL be accompanied by a visual cue, unless the station is in audio-only mode.
- c) No voting device SHALL cause electromagnetic interference with assistive hearing devices that would substantially degrade the performance of those devices. The voting device, measured as if it were a wireless device, SHALL achieve at least a category T4 rating as defined by [ANSI01] American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19.

### **3.3.7 Cognition**

These requirements specify the features of the accessible voting station designed to assist voters with cognitive disabilities.

- a) The accessible voting station should provide support to voters with cognitive disabilities.

### **3.3.8 English proficiency**

These requirements specify the features of the accessible voting station designed to assist voters who lack proficiency in reading English.

- a) For voters who lack proficiency in reading English, Acc-VS SHALL provide an audio interface for instructions and ballots as described in 3.3.3 b.

## Appendix B: Observer Checklist

### Examples of Difficulty

#### Clicking

- Problems selecting choice
  - Not knowing where to click
  - Clicking in wrong location (i.e., name instead of bubble)
- Problems de-selecting choice
- Unintentionally changed from one candidate/vote to another
- Manual difficulty with mouse

#### Navigation with-in a screen

- Problems with scrolling
  - Couldn't scroll when necessary
  - Tried to scroll when no scrolling is available
  - Tried to scroll beyond page limits
- Problems locating the help button or instructions
- Problems with pop-up messages, including warnings or error messages

#### Navigation between screens

- Problems advancing through the ballot via the next/submit button
- Problems going back to a previous page using the back button
- Problems navigating to or from a separate help screen or instructions

#### Physical configuration

- Problems with physical accessibility of the booth (i.e., not enough room for wheelchair, assistant)
- Problems with physical accessibility of the system
  - Laptop height or tilt
  - Problems using/reaching the keyboard or mouse
  - Problems adjusting physical configuration
- Problems with the visual display
  - Screen resolution, brightness, contrast, colors
  - Font or icon size
  - Difficulties adjusting visual display
- Problems with audio features
  - Lack of audio
  - Difficulty adjusting audio (increasing/decreasing volume, pace)
  - Poor synchronization between visual and auditory information
  - Privacy



### **Write-in**

- Problems writing in candidate correctly
- Accidental clearing of write-in
- Problems changing or editing text

### **Assistance**

- Critical (without assistance, voter would have been unable to cast ballot)
- Major (without assistance, voter would have cast a ballot, but with missing/incorrect contests)
- Inconvenience (voter experienced difficulty, but could have completed all contests without assistance)

### **Verification/Revision**

- Skipped verification (either accidentally or intentionally)
- Problems with verification
- Problems with revision of vote after verification

### **Ballot Assembly/Casting**

- Casting a ballot
  - Cast ballot early (before completing all contests)
  - Thought they cast a ballot but actually failed
  - Intentionally did not cast ballot
  - Assembly/mailing of ballot
- Assembling and 'mailing' the ballot (for Day 2 only)

### **Other**

- Mistakes & changes (i.e., over-vote, under-vote, changing vote)
- Skipping a contest
- Equipment malfunction (i.e., system freezing, internet issues, printing jams, etc.)
- Comprehension
  - Understanding instructions
  - Understanding ballot information

**Observer Checklist**

Date: \_\_\_\_\_ Voter ID: \_\_\_\_\_ System: \_\_\_\_\_

Red  V

Assistive Device?  Yes

What kind? (sip & puff, headphones, screen reader, wheelchair, etc) \_\_\_\_\_

Login	clicking	nav w/in screen	nav btw screens	physical configuration	?/assistance
President	clicking	nav w/in screen	nav btw screens	physical configuration	?/assistance
Senator	clicking	nav w/in screen	nav btw screens	physical configuration	write-in ?/assistance
Representative	clicking	nav w/in screen	nav btw screens	physical configuration	?/assistance
Governor	clicking	nav w/in screen	nav btw screens	physical configuration	?/assistance
Sec. of State	clicking	nav w/in screen	nav btw screens	physical configuration	?/assistance
County Clerk	clicking	nav w/in screen	nav btw screens	physical configuration	write-in ?/assistance

City Council	clicking	nav w/in screen	nav btw screens	physical config	write-in	under/over vote	?/assistance
Amend M	clicking	nav w/in screen	nav btw screens	physical configuration			?/assistance
Amend Z	clicking	nav w/in screen	nav btw screens	physical configuration			?/assistance
Prop 206	clicking	nav w/in screen	nav btw screens	physical configuration			?/assistance
Ballot Review	clicking	nav w/in screen	nav btw screens	verification/revision	physical configuration		?/assistance
Ballot Submission	clicking	nav w/in screen	nav btw screens	ballot assembly	physical configuration		?/assistance

Was the voter able to vote privately?  No

Circle One: voter successfully cast a ballot unassisted  
 voter successfully cast a ballot with assistance  
 voter unable to cast a ballot

Notes:

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## Appendix C: Post-Voting Questionnaire

### Explanation of the Questionnaire and Scale

This interview protocol gives FVAP an opportunity to collect data from Wounded Warrior voters on their experiences using electronic voting systems during Operation VOTE (Voting Operations Testing and Evaluation), conducted via a mock election process at Brooke Army Medical Center, San Antonio, TX.

Each interview should take approximately 15-20 minutes. Question types include YES/NO questions with follow-ups, as well as scalable questions regarding how satisfied or dissatisfied a voter was with particular aspects of their voting experience or voting system. The participants will be provided with a 1 to 5 scale (1 = extremely dissatisfied, 3 = neutral/no opinion, 5 = extremely satisfied) to answer these questions.

The interviewer will follow this interview protocol, and when appropriate, probe for more detailed answers, written in the appropriate comment line for each question.

### Interview Protocol

Good morning/afternoon, my name is \_\_\_\_\_, and I'm here on behalf of the Federal Voting Assistance Program, or FVAP. Thank you so much for taking the time to speak with me and for participating in Operation VOTE.

Your responses to these questions will help us understand what aspects of the voting process and associated systems need to be revised or enhanced to better support Wounded Warriors.

We will audio record this interview with your permission. This recording will only be used to transcribe your response and ensure the accuracy of our study. These tapes will be destroyed at the completion of this study.

Is it okay if we audio record this interview? Do you have any questions before we start?

[Answer any questions.]

Okay, if you're ready to start, I will begin by asking you some questions about your voting experience today.

### Questions

#### Overall Voting Experience Today

**1. How long did it take you to cast your ballot today (not including waiting time and demo)?**

**1.2 How did you feel about the amount of time that it took you to vote?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_



**9.1.1. If [NO] What difficulties did you encounter?**

Comments: \_\_\_\_\_

**10. Did you intentionally skip any races or ballot choices?** Yes  No **10.1. [If YES] Were you notified that you had not made a selection for a race?** Yes  No 

Comments: \_\_\_\_\_

**10.2. [If YES] Was it easy for you to go back and enter a selection for a race that you had skipped?**

Comments: \_\_\_\_\_

**11. How did you feel about the screen which summarized your selections before you cast the ballot?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**12. Was the ballot submission process easily accessible for you?** Yes  No **12.1. [If INTERNET] After you made all of your selections, how did you feel about the usability of the ballot submission function on this system (i.e.: confident that the ballot was cast)?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**12.2. [If PRINT & MAIL] How did you feel about the usability of the printing and mailing process?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**Voting Assistance****13. Did you need help at any point in the voting process?** Yes  No **13.1. [If YES] Did you use any of the voting system help features or did you ask for assistance from a poll worker?** Help Features  Poll Worker  Both **13.2. [If YES] How did you feel about the help that was provided?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**14. Did you receive any error messages during your voting session?** Yes  No **14.1. [If YES] How did you feel about the system's explanation of the error?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**14.2. [If YES] How did you feel about the system’s ability to assist in recovery from the error?**

Extremely 1 2 3 4 5 Extremely N/A  
 Dissatisfied      Satisfied

Comments: \_\_\_\_\_

**Voting System Features**

**15. Did you use any assistive devices while voting today (i.e.: sip and puff device, headphones, hearing aids, wheelchairs, etc?)** Yes  No

**15.1. [If YES] What assistive devices did you use?**

Comments: \_\_\_\_\_

**15.2. [If YES] How did you feel about the voting system’s ability to work with these assistive devices?**

Extremely 1 2 3 4 5 Extremely N/A  
 Dissatisfied      Satisfied

Comments: \_\_\_\_\_

**16. Was the default physical configuration (original set up before any changes or modifications were made) of the voting system easily accessible for you (comfortable voting stall size, reachable height or tilt of the voting system, etc)?** Yes  No

Comments: \_\_\_\_\_

**17. Did you have to make any adjustments to the physical configuration of the voting system?**

Yes  No

Comments: \_\_\_\_\_

**17.1. [IF YES] How did you feel about the physical adjustment process? (i.e.: could you make the adjustments easily and independently)**

Extremely 1 2 3 4 5 Extremely N/A  
 Dissatisfied      Satisfied

Comments: \_\_\_\_\_

**18. Were the default visual display settings (original set up before any changes or modifications were made) easily accessible for you (visual clarity, brightness, font/icon size, etc)?** Yes  No

Comments: \_\_\_\_\_

**19. Did you make any adjustments to the visual features of the display?** Yes  No

Comments: \_\_\_\_\_

**19.1. [If YES] How did you feel about the visual adjustment process?**

Extremely 1 2 3 4 5 Extremely N/A  
 Dissatisfied      Satisfied

Comments: \_\_\_\_\_

**20. Were the default audio features (original set up before any changes or modifications were made) easily accessible for you (volume, speech functions, etc)?** Yes  No  N/A

Comments: \_\_\_\_\_

**21. Did you make any adjustments to the audio features?** Yes  No

**21.1. [If YES] How did you feel about the audio adjustment process?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**22. Were the tactile controls easily accessible for you?** Yes  No  N/A

Comments: \_\_\_\_\_

**Open Ended Questions**

**1. What were some positive aspects of using the voting system?**

Comments: \_\_\_\_\_

**2. What were some negative aspects of using the voting system?**

Comments: \_\_\_\_\_

**3. Did the voting system have all the functions and capabilities you expected it to have?** Yes  No

**3.1. [If NO] What functions would you like for the system to have?**

Comments: \_\_\_\_\_

**4. Were you able to vote privately?** Yes  No

Comments: \_\_\_\_\_

**5. Overall, how confident would you feel using the system in a real election?**

Extremely	1	2	3	4	5	Extremely	N/A
Dissatisfied	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Satisfied	<input type="radio"/>

Comments: \_\_\_\_\_

**Previous Voting Experience**

**1. Have you ever voted before?** Yes  No

**1.1. [If YES] Have you voted in person, absentee, or both?** In Person  Absentee  Both

**1.1.1. [If ABSENTEE] Did you vote using a paper ballot or online?** Paper  Online

**1.1.1.1. [If ONLINE] Which method did you use? (e.g. FVAP Portal, State)**

Comments: \_\_\_\_\_

**2. Are you currently registered to vote?** Yes  No

**3. Have you ever used a voting system with any accessibility accommodations (magnification features, audio features, etc.)?** Yes  No



3.1. [If YES] What features? \_\_\_\_\_

**Medical Situation**

1. How long has it been since you were injured or became ill?

Comments: \_\_\_\_\_

2. To assist us in categorizing injuries and illnesses that could lead to challenges in the voting process, can you describe the general nature of your injuries or illness?

Comments: \_\_\_\_\_

3. On a scale of 1 to 5, with 1 being no difficulties and 5 being extreme difficulties, how significant are your current (last 30 days) difficulties in the following areas:

**3.1 Vision (such as direct vision loss or other issues such as focusing problems):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

**3.2. Hearing (such as hearing loss or interference such as tinnitus):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

**3.3. Mobility (such as standing, walking, and balance):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

**3.4. Dexterity (using your hands):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

**3.5. Neurological (such as TBI, headaches, memory, or concentration problems):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

**3.6. Behavioral Health (such as PTSD, irritability, depression):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

**3.7. Communication (such as speech or conversation):**

No	1	2	3	4	5	Extreme
Difficulties	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Difficulties

Comments: \_\_\_\_\_

4. Do you feel that your injury or illness has led to any other limitations that could impact your ability to vote?

Comments: \_\_\_\_\_

## Appendix D: Operation VOTE Ballot

**OFFICIAL GENERAL ELECTION BALLOT  
BROOKE ARMY MEDICAL CENTER, SAN ANTONIO, TX, USA  
July 26 - 27, 2011**

Precinct BAMC Pct

**Instruction Text:**

To vote you must darken the oval  completely next to the candidate or issue of your choice.

FEDERAL

**UNITED STATES PRESIDENT AND VICE PRESIDENT**  
(Vote for ONE.)

- General Ulysses S Grant / President Abraham Lincoln  
Civil War Party
- General Douglas MacArthur / General Dwight D. Eisenhower  
WWII Party
- Martha Washington / Benedict Arnold  
Revolutionary War Party

**UNITED STATES SENATOR**  
(Vote for ONE.)

- General George Washington  
Revolutionary War Party
- General William Tecumseh Sherman  
Union Party
- Betsy Ross  
Flag Party
- Write-In

**REPRESENTATIVE TO THE 120<sup>th</sup> UNITED STATES CONGRESS  
DISTRICT 16**

(Vote for ONE.)

- Stephen F. Austin  
Texas Rangers Party
- William T. "Slick" Clements  
Smith and Wesson Party
- George W. Baylor  
Rio Grande Party
- William A. A. (Big Foot) Wallace  
Texas Mounted Volunteers Party

STATE

**GOVERNOR / LT. GOVERNOR**

(Vote for ONE.)

- General George Patton / Rosie the Riveter  
WWII Party
- Mary Ludwig Hays McCauley "Molly Pitcher" / Paul Revere  
Revolutionary War Party

**SECRETARY OF STATE**

(Vote for ONE.)

- Clara Barton  
American Red Cross Party
- Alexander Hamilton  
Founding Father Party
- David "Davy" Crockett  
Wild Frontier Party
- General John Pershing  
WWI Party

LOCAL

**COUNTY CLERK**

(Vote for ONE.)

- Robert E. Lee  
Confederate Party
- Susan B. Anthony  
National Woman's Suffrage Association Party
- Harriet Tubman  
Civil War Party
- Write-In

**CITY COUNCIL**

(Vote for UP TO THREE.)

- T.J. "Stonewall" Jackson  
Confederate Party
- Frederick Douglass  
Civil Rights Party
- Abigail Adams  
Revolutionary War Party
- William Barret Travis  
Alamo Party
- Paul Revere  
Midnight Ride Party
- Write-In

*Ballot issues referred by the general assembly or any political subdivision are listed by letter, and ballot issues initiated by the people are listed numerically. A ballot issue listed as an "amendment" proposes a change to the constitution, and a ballot issue listed as a "proposition" proposes a change to the Statutes. A "yes" vote on any ballot issue is a vote in favor of changing current law or existing circumstances, and a "no" vote on any ballot issue is a vote against changing current law or existing circumstances.*

**AMENDMENT M (CONSTITUTIONAL)**

Shall there be an amendment to section 4 of article XVI of the U.S. Constitution, allowing the annexation of the country currently known as Texas to the United States of America?

- Yes  
 No

**AMENDMENT Z (CONSTITUTIONAL)**

Shall there be an amendment to section 4 (2) (b) of article XII of the U.S. Constitution, concerning an exemption from property taxation for all U.S. citizens residing in the original 13 U.S. colonies?

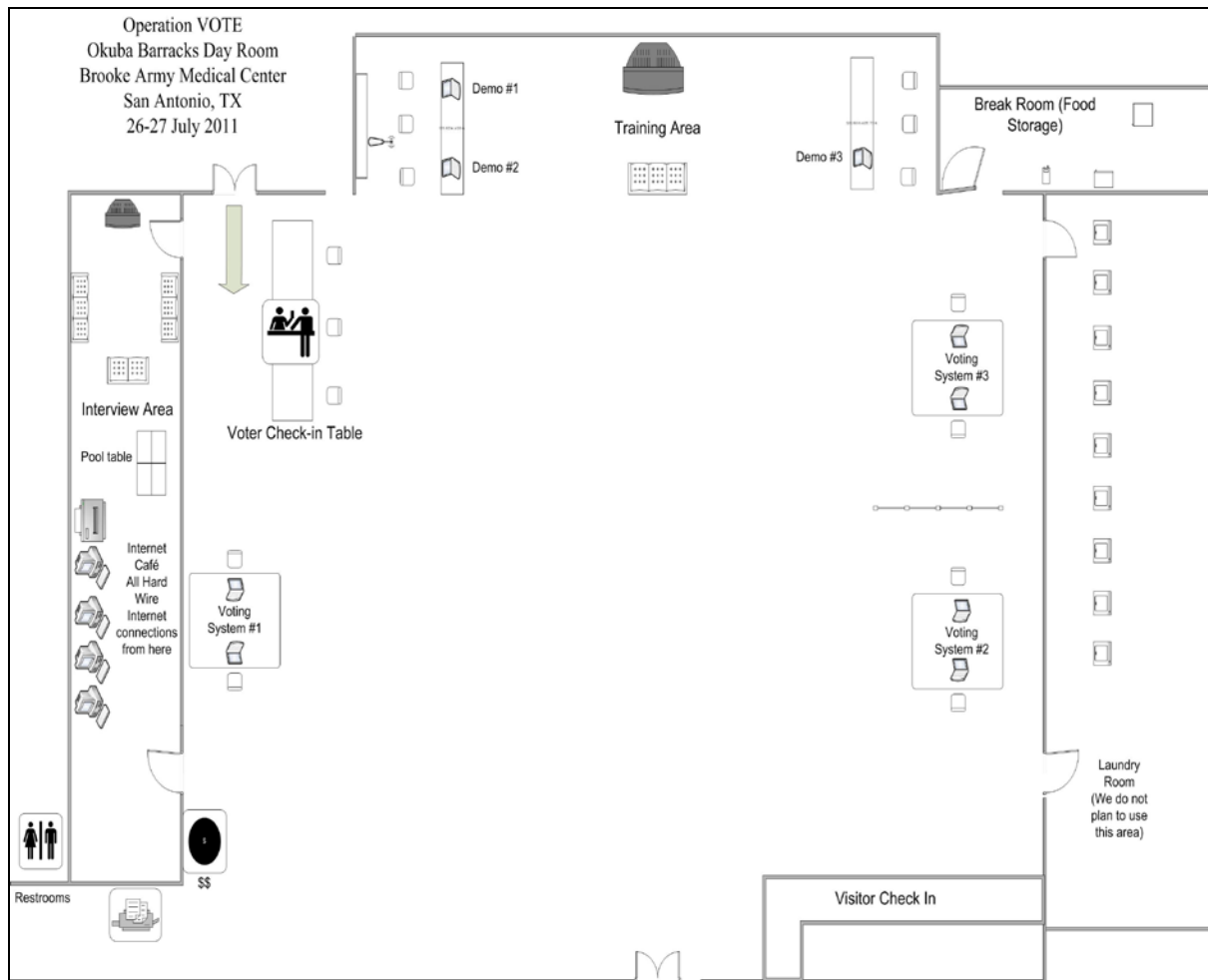
- Yes  
 No

**PROPOSITION 206 (STATUTORY)**

Shall there be an amendment to the Statutes concerning limits on government charges, and, in connection therewith, reducing horse & buggy ownership taxes over four years to nominal amounts; ending taxes on horse & buggy rentals and leases; phasing in over four years a \$25.00 horse & buggy sale price tax exemption; setting total yearly registration, license, and title charges at \$2 per horse & buggy and repealing other specific horse & buggy charges?

- Yes  
 No

## Appendix E: Okubo Barracks Layout



## Appendix F: BAMC Wounded Warrior Population (January 2011)

The following data was provided to FVAP by the U.S. Army Warrior Transition Command in January 2011, in response to an inquiry from FVAP about specific Wounded Warrior injuries. It is not intended as a complete listing of all Wounded Warrior injuries at BAMC at that time, but merely as a sampling of the common injuries seen there.

Additionally, it should be noted that combat conditions often result in multiple injuries to Wounded Warriors. The total injures listed below sum to 843, while the total Wounded Warrior population of BAMC in January 2011 was approximately 628.

Injury Type	Number of Cases
Amputations	81
Orthopedic	370
Eyes, Ears, Nose, & Throat	36
Burns	47
TBI	74
Neurological	81
PTSD	73
Other Behavioral Health	81

## Appendix G: UPPTR Results and Recommendations

As Operation VOTE was not a full compliance test against the UPPTR, the research team chose not to use the terms “Pass” and “Fail” when assessing whether each of the platforms complied with UPPTR requirements. Instead, the following definitions were used in the following table:

- Observed – At least one of the three systems within a platform was observed meeting the requirement.
- Not Observed – None of the three systems within a platform were observed meeting the requirement.
- Not Tested – The requirement was outside the scope of Operation VOTE, or was ambiguously phrased, and was thus not assessed.
- Not Applicable – The requirement was not applicable to either the platforms being assessed, or to the Operation VOTE environment.

The following recommendations summarize comments regarding UPPTR Section 3 organization and presentation made in the following table:

- It is recommended that the terms SHALL and SHALL NOT in all higher order requirements be changed to “should” and “should not.”
- It is recommended that Section 3 be renumbered with consistent titling at the third and fourth levels, and prescriptive language only at the fifth and sixth levels. It is possible that the most expeditious solution is the elimination of fourth level titles, such that lowercase letters become fourth level requirements, and Roman numerals become fifth level requirements.
- It is recommended that any requirement containing more than one unique SHALL or SHALL NOT statement be divided into separate requirements.
- It is recommended that any requirement containing redundant SHALL or SHALL NOT statements be changed to contain one clarifying “should” statement and one prescriptive SHALL or SHALL NOT statement.
- It is recommended that all non-prescriptive requirements be grouped together at the end of lists of prescriptive requirements, and that explicit language be added specifying why these requirements are not prescriptive.

The following recommendations summarize comments regarding UPPTR Section 3 contents in the following table:

- It is recommended that either requirement 3.2.2-a be modified to specifically mention accessibility features as valid system operations that require instructions, or that an additional requirement discussing this topic be added to the UPPTR.
- It is recommended that specific, testable requirements be adapted from available resources and added to subsection 3.3.7 of the UPPTR. These requirements may detail features such as:
  - consistent navigation (placement, display, and functionality);
  - avoidance of unnecessary time-outs or short time limits;
  - confirmation features for correctly casting the ballot; and
  - alerts for users to errors or possible errors.
- It is recommended that requirement 3.2.2-e(ii) be deleted from Section 3 of the UPPTR.



2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.1 Overview	3.1.1 Purpose	1	All eligible UOCAVA voters SHALL have access to the voting process without discrimination. The voting process SHALL be accessible to individuals with disabilities.	Introductory paragraph should not have a SHALL in it. Recommend changing SHALL statements to "should."	Not Tested	Not Tested	In order to avoid vagueness and redundancy, VSTLs prefer that higher-order requirements not contain the terms SHALL or SHALL NOT. These requirements are vague and not testable, and the use of proscriptive terms is not necessary, as there are many specific, testable requirements within Section 3, to which sub-sections 3.1 and 3.1.1 serve as an introduction.
		2	Each cast ballot SHALL accurately capture the selections made by the voter. The ballot SHALL be presented to the voter in a manner that is clear and usable.	Introductory paragraph should not have a SHALL in it. Recommend changing SHALL statements to "should."	Not Tested	Not Tested	
		3	The voting process SHALL preserve the secrecy of the ballot. The voting process SHALL preclude anyone else from determining the content of a voter's ballot, without the voter's cooperation.	Introductory paragraph should not have a SHALL in it. Recommend changing SHALL statements to "should."	Not Tested	Not Tested	
3.2 Usability	Intro	Intro	The voting system SHALL support voters in the task of effectively and accurately casting their ballots. The features of the voting system SHALL NOT contribute to the commission of voter error within the voting session.	Introductory paragraph should not have a SHALL in it. The second level requirement is fulfilled when all subordinate requirements are met.	Not Tested	Not Tested	In order to avoid vagueness and redundancy, VSTLs prefer that higher-order requirements not contain the terms SHALL or SHALL NOT, as each of the higher-order requirements should be met when all of their nested requirements are fulfilled.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.1 Privacy	3.2.1.1 a	The vote capture device SHALL prevent others from determining the contents of the ballot.	Guideline 3.2.1.1-a is subsumed by guideline 3.2.1.1-b. To differentiate between the two, guideline 3.2.1.1-a should read "The vote capture device SHALL support ballot privacy during the voting session."	Observed	Observed	
		3.2.1.1 b	The vote capture device SHALL support ballot privacy during the voting session and ballot submission.	Guideline 3.2.1.1-a is subsumed by guideline 3.2.1.1-b. To differentiate between the two, guideline 3.2.1.1-b should read "The vote capture device SHALL support ballot privacy during the ballot submission."	Observed	Observed*	*In network environment privacy could be compromised when printing ballots.
		3.2.1.1 c	During the voting session, if an audio interface to the vote capture device is provided, it SHALL be audible only to the voter.	No comment.	Observed	Observed	
		3.2.1.1 d	The vote capture device SHALL issue all warnings in a way that preserves the privacy of the voter and the confidentiality of the ballot.	No comment.	Observed	Observed	
		3.2.1.1 e	The vote capture device SHALL not issue a receipt to the voter that would provide proof to another of how the voter voted.	It is not clear whether the printed ballot from an EBDS would qualify as a receipt, and if so, if that would violate this requirement, as this ballot would not contain the voter's name or other identifying information.	Observed	Not Tested*	* Unclear language. Neither type of system required touch screen access as the sole means of operation.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.1 Privacy	3.2.2.1 a	No information SHALL be kept within an electronic cast voter record that identifies any alternative language feature(s) used by the voter.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	No alternative language features were used during Op. VOTE.
		3.2.2.1 b	No information SHALL be kept within an electronic cast voter record that identifies any accessibility feature(s) used by the voter.	No comment.	Not Tested	Not Tested	
	3.2.2 Cognitive Issues	a	The vote capture device SHALL provide instructions for all its valid operations.	It is not clear whether valid operations can refer to accessibility features. Clarifying language should be added to this requirement.	Not Observed	Not Observed	If valid operations refer to accessibility features, then this requirement was not observed by either IVS or EBDS systems.
		b	The vote capture device SHALL provide a means for the voter to get help directly from the system at any time during the voting session.	No comment.	Not Observed	Not Observed	
		c	Instructional material for the voter SHALL conform to norms and best practices for plain language.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Observed*	Observed*	* Except for the use of election jargon "under vote" and "over vote" in warning messages.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.2 Cognitive Issues	c (i)	Warnings and alerts issued by the vote capture device SHALL be distinguishable from other information and should clearly state: <ul style="list-style-type: none"> <li>• The nature of the problem;</li> <li>• Whether the voter has performed or attempted an invalid operation or whether the vote capture device itself has malfunctioned in some way; and</li> <li>• The set of responses available to the voter.</li> </ul>	Should be split into two requirements: one for warnings and alerts being distinguishable from other information, and one for the things they should clearly state.	Observed*	Not Observed*	* Warnings and alerts on both systems were clearly distinguishable from other information.
		c (ii)	When the instruction is based on a condition, the condition should be stated first, and then the action to be performed.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive.
		c (iii)	The vote capture device should use familiar, common words and avoid technical or specialized words that voters are not likely to understand.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive. However, both types of systems issued warnings using of election jargon (i.e.: "under vote" and "over vote").
		c (iv)	Each distinct instruction should be separated spatially from other instructions for visual or tactile interfaces, and temporally for auditory interfaces.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.2 Cognitive Issues	c (v)	The vote capture device should issue instructions on the correct way to perform actions, rather than telling voters what not to do.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive.
		c (vi)	The instructions should address the voter directly rather than use passive voice constructions.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive.
		c (vii)	The vote capture device should avoid the use of gender-based pronouns.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive. However, both types of systems avoided the use of gender-based pronouns.
		d	Consistent with election law, the voting application SHALL support a process that does not introduce bias for or against any of the contest choices to be presented to the voter. In both visual and aural formats, the choices SHALL be presented in an equivalent manner.	Two SHALL statements in this requirement refer to the same concept in different words. It is recommended that the first SHALL be changed to "should."	Observed	Observed	
		e	The voting system SHALL provide the capability to design a ballot with a high level of clarity and comprehensibility.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Observed	Observed	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.2 Cognitive Issues	e (i)	The vote capture device should not visually present a single contest spread over two pages or columns.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive. However, neither type of system presented a single contest spread over two pages or columns.
		e (ii)	The ballot SHALL clearly indicate the maximum number of candidates for which one can vote within a single contest.	This requirement refers to specific language on the ballot, which is not the purview of the system manufacturers, but rather election officials. Recommend deleting this requirement.	Observed	Observed	
		e (iii)	The relationship between the name of the candidate and the mechanism used to vote for that candidate SHALL be consistent throughout the ballot.	No comment.	Observed	Observed	
		e (iv)	The vote capture device should present instructions near to where they are needed.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive. Additionally, it is not clear if the instructions referenced here are for ballot choices only, or for the system as a whole.	Observed*	Observed*	*Assuming this requirement refers only to ballot instructions, it was observed for both types of systems.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.2 Cognitive Issues	f	The use of color SHALL agree with common conventions: green, blue, or white used for general information or as a normal status indicator; amber or yellow used to indicate warnings or a marginal status; red is used to indicate error conditions or a problem requiring immediate attention.	No comment.	Observed	Observed	
		g	When an icon is used to convey information, indicate an action, or prompt a response, it SHALL be accompanied by a corresponding linguistic label.	Not clear whether the linguistic label refers to only written text, or also to audio.	Observed	Observed	Although the use of linguistic labels was observed for one IVS and one EBDS system, it should be noted that other systems did not meet this requirement and generated user feedback.
	3.2.3 Perceptual Issues	a	The electronic display screen of the vote capture device SHALL have the following characteristics: <ul style="list-style-type: none"> <li>• Flicker frequency NOT between 2 Hz and 55 Hz.</li> <li>• Minimum display brightness: 130 cd/m2</li> <li>• Minimum display darkroom 7x7 checkerboard contrast: 150:1</li> <li>• Minimum display pixel pitch: 85 pixels/inch (0.3 mm/pixel)</li> <li>• Minimum display area 700 cm2</li> <li>• Antiglare screen surface</li> </ul>	No comment.	Not Tested	Not Tested	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.3 Perceptual Issues	a (cont'd)	that shows no distinct virtual image of a light source <ul style="list-style-type: none"> <li>• Minimum uniform diffuse ambient contrast for 500 1x illuminance: 10:1</li> </ul>				
		b	Any aspect of the vote capture device that is adjustable by either the voter or kiosk worker, including font size, color, contrast, audio volume, or rate of speech, SHALL automatically reset to a standard default value upon completion of that voter's session.	No comment.	Not Observed	Observed*	Systems generally used browser options for increasing magnification, which do not reset automatically between voters. * One exception was a EBDS system that used PDF functionality, which reset after each voter.
		c	If any aspect of a vote capture device is adjustable by either the voter or kiosk worker, there SHALL be a mechanism to allow the voter to reset all such aspects to their default values while preserving the current votes.	No comment.	Not Observed	Not Observed	Systems did not have a way to reset all adjustable features with one click.
		d	For all text the vote capture device SHALL provide a font with the following characteristics: <ul style="list-style-type: none"> <li>• Height of capital letters at least 3.0 mm</li> <li>• x-height of at least 70% cap height</li> <li>• Stroke width at least: 0.35 mm.</li> </ul>	This requirement should include requirement 3.2.3-f (sans serif font).	Not Tested	Not Tested	



2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.3 Perceptual Issues	e	<p>The vote capture device electronic image display SHALL be capable of showing all information in at least two font sizes:</p> <ul style="list-style-type: none"> <li>• 3.0-4.0 mm cap height, with a corresponding x-height at least 70% of the cap height and a minimum stroke width of 0.35 mm;</li> <li>• 6.3-9.0 mm cap height, with a corresponding x-height at least 70% of the cap height and a minimum stroke width of 0.7 mm; under control of the voter. The device SHALL allow the voter to adjust font size throughout the voting session while preserving the current votes.</li> </ul>	Should be split into two requirements: one size criteria, and one for the ability to adjust fonts while preserving the current votes.	Partially Tested, Observed	Partially Tested, Observed	The first portion of the requirement (font height and stroke width) was not tested. The second portion of the requirement was observed for both IVS and EBDS system.
		f	Text should be presented in a sans serif font.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive. Requirement should be a sub portion under 3.2.3-d (font characteristics).	Not Tested	Not Tested	Requirement is not prescriptive. However, both types of systems used sans serif fonts.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.3 Perceptual Issues	g	Vote capture devices providing paper verification records SHALL provide features that assist in the reading of such records by voters with poor reading vision.	Requirements 3.2.3-g (i) and (ii) should be bullet points under this requirement, as either of the options they present fulfill this requirement.	Not Applicable	Not Observed*	* The EVSW systems printed one font automatically. Although it may have been possible to change the font size on the printout, this feature would have come from the printer/browser, and not the system. No system was equipped with built-in magnification, although any magnifying glass would have worked with the print-outs.
		g (i)	The vote capture device may achieve legibility of paper records by supporting the printing of those records in at least two font sizes, 3.0-4.0 mm and 6.3-9.0 mm.	This requirement does not contain a SHALL statement. This requirement should be a bullet under 3.2.3-g	Not Applicable	Not Observed*	
		g (ii)	The vote capture device may achieve legibility of paper records by supporting magnification of those records. This magnification may be done by optical or electronic devices. The manufacturer may either: 1) provide the magnifier itself as part of the system, or 2) provide the make and model number of readily available magnifiers that are compatible with the system.	This requirement does not contain a SHALL statement. This requirement should be a bullet under 3.2.3-g	Not Applicable	Not Observed*	
		h	The minimum figure to ground ambient contrast ratio for all text and informational graphics (including icons) SHALL be	No comment.	Not Tested	Not Tested	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.3 Perceptual Issues	H (cont'd)	10:1. for paper records, contrast is measured based on ambient lighting of at least 300 lx.				
		j	The default color coding SHALL support correct perception by voters with color blindness.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Partially Observed*	Partially Observed*	* Partially Not Applicable
		j (i)	Ordinary information presented to the voter should be in the form of black text on a white background. The use of color should be reserved for special cases, such as warnings or alerts.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive.	Not Tested	Not Tested	Requirement is not prescriptive. However, both types of systems presented the voter black text on a white background.
		j (ii)	No information presented to the voter SHALL be in the form of colored text on a colored background. Either the text or the background SHALL be black or white.	Two SHALL statements in this requirement refer to the same concept in different words. It is recommended that the first SHALL be changed to "should."	Observed	Observed	
		j (iii)	If the text is colored other than black or white:	No SHALL statement in this requirement. It should be deleted, and the text incorporated into sub portions 1, 2, 3, 4.	Partially Tested, Observed	Partially Tested, Observed	
		j (iii) 1	The background SHALL be black or white.	Redundant with 3.2.3 j (ii), recommend deletion.	Observed	Observed	
		j (iii) 2	The text SHALL be presented in a bold font (minimum 0.6 mm stroke width).	No comment.	Not Tested	Not Tested	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.3 Perceptual Issues	j (iii) 3	If the background is black, the text color SHALL be yellow or light cyan.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	No systems tested during Op. VOTE used black backgrounds.
		j (iii) 4	If the background is white, the text color SHALL be dark enough to maintain a 10:1 contrast ratio.	No comment.	Not Tested	Not Tested	
		j (iv)	If the background is colored other than black or white, the presentation SHALL follow these guidelines:	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	No systems tested during Op. VOTE used colored backgrounds.
		j (iv) 1	The text color SHALL be black.	Redundant with 3.2.3 j (ii), should be deleted.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		j (iv) 2	The background color SHALL be yellow or cyan.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		k	Color coding SHALL not be used as the sole means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.	No comment.	Observed	Observed	
	3.2.4 Interaction Issues	a	The vote capture device SHALL not require page scrolling by the voter.	It is not clear whether the review screen is considered part of the vote capture device.	Not Observed	Not Observed	Both IVS and EBSD systems required page scrolling due to screen size, even when they implemented one race per screen.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.4 Interaction Issues	b	The vote capture device SHALL provide unambiguous feedback regarding the voter's selection, such as displaying a checkmark beside the selected option or conspicuously changing its appearance.	No comment.	Observed	Observed	
		c	Vote capture device input mechanisms SHALL be designed to prevent accidental activation.	It is not clear whether this requirement is applicable to non-touch screen systems.	Not Tested*	Not Tested*	* Unclear language
		c (i)	On touch screens, the sensitive touch areas SHALL have a minimum height of 0.5 inches and minimum width of 0.7 inches. The vertical distance between the centers of adjacent areas SHALL be at least 0.6 inches, and the horizontal distance at least 0.8 inches. Touch areas SHALL NOT overlap.	Split into 3 separate requirements.	Not Tested	Not Applicable *	* No EBDS system used touch screens.
		3.2.4.1 a	The initial system response time of the vote capture device SHALL be no greater than 0.5 seconds.	No comment.	Not Tested	Not Tested	Although these issues were not tested in Op. VOTE, at the macro level the participants did make comments about some systems running slowly or "lagging."

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.4 Interaction Issues	3.2.4.1 b	When the voter performs an action to record a single vote, the completed system response time of the vote capture device SHALL be no greater than one second in the case of visual response, and no greater than 5 seconds in the case of audio response.	No comment.	Not Tested	Not Tested	Although these issues were not tested in Op. VOTE, at the macro level the participants did make comments about some systems running slowly or "lagging."
		3.2.4.1 c	The completed system response time of the vote capture device SHALL be no greater than 10 seconds.	No comment.	Not Tested	Not Tested	
		3.2.4.1 d	If the vote capture device has not completed its visual response within one second, it SHALL present to the voter, within 0.5 seconds of the voter's action, some indication that it is preparing its response.	No comment.	Not Tested	Not Tested	
		3.2.4.1 e	If the vote capture device requires a response by a voter within a specific period of time, it SHALL issue an alert at least 20 seconds before this time period has expired and provide a means by which the voter may receive additional time.	No comment.	Not Tested	Not Tested	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.5 Alternative Languages	Intro	HAVA Section 301 (a) (4) states that the voting system SHALL provide alternative language accessibility pursuant to the requirements of Section 203 of the Voting Rights Act of 1965 (42 U.S.C. 1973aa-1a).	Introductory paragraph should not have a SHALL in it, as the 3.2.5-a requirement fulfills the same purpose.	Not Tested	Not Tested	
		a	The voting system SHALL be capable of presenting the ballot, contest choices, review screens, paper verification records, and voting instructions in any language declared by the manufacturer to be supported by the system.	No comment.	Not Tested	Not Tested	
	3.2.6 Usability for Kiosk Workers	a	Messages generated by the vote capture device for kiosk workers in support of the set up, maintenance, or safety of the system SHALL adhere to the requirements for clarity in Section 3.2.4 "Cognitive issues."	No comment.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.
		3.2.6.1 a	The procedures for voting system setup, polling, and shutdown, as documented by the manufacturer, SHALL be reasonably easy for the typical poll worker to learn, understand, and perform.	No comment.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.6 Usability for Kiosk Workers	3.2.6.1 b	The manufacturer SHALL provide clear, complete, and detailed instructions and messages for kiosk location setup, daily operation, and shutdown.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.
		3.2.6.1 b (i)	The documentation SHALL be presented at a level appropriate for kiosk workers who are not experts in voting system and computer technology.	No comment.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.
		3.2.6.1 b (ii)	The documentation SHALL be in a format suitable for use in the kiosk location.	No comment.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.
		3.2.6.1 b (iii)	The instructions and messages SHALL enable the kiosk worker to verify that the vote capture device, peripherals, and communications links: <ul style="list-style-type: none"> <li>• Has been set up correctly;</li> <li>• Is in correct working order;</li> <li>and</li> <li>• Has been shut down correctly.</li> </ul>	No comment.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.



2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.2 Usability	3.2.6 Usability for Kiosk Workers	3.2.6.2	Devices associated with the voting system SHALL be certified in accordance with the requirements of UL 60950-1, Information Technology Equipment – Safety – Part 1 by a certification organization accredited by the Department of Labor, Occupational Safety and Health Administration’s Nationally Recognized Testing Laboratory program. The certification organization’s scope of accreditation SHALL include IEC/UL 60950-1.	No comment.	Not Tested	Not Tested	Operation VOTE did not assess the usability of the systems for kiosk workers.
3.3 Accessibility	3.3.1 General	a	The Acc-VS SHALL be integrated into the manufacturer’s complete voting system so as to support accessibility for disabled voters throughout the voting session.	Requirement is not specific enough to be tested.	Not Tested*	Not Tested*	* Unclear language
		a (i)	The manufacturer SHALL supply documentation describing 1) the recommended procedures that fully implement accessibility for voters with disabilities and 2) how the Acc-VS supports those procedures.	Rather than being subordinate to requirement a, this should be a separate 4th level requirement.	Not Tested	Not Tested	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.1 General	b	When the provision of accessibility for Acc-VS involves an alternative format for ballot presentation, then all information presented to non-disabled voters, including instructions, warnings, error and other messages, and contest choices SHALL be presented in the alternative format.	No comment.	Observed*	Not Tested	* IVS systems that presented a screen reader audio functionality included all information presented in the written format.
		c	The support provided to voters with disabilities SHALL be intrinsic to the accessible voting system. It SHALL NOT be necessary for the accessible voting station to be connected to any personal assistive device of the voter in order for the voter to operate it correctly.	Two SHALL statements in this requirement refer to the same concept in different words. It is recommended that the first SHALL be changed to "should."	Observed*	Observed*	* Several vendors brought accessibility devices to Op. VOTE, such that voters did not have to connect their own. However, it is unclear whether these devices would come with the systems in a potential kiosk environment.
		d	If a voting system provides for voter identification or authentication by using biometric measures that require a voter to possess particular biological characteristics, then Acc-VS SHALL provide a secondary means that does not depend on these characteristics.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.1 General	e	If the Acc-VS generates a paper record (or some other durable, human readable record) for the purpose of allowing voters to verify their votes, then the system SHALL provide a means to ensure that the verification record is accessible to all voters with disabilities, as identified in 3.3 "Accessibility Requirements."	This requirement provides a reference to section 3.3, which encompasses the entire chapter this requirement is in. Perhaps the reference is meant to refer to 3.2.3 (g), which also mentions paper records?	Not Applicable	Not Observed*	* It is not clear if the ballots printed by the EBDS systems qualify as paper records referenced in this requirement. If so, means to make these ballots accessible were not observed. See comments in 3.2.3 (g).
		e (i)	If the Acc-VS generates a paper record (or some other durable, human readable record) for the purpose of allowing voters to verify their votes, then the system SHALL provide a mechanism that can read that record and generate an audio representation of its contents.	Rather than being subordinate to requirement e, this should be a separate 4th level requirement.	Not Applicable	Not Observed*	* It is not clear if the ballots printed by the EBDS systems qualify as paper records referenced in this requirement. If so, no means to generate an audio representation were present.
	3.3.2 Low Vision	a	An accessible voting station with a color electronic image display SHALL allow the voter to adjust the color saturation throughout the voting session while preserving the current votes. Two options SHALL be available: 1) black text on white background and 2) white text on black background.	The availability of black/white and white/black options should be a separate requirement from the adjustable color saturation requirement. Options 1 and 2 should be broken out in bullet points.	Not Observed*	Not Observed*	*Both IVS and EBDS systems had no means to adjust color saturation other than whatever monitor controls were available on the laptops. These monitor controls were not necessarily known to voters. Both types of systems displayed only black text on white background, and did not offer the option to inverse the colors.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.2 Low Vision	b	Buttons and controls on accessible voting stations SHALL be distinguishable by both shape and color. This applies to buttons and controls implemented either "on screen" or in hardware. This requirement does not apply to sizeable groups of keys, such as conventional 4x3 telephone keypad or a full alphabetic keyboard.	This requirement should be split into two requirements, one for on-screen controls and one for hardware controls. Language should clarify whether the buttons need be distinguishable from each other, or from non-button features.	Observed for onscreen, Observed for hardware*	Observed for onscreen, Not applicable for hardware*	On-screen icons and controls were distinguishable by size and color. *Both IVS and EBDS systems were designed for use with full keyboards. Some IVS vendors did bring optional controls using distinguishable shape and color buttons.
		c	The Acc-VS SHALL provide synchronized audio output to convey the same information as that which is displayed on the screen. There SHALL be a means by which the voter can disable either the audio or the video output, resulting in a video-only or audio-only presentation, respectively. The system SHALL allow the voter to switch among the three modes (synchronized audio/video, video-only, or audio-only) throughout the voting session while preserving the current votes.	This requirement should be split into three requirements (one for each SHALL statement).	Observed*	Observed*	Both IVS and EBDS systems have capability for audio output if assistive devices (i.e., screen readers) are utilized. Disabling the video would require turning off the laptop screen or monitor, while disabling the audio would require pulling out the assistive device headphones.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.3 Blindness	a	The accessible voting station SHALL provide an audio tactile interface (ATI) that supports the full functionality of the visual ballot interface.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Partially Observed	Not Tested	Some IVS vendors brought audio and tactile devices for use with their machines. One EBDS vendor also brought an audio device, but this functionality could not be tested due to time constraints and the flow of voters.
		a (i)	The ATI of VEBD-A of the accessible voting station SHALL provide the same capabilities to vote and cast a ballot as are provided by its visual interface.	The acronym VEBD-A was not previously introduced.	Observed	Not Tested	
		a (ii)	The ATI SHALL allow the voter to have any information provided by the voting system repeated.	No comment.	Observed	Not Tested	
		a (iii)	The ATI SHALL allow the voter to pause and resume the audio presentation.	No comment.	Not Observed	Not Tested	
		a (iv)	The ATI SHALL allow the voter to skip to the next contest or return to the previous contests.	No comment.	Observed	Not Tested	
		a (v)	The ATI SHALL allow the voter to skip over the reading of a referendum so as to be able to vote on it immediately.	No comment.	Observed	Not Tested	
		b	Voting stations that provide audio presentation of the ballot SHALL do so in a usable way, as detailed in the following sub-requirements.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Partially Tested, Observed*	Partially Tested, Observed*	* The screen readers provided were difficult for first-time users to comprehend due to a mechanical voice with an odd cadence, and the reading of irrelevant information from the screen.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.3 Blindness	b (i)	The ATI SHALL provide its audio signal through an industry standard connector for private listening using a 3.5 mm stereo headphone jack to allow voters to use their own audio assistive devices.	No comment.	Observed	Observed	Both IVS and EBDS systems used laptops or computers, which have industry standard headphone jacks.
		b (ii)	When VEBD-A utilizes a telephone style handset or headphone to provide audio information, it SHALL provide a wireless T-Coil coupling for assistive hearing devices so as to provide access to that information for voters with partial hearing. That coupling SHALL achieve at least a category T4 rating as defined by [ANSI01] American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19.	The acronym VEBD-A was not previously introduced. This requirement should be split into two separate requirements; one for each SHALL statement.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	No vendors provided telephone style handsets or headphones.
		b (iii)	A sanitized headphone or handset SHALL be made available to each voter.	No comment.	Observed*	Observed*	*Level of sanitation was not tested.
		b (iv)	VEBD-A SHALL set the initial volume for each voting session between 40 and 50 dB SPL.	The acronym VEBD-A was not previously introduced.	Not Tested	Not Tested	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.3 Blindness	b (v)	The audio system SHALL allow the voter to control the volume throughout the voting session while preserving the current votes. The volume SHALL be adjustable from a minimum of 20 dB SPL to a maximum of 100 dB SPL, in increments no greater than 10 dB.	This requirement should be split into two separate requirements; one for each SHALL statement.	Not Tested	Not Tested	
		b (vi)	The audio system SHALL be able to reproduce frequencies over the audible speech range of 315 Hz to 10 KHz.	No comment.	Not Tested	Not Tested	
		b (vii)	The audio presentation for VEBD-A of verbal information should be readily comprehensible by voters who have normal hearing are proficient in the language. This includes such characteristics as proper enunciation, normal intonation, appropriate rate of speech, and low background noise. Candidate names should be pronounced as the candidate intends.	This requirement does not contain a SHALL statement. It is recommended that explicit language be added specifying why this requirement is not prescriptive. The acronym VEBD-A was not previously introduced.	Not Tested	Not Tested	Requirement is not prescriptive. However, see comment for 3.3.3-b.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.3 Blindness	b (viii)	The audio system SHALL allow the voter to control the rate of speech throughout the voting session while preserving the current votes. The range of speeds supported SHALL include 75% to 200% of the nominal rate. Adjusting the rate of speech SHALL not affect the pitch of the voice.	Requirement should be written as one non-SHALL statement with two subordinate requirements (75-200% and adjustment not affecting pitch).	Not Tested	Not Tested	
		c	If Acc-VS supports ballot activation for non-blind voters, then it SHALL also provide features that enable voters who are blind to perform this calculation.	Define ballot activation in the context of a kiosk environment.	Observed	Observed	CAPTCHAs had audio features.
		d	If Acc-VS supports ballot submission or vote verification for non-blind voters, then it SHALL also provide features that enable voters who are blind to perform these actions.	No comment.	Observed*	Not Observed**	* IVS systems that presented a screen reader audio functionality included all information presented in the written format, including the vote verification and ballot submission screens. ** Although the EBDS systems could be used with screen readers during the vote verification screen, there was no functionality to assist blind voters printing out and mailing their ballots.



2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.3 Blindness	e	Mechanically operated controls or keys, or any other hardware interface on Acc-VS available to the voter SHALL be tactilely discernible without activating those controls or keys.	No comment.	Observed*	Not Observed	*Both types of systems used full keyboards, but some IVS vendors brought special keypads with discernible controls.
		f	The status of all locking or toggle controls or keys (such as the 'shift' key) for Acc-VS SHALL be visually discernible, and also discernible through either touch or sound.	No comment.	Not Observed	Not Observed	Both types of systems used full keyboards, which do not provide such functionality.
	3.3.4 Dexterity	a	The accessible voting station SHALL provide a mechanism to enable non-manual input that is functionally equivalent to tactile input. All the functionality of the accessible voting station (e.g. straight party voting, write-in candidates) that is available through the conventional forms of input, such as tactile, SHALL also be available through the non-manual input mechanism.	Two SHALL statements in this requirement refer to the same concept in different words. It is recommended that the first SHALL be changed to "should."	Observed	Not Observed	IVS vendors provided various forms of assistive devices to enable non-manual input. EBDS vendors did not provide such assistive devices during Op. VOTE.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.4 Dexterity	b	If Acc-VS supports ballot submission or vote verification for non-disabled voters, then it SHALL also provide features that enable voters who lack fine motor control or use of their hands to perform these actions.	No comment.	Observed	Not Observed	Assistive devices brought by IVS vendors could facilitate vote verification and ballot submission on those systems. EBDS vendors did not provide such assistive devices, and if they had, these devices would not have helped voters fold and mail their ballots.
		c	Keys, controls, and other manual operations on the accessible voting station SHALL be operable with one hand and SHALL not require tight grasping, pinching, or twisting of the wrist. The force required to activate controls and keys SHALL be no greater than 5 lbs.	Split into 3 separate requirements.	Partially Tested and Observed	Partially Tested and Observed	Both types of systems could be operated using one hand. Levels of grasping, pinching, twisting, and force were not tested.
		d	The accessible voting station controls SHALL not require direct bodily contact or for the body to be part of any electrical circuit.	This requirement should be clarified, as it is not clear whether it refers to prosthetic devices touching the controls, or simply the avoidance of touch-screen only technology.	Not Tested*	Not Tested*	* Unclear language. Neither type of system required touch screen access as the sole means of operation.
	3.3.5 Mobility	a	The accessible voting station SHALL provide a clear floor space of 30 inches minimum by 48 inches minimum for a stationary mobility aid. The clear floor space SHALL be designed for a forward approach or a parallel approach.	Split into 2 separate requirements.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.5 Mobility	b	When deployed according to the installation instructions provided by the manufacture, Acc-VS SHALL allow adequate room for an assistant to the voter. This includes clearance for entry to and exit from the area of the voting station.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems. Additionally, no vendors provided set-up documentation.
		c	Labels, displays, controls, keys, audio jacks, and any other part of the accessible voting station necessary for the voter to operate the voting system SHALL be legible and visible to a voter in a wheelchair with normal eyesight (no worse than 20/40, corrected) who is in an appropriate position and orientation with respect to the accessible voting station.	No comment.	Observed	Observed	
		3.3.5.1 a	If the accessible voting station has a forward approach with no forward reach obstruction then the high reach SHALL be 48 inches maximum and the low reach SHALL be 15 inches minimum.	This requirement should contain one SHALL statement, and the maximum and minimum should be bullets under that SHALL statement.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.5 Mobility	3.3.5.1 b	If the accessible voting station has a forward approach with a forward reach obstruction, the following sub-requirements SHALL apply.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems.
		3.3.5.1 b (i)	The forward obstruction for Acc-VS SHALL be no greater than 25 inches in depth, its top no higher than 34 inches and its bottom surface no lower than 27 inches.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 b (ii)	If the obstruction for Acc-VS is no more than 20 inches in depth, then the maximum high reach SHALL be 48 inches, otherwise it SHALL be 44 inches.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 b (iii)	Space under the obstruction between the finish floor or ground and 9 inches above the finish floor or ground SHALL be considered toe clearance and SHALL comply with the following provisions for Acc-VS:	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 b (iii) 1	Toe clearance depth SHALL extend 25 inches maximum under the obstruction;	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.5 Mobility	3.3.5.1 b (iii) 2	The minimum toe clearance depth under the obstruction SHALL be either 17 inches or the depth required to reach over the obstruction to operate the accessible voting station, whichever is greater; and	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems.
		3.3.5.1 b (iii) 3	Toe clearance width SHALL be 30 inches minimum.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 b (iv)	Space under the obstruction between 9 inches and 27 inches above the finish floor or ground SHALL be considered knee clearance and SHALL comply with the following provisions:	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 b (iv) 1	Knee clearance depth SHALL extend 25 inches maximum under the obstruction at 9 inches above the finish floor or ground;	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 b (iv) 2	The minimum knee clearance depth at 9 inches above the finish floor or ground SHALL be either 11 inches or 6 inches less than the toe clearance, whichever is greater;	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.5 Mobility	3.3.5.1 b (iv) 3	Between 9 inches and 27 inches above the finish floor or ground, the knee clearance depth SHALL be permitted to reduce at a rate of 1 inch in depth for each 6 inches in height. (It follows that the minimum knee clearance at 27 inches above the finish floor or ground SHALL be 3 inches less than the minimum knee clearance at 9 inches above the floor.); and	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems.
		3.3.5.1 b (iv) 4	Knee clearance width SHALL be 30 inches minimum.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 c	If the accessible voting station has a parallel approach with no side reach obstruction then the maximum high reach SHALL be 48 inches and the minimum low reach SHALL be 15 inches.	This requirement should contain one SHALL statement, and the maximum and minimum should be bullets under that SHALL statement.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
		3.3.5.1 d	If the accessible voting station has a parallel approach with a side reach obstruction, the following sub-requirements SHALL apply.	Requirement should not have a SHALL in it, requirement will be passed if all subordinate clauses are passed.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.5 Mobility	3.3.5.1 d (i)	The side obstruction for Acc-VS SHALL be no greater than 24 inches in depth and its top no higher than 34 inches.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Both IVS and EBDS systems consisted only of laptops, and in the case of EBDS systems, printers. Voting space set-up was dependent on the poll workers, not the systems.
		3.3.5.1 d (ii)	If the obstruction is no more than 10 inches in depth, then the maximum high reach SHALL be 48 inches, otherwise it SHALL be 46 inches.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	
	3.3.6 Hearing	a	The accessible voting station SHALL incorporate the features listed under Requirement 3.3.3-C for voting systems that provide audio presentation of the ballot.	The referenced requirement (3.3.3-C) deals with ballot activation features for blind voters. If this is the correct reference, additional explanatory language is needed for this requirement.	Not Tested*	Not Tested*	*Unclear language.
		b	If the accessible voting system provides sound cues as a method to alert the voter, the tone SHALL be accompanied by a visual cue, unless the station is in audio only mode.	No comment.	Not Applicable to Op. VOTE	Not Applicable to Op. VOTE	Neither the IVS nor EBDS systems used sound cues.

2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.6 Hearing	c	No voting device SHALL cause electromagnetic interferences with assistive hearing devices that would substantially degrade the performance of those devices. The voting device, measured as if it were a wireless device, SHALL achieve at least a category T4 ranking as defined by [ANSI01] American National Standard for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19.	Split into 2 separate requirements; one for each SHALL statement.	Not Tested	Not Tested	
	3.3.7 Cognition	a	The accessible voting station should provide support to voters with cognitive disabilities.	This requirement is very vague. Suggest adding additional specific requirements, including consistent navigation (placement, display, and functionality), avoidance of unnecessary time-outs or short time limits, confirmation features for correct usage, and alert for users to errors or possible errors, etc. Suggest referencing back to other requirements, including plain language.	Not Tested	Not Tested	Requirement is not prescriptive.



2nd Level	3rd Level	4th -6th Level	UPPTR Requirement Language	Comments Regarding UPPTR Language	IVS	EBDS	Notes
3.3 Accessibility	3.3.8 English Proficiency	a	For voters who lack proficiency in reading English, Acc-VS SHALL provide an audio interface for instructions and ballots as described in 3.3.3 b.	No comment.	Partially Tested, see 3.3.3-b.	Partially Tested, see 3.3.3-b.	

## Appendix H: After Action Report

FVAP successfully conducted Operation VOTE at Brooke Army Medical Center (BAMC) from 26-27 July, 2011. Part of any operation of this size is conducting an after action review (AAR). The AAR allows for the listing of lessons learned and recommendations to improve future exercises of this nature. It should be noted that Operation VOTE was intended as an initial, qualitative assessment, and, as such, it was limited in scope and location. Future tests in an operational environment will require more coordination and logistical planning.

Many aspects of Operation VOTE worked very well:

- **Advance planning:** A kickoff meeting for the project was conducted six months prior to the exercise. Weekly meetings were conducted involving FVAP and contractor staff. Starting three months ahead of the exercise, FVAP incorporated key personnel from BAMC into these meetings. The weekly meetings were instrumental in keeping all stakeholders engaged and informed.
- **Coordination with the voting system vendors:** FVAP engaged system manufacturers early in the planning process. To facilitate coordination between FVAP and system vendors, a voting industry consultant was brought onto the team. The complicated planning process was simplified by this liaison between the stakeholders.
- **BAMC support:** Representatives from BAMC were highly engaged in supporting Operation VOTE. Their assistance was critical for participant recruitment, site selection, and logistical coordination.
- **Sensitivity training for observers:** To bolster available FVAP staff, poll workers from the local county were hired to collect observer data during Operation VOTE. These individuals were provided with sensitivity training to better prepare them to engage with Wounded Warrior participants.
- **Internet connectivity:** All of the voting system manufacturers rely on the internet to deliver their solution. As this was a potential failure point for all systems, FVAP asked all vendors to bring backup, self-sufficient internet connectivity solutions (e.g., air cards). Additionally, FVAP asked that an IT technician well-versed in the local system configuration be available on the morning of the exercise.

Future iterations of electronic voting system testing may be improved with the following recommendations.

- **Voting area size:** The location for Operation VOTE was a small atrium in the common area of the Okubo Barracks. This location was convenient for Wounded Warrior participants as many lived in the surrounding barracks. However, when filled to maximum capacity with observers, vendors, FVAP staff, and the volunteer voters, the area felt somewhat crowded. Additionally, the noise sometimes exceeded an optimal level. The dimensions of the atrium were roughly 32.5 feet

by 32.5 feet, but a slightly larger location would work better and provide for a more comfortable environment.

- **Observer training:** The observers were tasked with documenting the actions of the volunteer voters. While observers were given a general orientation to their role and specific examples of issues to document during the exercise, more extensive training would have been helpful. In particular, a practice experience in which observers could note various system issues would help to reinforce the initial training.
- **Voting machine orientation:** All volunteer voters were provided a training orientation on how to use the voting machines. While this was helpful for the volunteers in this particular exercise, it may have masked some of the challenges the voters would have experienced had they not received the training. Future testing, especially using able bodied participants, should not incorporate such an orientation.
- **Test case development:** Operation VOTE assessed accessibility, usability, and privacy in a simulated voting environment. This methodology was helpful to gather qualitative information about user experiences. Future testing efforts should consider an additional testing component: the development of specific test cases. For example, participants could be asked to intentionally over or under-vote to better assess various system features.