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An Investigation of the Voting System Certification Procedures

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Executive Summary

Voting technologies have improved over the last decade due to a number of issues at the polling place. However, evaluation procedures for certification of these newer voting technologies have not kept up with these modernizations. The goal of this work was to evaluate the current voting system certification procedures and identify gaps that affect usability and accessibility across the current voting standards. In other words, GTRI wanted to provide greater usability and accessibility to a wider range of people and provide test methods that are easier to understand and execute than those currently in circulation. A gap analysis of the Voluntary Voting System Guidelines (VVSG) and Voting System Standards (VSS) certification procedures was conducted in an effort to recommend changes to the test procedures that reflect the modernization of the voting process.

Overall, the following gaps were found within the standards: vague or incomplete wording, unspecified usability and accessibility guidelines, and no distinction made between accessibility and usability. A number of gaps within the current standards were identified including lack of guidance on the user interface. Some examples of missing information included not incorporating anti-glare or color contrast requirements, and guidelines for tilt orientation. Latency guidelines have not been updated to take into account faster operating systems and user expectations as they relate to new technologies. A number of inconsistencies in use of language (e.g., “voting station” versus “voting system”) as well as wording that was irrelevant to the guidelines were also identified.

A gap analysis of the Voluntary Voting System Guidelines (VVSG) and Voting System Standards (VSS) certification procedures was conducted in an effort to recommend changes to the test procedures that reflect the modernization of the voting process. Recommendations include removing extraneous text would provide the reader with only the necessary information for designing/certifying the voting system. Another important recommendation was to establish Plain Language as the overarching instructional language of voting systems. In addition to rewriting a number of the VVSG standards to coincide with the modernization of voting systems and procedures, several improvements to overcome issues related to the actual design and testing of voting systems are provided. An example improvement is to create a Usability Guidelines Document, allowing developers to document how usability was addressed during the design process and how it is evident in the design. This document would also address defining the target user groups. Another improvement to the process would be to establish a set of recommendations for how to conduct usability testing as part of the product development process. This type of document would describe details on what evidence is acceptable proof that usability was considered during the design process. Other solutions are also addressed in the Discussions section of this document.

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Introduction

Electronic voting machines have become more popular, not only due to the speed and accuracy of casting a vote, but also to usability problems associated with paper and mechanical voting devices. These issues were brought to public attention after the 2000 elections. Election results hinged on Florida results where the margin of victory triggered a mandatory recount. Many of the issues stemmed from usability and ballot design factors with voting systems. Numerous votes in question used Votomatic style punched card ballots, where incompletely-punched holes resulted in partially punched chads: a *hanging chad*, in which one or more corners were still attached, or a *dimpled chad* or *pregnant chad*, where all corners were still attached, but an indentation appears to have been made. This resulted in an unusual amount of over-votes and under-votes.

A proposed solution to these problems was the installation of modern electronic voting machines (How we got here: A timeline of the Florida recount, 2000) (Jackson, 2000). In response, many precincts nationwide now use electronic voting machines. However, these machines also have usability problems. Currently, the usability and accessibility of voting systems is inadequately tested during the system certification process. Despite efforts to include guidelines and requirements for testing, Voting System Test Labs (VSTLs) spend approximately 1% of their resources on testing for usability and accessibility. In an effort to improve the clarity and direction of the guidelines, Georgia Tech Research Institute (GTRI) reviewed the Voluntary Voting System Guidelines. High level recommendations will be discussed in this report, as well as future directions for improving overall voting standards.

Background

The federal government issued three iterations of the federal voting system standards. The first set was created in 1990 by the Federal Election Commission (FEC). The FEC then developed a second iteration of the standards in 2002. After the Help America Vote Act of 2002 (HAVA) was created, the FEC responsibility was transferred to the newly created U.S. Election Assistance Commission (EAC). In 2005, the EAC, in accordance with HAVA direction, issued a third iteration of the standards, called the Voluntary Voting System Guidelines (VVSG). EAC-accredited test laboratories currently test voting systems to both the 2002 voting system standards and the 2005 VVSG. According to the EAC website, voting systems submitted for testing after December 2007 are tested against only the 2005 VVSG. Therefore, the gap analysis includes the 2005 VVSG (Version 1.1) as well as the most recent iteration of the Voting System Standards (VSS).

Voting and Disabilities

Despite guidance provided by the Americans with Disabilities Act (ADA) Amendments Act Accessibility Guidelines (ADAAG), significant barriers continue to exist for voters with disabilities (Sanford, Echt, & Malassigne, 1999). For voters with disabilities, the accessibility of polling places and voting technologies, as well as other aspects of the voting process can impact their ability to exercise their civil rights. As part of the Accessible Voting Technology Initiative, the overall goal is to “use a design-led innovation process to translate research, observations and insights into actionable steps to change voting system technologies and processes in ways that will improve the voting experience for people with disabilities” (Castro & Quesenbery, June 6, 2011). It is imperative to ensure that voting system manufacturers and

certification entities understand the importance of implementing and evaluating usability and accessibility.

Voting Technologies and Certification Procedures

Assistive Technologies

Voting systems have potential accessibility issues across a range of areas, including physical access, reach and visibility, labeling, touchscreen interfaces and other displays, physical buttons, etc. Fortunately, there are a variety of technologies that integrate with voting systems to make them more accessible. It is important to define the interrelationship between assistive technologies and accessible systems. An accessible voting machine is a type of interactive device that a voter with a disability (visual/hearing/mobility impairments, cognitive and/or functional limitations) can use to produce a marked ballot independently. Accessible voting machines can reduce interaction times and enhance privacy. Assistive technologies aid a person in interacting with a system. AT are pieces of equipment or software that are used--in this case, with the voting machine--to increase the functional capabilities of people with disabilities. AT are used by people who have limited functionality such as upper or lower mobility impairments, people who are blind or have low vision, and people who have limited strength or reach capabilities. Some technologies, such as touch screens, pushbuttons and audio displays are not inherently accessible per se. They may be implemented in a way to produce an accessible solution; however, they may also reduce accessibility if implemented poorly. The following is a sample list of AT that people might use either when interacting with voting systems. For more information about the various types of AT and the impact of AT, please visit GTRI's Accessibility Assistant website at http://accessibility.gtri.gatech.edu/assistant/acc_info.php.

- Scooters/ wheelchairs
- Wands and sticks
- Sip and puff systems
- Trackballs and joysticks
- Magnifying glass or screen magnifiers
- Screen readers

Testing

A thorough formal evaluation process is missing from the guidance documents. Performance-based requirements are needed to ensure compliance and should be contained in the VVSG. Voting System Test Labs (VSTLs) are provided with minimal procedural guidance to conduct usability and accessibility testing, which is cause for concern as they do not typically employ human factors practitioners or user-centered design professionals needed to conduct or oversee usability testing. An overarching document describing how to test for accessibility and usability should be developed for test labs and vendors alike.

There are different levels of testing the accessibility of a system. At one level, a tester might evaluate the functionality, placement, and size of pushbuttons. These items can be fairly easily expressed in terms of guidelines. Oftentimes, a simple measure is taken to ensure compliance, for example, adequate space between buttons or force of a pushbutton. At another level, you must consider the overall integration of the button in the system. This is much harder to address and requires a systems perspective. For instance,

assessing the compatibility of a specified button configuration with the use of a device that was intended to be operated by touch screen may be an issue.

Three main accessibility evaluation techniques are functional assessments, checklist evaluations, and user testing. Each of these techniques provide different, yet important information about the accessibility of the system being tested. We emphasize user testing here as it is the most challenging of the three when evaluating the accessibility of voting systems. It is also the least likely evaluation technique to be utilized among VSTLs due to the variation among the sample.

A *functional assessment* may be used to determine which performance requirements are necessary to complete a specific task. For a vision requirement, the evaluator might determine that, in order to complete a menu item selection task, the user must have 20/50 visual acuity. Another example may be that the activation of a small button on a tactile control requires fine motor ability compared to a larger button. The results of the functional assessment are used in determining the focus and scope of user testing. If the device does not require hearing to operate, then there is no reason to test users who are deaf or have limited hearing. Also, if the evaluator identifies a number of instances where a particular ability is exercised, it might be useful to focus user testing on the collection of data relative to that ability. In addition, the results of the functional assessment can be used during the checklist evaluation when the item is based on a human performance measurement. For instance, when designing for someone with limited strength, an important accessibility guideline is to not require the user to apply more than a certain amount of linear force to operate the system.

Checklist evaluations may have varied goals, such as measuring general accessibility and testing conformance with guidelines, such as Section 508. When measuring general accessibility, evaluators should select a broad range of recognized design guidelines, standards and principles to include in their checklist evaluation. Three methods may be used during checklist evaluations. These include direct observation, measurement, or expert inspection. Evaluators determine which method is most suitable for the assessment and rate each item as “pass” or “fail”.

User testing is essential to ensure a system is meeting accessibility requirements. Take, for example, the evaluation of audio message content. Verification of the content itself is rather simple. However, verifying that the audio message content is *useful* and presented in such a way that facilitates the task is not so simple. This requires user testing, which is essential to successfully evaluating the accessibility of a voting system. Test requirements should specify how the certification entity (or vendor) tests the system to ensure compliance with those requirements. Audio feedback must always have a secondary feedback mechanism to support users who are deaf or hard of hearing, for example: a sound alert for the arrival of a message should also be accompanied by a system notification, haptic feedback or another visual alert.

Care should be taken to ensure that the “user population of interest” is not defined based on the types of impairments that happen to be conveniently present. Effective sampling for accessibility evaluations can be challenging—not only are there a variety of disability types to consider, but a variety of functional abilities within each disability type to consider as well. By testing a diverse and representative group of users, evaluators can generalize findings to a larger population segment with better accuracy. However, given the challenges of sampling from a diverse population it is necessary to combine data from both direct measurement and derived assessment evaluation techniques to obtain the desired

degree of confidence in the evaluation results. Gaps in our knowledge in designing for people with disabilities can be addressed by performing user testing. A typical accessibility evaluation might include representatives from the following user populations:

- Users with upper mobility impairments, including users with limited strength, limited reach, and limited fine motor control
- Users with lower mobility impairments, including users who use a manual wheelchair, a powered wheelchair, and users who use personal mobility aids such as scooters
- Users who have hearing impairments
- Users who are deaf
- Users who have visual limitations including users who are color blind, users with poor visual acuity, and users with central field obstructions
- Users who are blind
- Users who have speech impairments

Develop or modify certification procedures to address new voting technologies

GTRI queried several vendors and technology developers to better understand the issues they face when testing voting systems against the current voting system certification process. Of the entities questioned, only a handful provided feedback. An overarching idea is that current federal certification is based on a complete all-inclusive single closed system model. Implementing a unit-level testing method could potentially lower costs, such that if a discrete element needs to be replaced, the entire system would not have to go through re-certification, just the unit being replaced. Conflicting sentiments on this notion include whether or not the entire system would operate in an unchanged manner once that element has been replaced. Below are some of the vendor and technology developer recommendations for improving Chapter 3 of the VVSG 1.1.

- Chapter 3 applies to components that are used by voters for casting and counting of ballots, especially a ballot marking device (like DRE, but doesn't tabulate), and an optical scanning ballot counting device.
- Certify individual components of a voting system, not just the system as a whole.
 - Separate the guidelines specifically for Usability and Accessibility of the User Interface presented by the software of a Ballot Marking Device.
 - Separate the guidelines specifically for hardware -- physical accessibility, support for assistive peripheral devices, environmental recommendations (e.g. Ballot Marking Device (BMD) should be physically designed to be deployed on an adjustable height table).
 - Separate the guidelines specifically for usability and accessibility of a marked paper ballot created by a BMD, which contains only the contests and voter's selections or non-selections (suggest including a few model layouts within the chapter).
 - Separate the guidelines specifically for usability and accessibility of a precinct polling place opscan device's physical interaction during ballot casting.
 - Separate guidelines specifically for usability and accessibility of a precinct polling place op-scan device's non-physical interaction with the voter (e.g., User Interface (UI) for

indicating presence of over-votes, presence of under-votes, capture intent to proceed even with under-votes, etc.)

- Ch3 does not apply to types of component other than Precinct Count Optical Scans (PCOS), BMD, and for historical reasons, Direct Recording Electronic (DRE) +Voter-verified Paper Audit Trail (VVPAT). No other voting system components have U&A requirements, e.g. Central Count Optical Scan (CCOS) and EMS, due to a lack of concern about accessibility to election officials of devices and systems for election administration.
- VVSG does not apply to any type of device or software that is not a part of a current voting system product, e.g. electronic poll book (EPB); that is, today a voting system can be certified without an EPB, but you must have some device for ballot casting/counting. In this future, the footprint of certification should include ballot casting/counting, but not components that are today acquired separately from voting system products and are not certified.

The above concepts warrant further discussion among all stakeholders as certification procedures begin to be restructured. Stakeholders should include election officials, vendors, technology developers, VSTLs, as well as voting standards committee members and EAC representatives.

VVSG Recommendations

Areas of improvement were pinpointed in the VVSG and are listed out with page numbers, line numbers, and section headings in **Error! Reference source not found..** The recommended changes are intended to improve consistency, clarity, and applicability of the VVSG. Overall, the following gaps were found within the standards: vague or incomplete wording, no distinction made between accessibility and usability, and unspecified usability and accessibility guidelines.

Clear, Consistent Language

There are a number of lines within the guidelines that could be rewritten for clarity and to address all parties for whom the guidelines pertain. For instance, in Section 3.1.1.c of the VVSG version 1.1, clarification should be made regarding the privacy rights of disabled voters. The document notes that privacy requirements may be disregarded by poll workers if the voter makes a request that would violate secrecy of the ballot. Additionally, poll workers should be included more consistently as parties affected by usability and accessibility of electronic voting systems, as with Section 3.1.3.

To further improve the clarity of the VVSG, glossaries can be included that define all terms within the guidance. Terminology inconsistencies and inappropriate interchangeable use of words (i.e., “voting system,” “voting machine,” “voting system,” and “voting equipment” despite different definitions in Section 3.1.2, Special Terminology) reduces the readability of the VVSG and can alter the intended guideline goals. A full list of these definitions can be found in **Error! Reference source not found..** Averaging clear and consistent language is a suggested improvement that will benefit the entirety of the guidelines.

Usability and Accessibility Distinction

Usability is measured across all voters, including people with disabilities. For a voting system to be accessible means it should allow people with disabilities the ability to access the system in a manner that provides the same opportunities for participation (including privacy and independence) as other voters. On the other hand, a product or system is deemed 'usable by people with disabilities' if it complies with Section 508 provisions for Self Contained, Closed Products, Functional Performance provisions, and any other technical provisions that apply. A system may be accessible (physically) without being usable--or usable (to the general population) without being accessible (to those with disabilities). The goal is for the system to be both usable and accessible.

These terms need to be properly defined and outlined so that the VVSG may effectively inform voting system designers of requirements and constraints. Specifically, the VVSG should note that accessibility and usability are both necessary for a successful voting system. If a system is inaccessible for individuals with disabilities, it is not usable for all potential users. As such, accessibility testing must be performed before usability testing, and any design changes made to improve usability must uphold accessibility.

Usability Guidelines

Terms such as "effective, clear, and usable" are mentioned as requirements for design yet they are ambiguous and cannot be measured in a test environment. If operationally defined, these elements become measurable, testable. Requirements should be specific to the voting process and elaborate upon which voting experiences would allow for or prohibit effective, clear, and usable systems (e.g., error frequency). By listing measurable requirements for voting systems, inconsistencies among polling locations can be minimized and successful completion of ballots by all voters can be supported.

The VVSG should take into account the various requirements derived from the diversity of voters and polling locations. A formal process for usability testing (e.g., inclusion criteria for participants, required results) would be helpful to ensure consistency across polling locations. Specific procedures on how to perform usability testing, as well as what to test and what constitutes a "pass" or "fail" could limit error rate on-site and reduce frustrations of poll workers and voters. Sample checklists for polling place readiness would also be useful, though this may push the boundaries of VVSG scope. Samples could include checklists for voting system setup as well as polling place flow (flow of traffic), and adequate accommodations within/around the polling environment to meet ADA and HAVA requirements.

The VVSG could also include specific design recommendations for the user interface of the voting technologies that address efficiency, such as expected time required for the average voter to complete a ballot. These resources would provide perspective and communicate details of effective design solutions to voting system designers to prevent certain aspects of the voting process from being overlooked. For example, Section 3.2.6.1 refers to Timing. Some of the design recommendations should be updated to reflect improved system latency. Does it really take 5 seconds for the system to respond to a user's input? This is not an acceptable requirement since systems are responding much faster than that, and users expect faster response times. This type of lag in the system may cause more errors, as the voter

will likely keep pressing the button or press another button if that is not working according to their expectations. As technology improves, guidelines should be updated to reflect new expectations.

The VVSG should advise designers to outsource testing efforts if they feel inadequately trained or incapable of introducing bias in results. VSTLs indicated that they did not have the appropriate personnel to execute usability and accessibility testing. Due to ambiguous guidelines and inadequate test metrics, VSTLs are challenged to perform these evaluations with little or no experience. Providing a document that describes how to plan for and test for accessibility and usability should be developed to aid stakeholders in successfully executing these evaluations, as described in the Recommendations section of this document.

Accessibility Guidelines

Similar to the usability guidelines, the VVSG should include measurable metrics, specific testing requirements, and examples of design solutions for reference by designers. The VVSG should give designers a standard against which to evaluate their voting systems for accessible use in elections before they invest time and other resources into optimizing usability.

Accessibility requirements must be considered for all aspects of the voting process and should permit disabled voters comfortable access to ballots without sacrificing voter rights. For example, voters should be able to maintain their privacy when accessing a voting booth via a wheelchair. They should not need additional assistance from poll workers just because they are using an accessible system. The system should be designed such that the user can access all features necessary to complete the act of casting their vote, such as access to the audio ballot, viewability of user interface, and access to the same privacy rights as other voters. Privacy specifications should take into account accessibility concerns, such as size of privacy shields and touchscreen overlays, should take into account voters who are using wheelchairs, possibly accessing the system from a different angle (see Section 3.2.3.1, **Error! Reference source not found.**). General accessibility recommendations are included in **Error! Reference source not found.** under Section 3.3 comments.

Examples of common disabilities, both physical and cognitive, should be included in the special terminology and glossary sections of the VVSG, in addition to suggested accessibility requirements sections to better inform designers of the demographics of the voter population. Cognitive disabilities can be addressed through implementation of plain language, intuitive controls, and clear yet concise instructions for unfamiliar tasks, such as how to fix under-votes or over-votes and the required format for write-ins (i.e. first name and last name, no capitalization necessary, etc.).

Discussion

The purpose of this work was to gain a better understanding of the gaps in guidance for designers and VSTLs to provide voting systems and technologies that are accessible to everyone. In addition to rewriting a number of the VVSG standards to coincide with the modernization of the voting technologies and processes, the integration of the following recommendations would empower test laboratories and voting system designers to develop and test systems that provide accessibility and usability to all voters.

1. Create usability guidelines document and allow developers to document how usability was addressed during the design process and how it is evident in the design. (This document should teach developers how to define the target demographics.)
2. Establish a set of recommendations for how to conduct usability testing as part of the product development process. Within this set of recommendations, describe details on what evidence is acceptable proof that usability was considered during the design process.
3. Cognitive issues should be addressed with measureable goals, establishing minimums (e.g., 4th grade reading level or other suitable measure). Address ballot design issues including both hardware- and software-related elements. For example, recommend considering simple instructions for write-in candidates, correcting under and over-votes, changing font sizes and other settings, as well as accessing the audio ballot. Hardware elements, such as button sizing/shapes, tactile controls, etc. should also be considered.
4. Where paper handling is necessary, recommend providing an accessible alternative to paper. Paper is not an accessible medium; thus, guidelines regarding paper will likely not meet accessibility guidelines.
5. Guidelines for accessibility do not address power or motorized wheelchairs. Update guidelines to include motorized wheelchairs (See <http://www.resna.org/atStandards/standards.dot> for details.)
6. Recommend including plain language requirement as an overarching VVSG requirement.
7. Recommend defining usability testing separate from accessibility testing.
8. Recommend stating that accessibility testing should be performed prior to usability testing and should be separate events. Usability testing with people with disabilities is not effective if the system is not accessible. The goal of accessibility testing is to determine if all the barriers to use have been removed, while the goal of usability is to optimize the UI.

Enlisting the help of experts in voting technologies and usability, the following list of resources would be valuable in the development of portable accessible voting systems:

- National Federation of the Blind:
<https://nfb.org/purchasing-voting-machine>
- Android Accessibility Testing Checklist:
http://developer.android.com/tools/testing/testing_accessibility.html
- Making Applications Accessible:
<http://developer.android.com/guide/topics/ui/accessibility/apps.html>

- Blackberry: Accessibility Best practice: Designing accessible applications:
http://docs.blackberry.com/en/developers/deliverables/17965/Accessibility_825872_11.jsp

Future Work in Usability/Accessibility Test Methods Development

It is recommended that the usability and accessibility test methods for certification of voting system be updated. Collaboration among stakeholders may well be the best strategy for successful integration of new test methods and proper execution of the evaluations. Reviewing relevant documentation, organizing and assimilating test materials and identifying any remaining gaps in test methods for VVSG 1.0, 1.1, and 2.0 will be essential.

As a strategic initiative, usability designers and human systems integration practitioners need to conduct research designed to address any identified gaps and provide a recommendation for the revision of applicable methods. The test methods should be revised to be more usable by VSTLs. In addition, the role of VSTLs in user based usability/accessibility testing in the context of improving the VSTL test and certification process must be addressed.

Some of the test labs do not feel they have adequate staff to support usability/accessibility testing, particularly since they are only called upon during a small portion of the VS certification testing. Therefore, the testing guidelines and procedures must be revised to be easier for them to conduct the testing. By including technical definitions, usability checklists, and report templates inexperienced support staff will be able to successfully conduct the testing.

Applying Human Factors and Usability Engineering to Voting System Design

A guidance document that contains human factors and usability processes, as well as best practices would be suitable for implementation by voting system developers and VSTLs. GTRI will continue reviewing current documentation and guidance, and look to other sources of guidance on testing devices (e.g., AAMI/FDA on medical device human factors).

In addition to creating sound documentation for the process, it would be practical to evaluate the impact each approach is likely to have on voting system design and testing by developing evaluation metrics such as ease of use of the evaluation approach and the level of qualifications required of the experts performing the evaluations to determine a recommended approach. At a minimum the recommended approach document should include important technical definitions, human factors engineering design guidance, usability and accessibility evaluation instructions, as well as best practice process descriptions.

Collaboration with IEEE

Over the past year, GTRI has had a presence on the IEEE 1622 Voting Systems Electronic Data Interchange working group. On December 10th, 2013, the IEEE Standards Activity Board (SAB) approved the formation of the Voting Systems Standards Committee (VSSC). The VSSC is now an official IEEE standards committee that will manage requests for formation and publication of standards associated

with Voting Systems. The GTRI team will be involved with the work brought upon by this new committee. The VSSC will consist of various working groups constructed of a variety of stakeholders that may include election officials, manufactures, and researchers. The working groups will report to the VSSC, who will be the approval body of the working group standards, before submitting these standards to the IEEE SAB for final approval. The benefit of the VSSC is that it affords independent third party validation of the voting system standards that could potentially lead to quicker implementation of these standards by manufacturers.

To date VSSC has published one standard, "Standard for Voter Registration Data Interchange Format", and have two more in progress, "Standard for Event Logging Data Interchange Format" and "Standard for Election Results Reporting Data Interchange Format." The Event Logging standard is aimed at defining the common data interchange formats for event records for voting systems. The Voting App that GTRI has developed provided direct input into the development of this standard. For details of the event logging work conducted by GTRI, please refer to Working Paper Series #4, "A Web Based Voting Application Software Design." This event logging data afforded GTRI the opportunity to quantitatively define user experience with the voting system that assisted in the refinement of the Voting App design. The election results reporting standard focusses on the common data exchange between the capture devices to local jurisdiction, to the state level and out to the media. NIST is in the process of developing the schema and model from feedback from election officials, manufacturers, researchers, and media consultants. This common data format will ease the burden for post processing of the data if all data is in the same format. Both of these standards are set to be delivered for final approval in 2016.

On February 5-7, GTRI will be hosting the first annual VSSC meeting at the GTRI campus. The working groups will report on their yearly progress, and we will discuss future potential working group projects. In addition, the VSSC Administrative committee will meet on the last day, to plan activities and management of the group's efforts. GTRI is pleased to host this event, as it affords the opportunity for manufacturers, election officials, media and researchers to come together to foster relationships and share knowledge on the status of voting system development.

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Appendix A

Chapter 3 Comments, per Section/Subsection

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3.1 Overview

Line 4 2nd sentence: Add the word “voting” before the word “systems” so that it reads “operation of voting systems”

3.1.1 Purpose

Line 28 3.1.1.b: “Clear and usable” is not a measurable requirement. This should be explained in greater detail and testable criteria should be provided. Recommend striking “clear and usable” and adding measurable criteria. Recommend the following statement: *“The ballot shall be presented to the voter in a manner that allows voters to cast valid votes as they intended quickly, without errors, and with confidence that their ballot choices were recorded correctly.”*

Line 31 3.1.1.c: Someone with a disability may need assistance from a family member, poll worker, or other designated person, meaning this statement would be violated. Include *“unless otherwise requested by the voter”* at the end of the sentence. The sentence should read as follows: *“The voting process shall preserve the secrecy of the ballot unless otherwise requested by the voter.”*

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Line 5 There is no mention of poll workers in this sentence. Add the words “as well as between poll workers and voting systems.” So that it reads “interaction between voters and voting systems, as well as between poll workers and voting systems.”

3.1.2 Special Terminology

It appears that a list of definitions was removed from this section, based on previous draft. Not sure why they were removed, but some, if not all, should remain within the chapter for quick and easy access to the reader. The first three definitions--Usability, Accessibility, and Disability-- should be addressed at the beginning of this chapter (intro section). Remove any terms that are not actually used in this chapter. Define important terms prior to discussing in the section (definitions pulled from Glossary).

Line 11 1) Note that voting machine, voting system, and voting equipment are used interchangeably but are defined individually. Need to use consistent terminology to avoid confusion.

2) Note that some of the following terms are not currently listed in this section:

- **Usability:** Effectiveness, efficiency and satisfaction with which a specified set of users can achieve a specified set of tasks in a particular environment. Usability in the context of voting refers to voters being able to cast valid votes as they intended quickly, without errors, and with confidence that their ballot choices were recorded correctly. It also refers to the usability of the setup and operation in the polling place of voting equipment. (Recommend rep VVSG definition (currently in glossary) to read *“voters and poll workers”* vice *“specified set of users”*.)
- **Disability:** With respect to an individual; (1) a physical or mental impairment that substantially limits one or more of the major life activities of such individual; (2) a record of such an impairment; (3) being regarded as having such an impairment (definition from the Americans with Disabilities Act). Include in this definition the following: *“The most common disabilities include those associated with vision, hearing and mobility, as well as cognitive disabilities. However, beyond the commonly listed terms are hidden disabilities affecting a large portion of the*

population, including dyslexia, brain injuries, arthritis, and temporary disabilities due to an injury or medical treatment, etc.

- **Accessibility:** Measurable characteristics that indicate the degree to which a system is available to, and usable by, individuals with disabilities. The most common disabilities include those associated with vision, hearing and mobility, as well as cognitive disabilities. (Recommend removing this sentence and including it as suggested in the above definition of Disability.)
- **Accessible Voting Station (Acc-VS)** Voting station specially equipped for individuals with disabilities referred to in HAVA 301(a)(3)(B).
- **Direct-recording electronic (DRE) voting system:** Combination Voter-Editable Ballot Device (VEBD) and tabulator that gathers votes via an electronic voter interface, records voting data and ballot images in memory components, and produces a tabulation of the voting data.

The next 4 terms appear to be used interchangeably (and according to the definition used for electronic voting machine). Is there a way to be consistent with this terminology? If they are different, state them as such; if not, distinguish between them and do not use the terms interchangeably.

- **Electronic voting machine:** Any system that utilizes an electronic component. Term is generally used to refer to DREs. See also voting equipment, voting system.
- **Electronic voting system:** An electronic voting system is one or more integrated devices that utilize an electronic component for one or more of the following functions: ballot presentation, vote capture, vote recording, and tabulation. A DRE is a functionally and physically integrated electronic voting system which provides all four functions electronically in a single device. An optical scan (also known as marksense) system where the voter marks a paper ballot with a marking instrument and then deposits the ballot in a tabulation device is partially electronic in that the paper ballot provides the presentation, vote capture and vote recording functions. An optical scan system employing a ballot marking device adds a second electronic component for ballot presentation and vote capture functions.
- **Voting system:** The total combination of mechanical, electromechanical or electronic equipment (including the software, firmware, and documentation required to program, control, and support the equipment) that is used to define ballots; to cast and count votes; to report or display election results; and to maintain and produce any audit trail information; and the practices and associated documentation used to identify system components and versions of such components; to test the system during its development and maintenance; to maintain records of system errors and defects; to determine specific system changes to be made to a system after the initial qualification of the system; and to make available any materials to the voter (such as notices, instructions, forms or paper ballots).
- **Voting station:** The location within a polling place where voters may record their votes. A voting station includes the area, location, booth or enclosure where voting takes place as well as the voting machine. See voting machine: As defined in the glossary, this is not the same as voting machine.
- Editable Electronic Ballot Interfaces: **Voter-Editable Ballot Device (VEBD):** Vote-capture device that gathers votes via an electronic voter interface and allows the voter to alter previously made votes without spoiling the ballot. NOTE: "VEBD-V"

denotes the visual interface of such systems and "VEBD-A" denotes the audio interface. (In the glossary, this is referred to as 'Voter-Editable Ballot Device' or VEVD. Is this the same thing? If so, the wording needs to be consistent throughout.)

- **Electronically Assisted Ballot Marker (EBM)** VEVD that produces an executed, human-readable paper ballot as a result, and that does not make any other lasting record of the voter's votes.
- **Non-editable Ballot Interfaces:** Not in Glossary, but is a subsection in Ch 3 therefore, NEEDS TO BE DEFINED and included in the Glossary.
- **Optical scan, optical scan system:** System by which votes are recorded by means of marks made in voting response fields designated on one or both faces of a ballot card or series of cards. An optical scan system reads and tabulates ballots, usually paper ballots, by scanning the ballot and interpreting the contents. Also known as marksense.
- **Precinct Count Optical Scanner (PCOS):** Optical scanner used as a precinct tabulator. A PCOS is a special purpose scanner designed to enable the voter to feed his or her own paper ballot—one ballot at a time.
- **Precinct count voting system:** A voting system that tabulates ballots at the polling place. These systems typically tabulate ballots as they are cast and print the results after the close of polling. For DREs, and for some paper-based systems, these systems provide electronic storage of the vote count and may transmit results to a central location over public telecommunication networks.
- **Precinct tabulator:** Tabulator that counts votes at the polling place.
- **Paper record:** Paper cast vote record that can be directly verified by a voter.
- **Over-vote:** Voting for more than the maximum number of selections allowed in a contest.
- **Under-vote:** Occurs when the number of choices selected by a voter in a contest is less than the maximum number allowed for that contest or when no selection is made for a single choice contest.
- **Manual system interface:** Not in Glossary, but needs to be defined and included in the Glossary.
- **Audio-tactile interface (ATI):** Voter interface designed to not require visual reading of a ballot. Audio is used to convey information to the voter and sensitive tactile controls allow the voter to convey information communicate ballot selections to the voting system.
- **Audio ballot:** a ballot in which a set of offices is presented to the voter in spoken, rather than written, form.
- **Alternative format:** The ballot or accompanying information is said to be in an alternative format if it is in a representation other than the standard ballot language and format. Examples include, but are not limited to languages other than English, Braille, ASCII text, large print, recorded audio.
- **Alert time:** The amount of time the system will wait for detectable voter activity after issuing an alert before going into an inactive state requiring poll worker intervention.
- **Common Industry Format (CIF):** Format to be used for summative usability test reporting, described in ISO/IEC 25062:2006 "Common Industry Format (CIF) for Usability Test Reports"
- **Formative usability testing:** Evaluation of a product that solicits qualitative inputs

from evaluators. These inputs may be in the form of suggestions for improvement, ideas on alternatives, and expressions of preferences. Formative evaluations provide an opportunity to consider two or more design alternatives and to identify potential enhancements to an existing design. Recommend adding this definition to the glossary as well. (In order use “formative testing” in the following definition of summative testing, include a definition of formative testing prior, such as this.)

- **Summative usability testing**: Evaluation of a product with representative users and tasks designed to measure the usability (defined as effectiveness, efficiency and satisfaction) of the complete product. The purpose of a summative test is to evaluate a product through defined measures, rather than diagnosis and correction of specific design problems, as in formative testing.
- **Touch screen voting machine**: A voting machine that utilizes a computer screen to display the ballot and allows the voter to indicate his or her selections by touching designated locations on the screen
- **Voter inactivity time**: The amount of time from when the system completes its response until there is detectable voter activity. In particular, note that audio prompts from the system may take several minutes and that this time does not count as voter inactivity.
- **Completed system response time**: The time taken from when the voter performs some detectable action to when the voting system completes its response and settles into a stable state (e.g., finishes "painting" the screen with a new page).

Most of these terms are located in the Glossary but including them here would be advisable for quick access.

3.1.3 Interaction of usability and accessibility requirements

Line 27 Add the word “poll workers” so that it reads *“between voters/poll-workers and voting systems.”*

Line 33 This description of the interaction between usability and accessibility requirements seems confusing. Suggest clarifying usability and accessibility: for example, Access: Can users with disabilities perform all the tasks associated with usage of the voting machine? Usability: Is the machine *usable* for most people, including those disabilities or other limitations?

Line 37 Add the words “and accessibility” so that it reads *“Therefore, to determine what usability and accessibility features are required...”*

General Include a more thorough discussion of the interaction of usability and accessibility in this introduction. The section covers usability and accessibility, however, the intro does not mention disabilities at all. There seems to be a disconnect between usability and accessibility. Suggest something such as:

*“Usability, as defined in this document, is measured across all voters, including people with disabilities. For a voting system to be **accessible** means it should allow people with disabilities the ability to access the system in a manner that provides the same opportunities for participation (including privacy and independence) as with other voters.*

*A product or system is deemed ‘**usable by people with disabilities**’ if it complies with Section 508 provisions for Self Contained, Closed Products, Functional Performance provisions, and any other technical provisions that apply” . A system may be accessible (physically) without being usable or usable (to the general population) without being accessible (to those with disabilities). The goal is for the system to be both usable and accessible.”*

Currently, there is no reference to Section 508 in the VVSG. Recommend including it and referencing it where appropriate, such as here.

Page 44

3.2 General usability requirements

Line 4 What is meant by the words “high level”? As compared to a “low level.”

Line 5 What is considered to be “effective, efficient, and comfortable”? These are not testable metrics. Items such as frequency of errors and time to accomplish the voting task or sequence of tasks can produce measures of effectiveness and efficiency (e.g., sequence of activities from inserting scan card to casting the ballot).

- For effectiveness, consider statements such as *“The voting system shall produce exactly the number of errors that the user causes during testing” ...The mean frequency of errors should be X...Voters shall be protected from making errors to the maximum possible extent...”*etc.
- For efficiency, consider statements such as *“Given X number of contests on the ballot, the voting system shall complete the voting task sequence within X minutes”*...etc.
- For comfort, consider a statement such as *“Voting station will be accessible in such a way that voter can view screen or listen to audio without assuming uncomfortable positions. According to draft VVSG1.1 documentation, the EAC plans to address metrics for effectiveness, efficiency, and satisfaction in a set of high-level performance-based requirements. Include those metrics here, in this section.*

Page 45

3.2.1 General usability

According to documentation in the draft VVSG1.1 usability will be addressed by high-level performance-based requirements. These requirements are said to address metrics for effectiveness, efficiency and satisfaction. Contents are not yet included, thus some overarching recommendations have been included here that will likely duplicate that effort.

Suggest incorporating a placeholder for Usability Testing in this draft version.

Recommend including a subsection entitled “Report Requirements” and include 3.2.1a-c in that section as it directly reflects the report requirements, not general usability.

Line 19 What is meant by the word “effectively”? Recommend rewording to state, “support voters in the task of completing their ballots.” The word effectively can have various levels of meaning depending on the reader.

Line 22-23 Having the vendor do the testing and submitting a report is a good solution, however they have to follow some guidelines for the usability testing. There should be some sort of “minimum usability test” requirement that is written into the document. There should be an entire section on “summative usability tests” to define what is/is not considered to be acceptable.

Line 23 Earlier in this chapter, there is a distinction drawn between “general population and voters with disabilities” on page 43, section 3.1.3 Interaction of usability and accessibility requirements, first bullet point line 30 from the top of the page. Therefore, one could interpret Line 23 on page 45, as that the usability testing only has to be conducted on the “general population”, which a vendor could argue is an able-bodied population. Thus, recommend adding the words “and voters with disabilities” so that it reads *“systems using individuals who are representative of the general population and voters with disabilities.”* This is vague enough, so that the vendor can choose appropriate participants to include in their usability testing.

Page 46

Line 1 If voting systems developers are required to conduct realistic usability tests, reference where to find those test requirements, need to provide them with a set of test requirements and test plan templates. Need set of recommendations for conducting USABILITY TESTING (e.g., use cases, inclusion criteria for users, etc.) It is critical to include it somewhere for test labs, particularly if there are no requirements that the labs use human factors or usability experts to conduct Ch 3 testing.

Line 5-8 This discussion implies that all the VSTL must do is check that all the parts of the report are present. This does not express whether the vendor met the standards set forth. There should be an addition to the effect of “and that the usability and accessibility standards set in the VVSG have been met.” It is one thing to say the report has all its parts; it’s another to say that the quality of the material in the report meets the standards.

3.2.2 Functional capabilities

Line 18 3.2.2.a: Here new terminology is introduced “manual system.” Recommend either adding this term to the special terminology (as recommended above) or adding the following text “manual system” to line 13 so that it reads “*or a manual system interface in which...*” In this manner in which it is defined earlier and can be used.

Line 19 Instead of using the words “has no force” reword to say “*This requirement does not apply to electronic ballot interfaces...*” OR see line 20...

Line 20 Recommend deleting this entire sentence, “This requirement has no force for electronic ballot interface, since they prevent overvoting in the first place.” Does this mean that a DRE never allows the voter to select more than allowed number of votes with or without notification? This sentence just makes it seem like it happens automatically without notification. This is a problem for people with cognitive disabilities. They will not understand what is occurring, or why the system will not allow them to cast another vote on the contest, without telling them and giving them a notification about this. A DRE won’t allow them to cast the ballot, but they should still receive notification as to why they cannot cast the ballot.

Line 30 3.2.2.d: Strike the word “so” so that it reads “*system shall notify the voter.*”

Page 47

3.2.2.1 Editable electronic ballot interfaces: Define this term in Special Terminology section.

Line 11-13 This discussion box deals with over-voting, and states that there are no specifications with regard to how the system should behave. It is critical to inform people when an over-vote is occurring, and not automatically change the vote or not allow the vote to be changed without deselecting previous vote. Voters may not be aware if the system automatically deselects their previous vote. Therefore, it is recommended that notification of an over-vote always occur, when a voter is trying to vote for more than the required number of candidates. Recommend including wording such as: “*If not able to provide a visual cue (such as when the contest runs over more than one page and a new candidate is selected on a different page), provide some type of notification of the de-selection action.*” (Comments).

Line 18 3.2.2.1.b.: The Plain Language requirement should be embedded in the guideline, not in the discussion box (if it is not listed as an overarching requirement, as recommended in General

Line 21-22 3.2.2.1.c: To be consistent with other **shall** statements, recommend changing the text to read, “*The electronic ballot interface shall allow the voter to make these corrections without external assistance.*”

Additionally, what is meant by “external” assistance? Needs clarification or recommend removing “external”. Is this referring to assistance from the poll worker or friend/family

member accompanying the voter?

Page 48

- Line 2 3.2.2.1.f: Recommend adding the words “and accurately” so that the statement reads “*If the voter takes the appropriate action to cast a ballot, but the DRE does not accept and record it successfully and accurately...*” Accurately implies that the quality of the data stored by the DRE is what the voter intended.
Additionally, see 3.2.2.2.g: These two statements are similar and should be written in a consistent manner.
- Line 10 Recommend replacing the word “freezes” with “stops responding”, so that it reads “A device that stops responding when the voter...” Also, it is unclear why the taxonomy here changes and the word “device” is used. Everywhere else it’s referred to as the DRE or the system.
Recommend consistency with terminology.
- Line 14 3.2.2.1.g: Include a comma after third “record” in the sentence; change “vote the ballot” to “cast the ballot” for consistency. Would then read: “*If the electronic ballot interface generates a paper record (or some other durable, human-readable record) then that can be the official ballot or determinative vote record, then the voting system shall allow the voter to verify that record using the same access features used by the voter to cast the ballot.*”
Where paper handling is necessary, an accessible alternative shall be provided. (e.g., Automark, VVPAT)
- Line 13-16 Additionally, this voter verification requirement should flow down to the non-editable ballot interfaces as well. When the DRE prints out a paper record, that is also the official ballot, then that paper record becomes a non-editable ballot, similar to what a paper version would be.
The same standards should be applied to non-editable ballots because the same problem exists there, however instead of trusting the machine to cast their vote properly, they may be relying on an individual to fill it out correctly. As we are promoting independence in voting, this should hold true whether it is an editable or non-editable ballot.

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3.2.2.2 Non-Editable ballot interfaces

- Line 26 3.2.2.2.e: Discussion: Recommend specifying the “gray area”. One manner in which to further
– 33 quantify marginal marks might be to recommend the vendor use statistical analysis to determine what is the mean correct response of the system (as defined in the document) and then say, that 2 standard deviations from the mean is the acceptable “gray area”. This would make this requirement less vague, while still allowing vendors the ability to design to their own accord.

Page 50

- Line 3-5 3.2.2.2.g: Recommend adding the words “and accurately”, removing the word “so”, and including the phrase “and provide clear instruction as to the steps the voter should take to cast the ballot”. The statement would then read: “*If the voter takes the appropriate action to cast a ballot, but the PCOS system does not accept and record it successfully and accurately, including failure to read the ballot or to transport it into the ballot box, the PCOS shall notify the voter*” ‘Accurately’ implies that the quality of the data stored by the PCOS as the voter intended. Other recommendations ensure consistency with 3.2.2.1.f.
Additionally, consider including discussion section of 3.2.2.1.f here, as it reflects consistency across the two guidelines.

3.2.3.1 Privacy at the polls

- Line 26 3.2.3.1.b: Wording should be consistent. Strike “electronic and paper interfaces” and replace with “editable and non-editable interfaces” (or other terminology that will be consistent within document)
- Line 26 Additionally, recommend including minimum shielding requirements, such as “*Voting station curtains/shields shall be, at minimum, 72 inches from ground and shall protrude at minimum 16 inches from display.*”

Page 51

- Line 10-11 3.2.3.1.e: “The voting system shall not issue a receipt to the voter that would provide proof to another of how the voter voted.” How can the VVSG enforce this requirement? One could argue that a ballot that is completed by pencil is a “receipt” that records someone’s vote. What constitutes a receipt? The fact that the voter walks out the precinct with a piece of paper stating their votes, or that the voting system prints out a document that has their votes on it. Perhaps define what constitutes a “receipt” or consider removing this requirement.
- 3.2.3.2 No recording of alternative format usage**
- Line 18, 20 3.2.3.2a-b: What is “electronic cast voter record”? Consider rewording or clarifying the term to avoid confusion.
- 3.2.4 Voter instructions, plain language, and information presentation**
- See general comment on page 1 regarding cognitive requirements and issues.
- General Line 28 3.2.4.a: Consider including the Plain Language requirement an overarching VVSG requirement. The Plain Language requirement itself is not really testable, and thus, it should be used for consistency throughout the voting system, but additional testable requirements will be necessary for testing (e.g., Flesch-Kincaid Reading Level).

Page 52

- Line 3 3.2.4.b: Discussion box, Change “get” to “access” and remove “when needed”. Sentence should read, “*The voter should always be able to access context sensitive help from the system.*”
- Line 9 - 10 3.2.4.c: This requirement is untestable. Plain language can be biased depending on who is evaluating the language. Consider including a maximum grade reading level requirement for written instructional material (e.g., Flesch-Kincaid Reading Level) to further clarify the guidelines. Suggest, at a maximum, Grade 8 Reading Level.
- Line 15 The wording “... they are beyond the scope of this requirement” is contradictory to make line 9 a **shall**, by implementing a grade level it is more standardized and simple to test.
- Line 17-18 The guidance for implementing 3.2.4.c. requirement (Guidelines for Writing Clear Instructions and Messages for Voters and Poll Workers) is listed in the discussion section. Suggest including this reference in the wording of the requirement, not in the discussion section if it is actually a part of the requirement that vendors must adhere to.
- Line 21 3.2.4.c.i: Suggest changing “should” to “shall” in second part of sentence. Not sure why is the second part of this statement is a *should* statement. Is it not required that warnings and alerts clearly state 1) the nature of the problem, 2) whether the voter has performed or attempted an invalid operation and 3) the set of responses available to the voter?
- Line 34 3.2.4.c.iii: This requirement could easily be dealt with the grade level requirement, as opposed to leaving it open to interpretation.

Page 53

- Line 3.2.4.d: In addition to the current guideline, recommend including wording about using one

20-23 person to read entire contest in order to maintain consistency across that contest (e.g., rate of speech, frequency, pitch, etc.). In previous interviews with low vision voters, using various speakers (recordings) within the same contest was distracting.

Line 28 3.2.4.e: How do you quantify “high level of clarity and comprehensibility”?

Line 31 Additionally, in 3.2.4e: In determining the amount of content to be displayed on one page, consider including minimum font size requirements (See Section 3.2.5 for details). To ensure readability, recommend the following, *“Maintain a minimum font size of 12pt. Additionally, minimum space between lines shall be one-half character height (e.g., line spacing in points equals ½ font size in points).* Refer to MIL STD 1472G, Section 5.4.6.3.11
Additionally, the results from one of our voting test bed studies demonstrated that spreading a single contest over more than one page can be confusing and cumbersome. However, our results found that most people preferred multiple columns approach over scrolling. For extensively long contests, it’s impossible to get all the names in one column without scrolling or making the text so small that no one can read it. Multiple columns are preferred to scrolling in most instances. However, minimum spacing between columns should be considered. According to MIL STD 1472, Section 5.2.2.4.5.k, column separation not less than three spaces shall be maintained.

Page 54

Line 12 3.2.4.e.iv: Delete the following “near to where they are needed” and replace with “directly above the content for which they are being provided’. Statement would read, *“The voting system should present instructions directly above the content for which they are being provided.”* OR include discussion box as part of the guideline to clarify between general instructions and specific situations.

Line 22 3.2.4.g: This statement only refers to voters with poor reading vision. What about those with hearing impairments? If we include voters with hearing impairments (or cognitive impairments for that matter, it may be beneficial to provide pictorial symbols and icons where applicable. If using icons and other pictorial symbols to provide features that assist in the reading of ballots, recommend using universally known icons and symbols to avoid confusion and ambiguity.

3.2.5 Visual display characteristics

Line 33 The third sentence of this paragraph seems confusing. Referring back to Section 3.1.3, suggest including the following (or similar) verbiage: *“The features of the ACC-VS may also assist those not usually described as having a disability, e.g., voters with poor reading vision or somewhat limited dexterity.”*

Page 55

Line 1 3.2.5a: Flicker frequency is generally for CRT monitors, and HFDS 5.1.5.1 aims for 80-100Hz as the flicker rate.

Line 4 HFDS 5.1.8.2, Resolution for high reading speed, designates 90 pixels/inch for pixel pitch.

Line 6 *Antiglare screen surface that shows no distinct virtual image of a light source.*--Varied light sources should be prescribed. Polling places vary, as do light sources, from overhead fluorescent to ambient outdoor light streaming through windows. Common light levels include: Sunlight= 10,000ft/cd; Full Daylight=1,000ft/cd; Overcast Day=100 ft/cd. Recommend including a light source specification, for example. *“A light source shall be tested, at minimum, for sunlight conditions, such that the display is readable at 10,000 ft/cd.”*

- Line 7 Recommend setting a requirement for testing glare: HFDS 5.1.7.8 specifies that the luminance contrast of specular glare that should be less than or equal to: $1.25[(L_{\text{Min}} + L_{\text{Specular Glare}})/L_{\text{Min}}]$ HFDS 5.1.7 also has good general guidelines for diffuse glare.
“Minimum uniform diffuse ambient contrast ratio for 500 lx illuminance: 10:1”: This statement needs to be more clearly defined. Is there an existing metric for “diffuse ambient contrast ratio for illuminance”?
- General There is currently no guideline for off-axis color uniformity (HFDS 5.1.10.3) or color contrast. This is important because of variation in height or people sitting without adjusting a display angle. Recommend including the following guideline for off-axis color uniformity, based on HFDS 5.1.6.7. *“Display contrast shall not change by more than 20% when viewed at +/- 30 degrees.”* Additionally, *“Color shall be consistent and uniform within +/- 30 degree viewing angle.”*
- Line 8 Discussion section is not in correct location for discussing only flicker frequency. Recommend moving it to appropriate location or deleting this discussion box.
- Line 10 3.2.5b: Several of this items are NOT display characteristics as indicated by Section title (e.g., Audio volume and rate of speech)
- Line 23-35 3.2.5d-e: As prescribed in HFDS 5.1.8, recommend defining font size by minutes of arc, not mm. Recommend including the following:
- *10 min arc for non-critical information*
 - *MIN 16 min arc for critical information, with 22-24 min arc preferred*
 - *Easy formula that can be defined in the guidelines: Object of size **h** is at a distance **d** from the retina, the visual angle **x** is: **x = arctan(h/d)**. This is important to note, because it is based on actual viewing distance, NOT just a display size with no frame of reference*
 - *Stroke width is based off of character height, NOT just a minimum size (Stroke width 1/12 to 1/6 of character height)*
- Recommend including measurements for minimum spacing between characters (at least one stroke width, with two stroke widths preferred) and minimum spacing between lines of text (at least two stroke widths, with 50-100% of character height separation preferred) as both are VERY important to readability.

Page 56

- Line 11 3.2.5.g.: Inconsistency in wording. Initially the document defined “non-editable ballots” as paper ballots. This statement also contradicts a previous clause that stated voters are not allowed a ‘receipt’ of their vote. A paper ballot could be considered a receipt until it is submitted.
- Line 12 Additionally, replace “poor reading vision” with “low vision”.
- Line 7 3.2.5.f: There is a new dyslexia font for the internet and display systems that may be more appropriate for people with dyslexia. Include the following text in the requirement: “except where distinguishing serifs are needed”. The requirement should read: *“Text intended for the voter should be presented in a sans serif except where distinguishing serifs are needed.”*
- Line 16 3.2.5.g.i: Strike the word “may” and replace with “should” so that it reads *“The voting system should achieve legibility of...”* this is to be consistent with the format of this document.
- Line 17 Refer to HFDS 5.1.8, recommend defining font size by minutes of arc, not mm.
- Line 22 3.2.5.g.ii: Strike the word “may” and replace with “should” so that it reads *“The system should achieve legibility of paper records...”*

Page 57

- Line 1 3.2.5.h: Discussion box references the following guidance for implementing the default color coding requirement: NISTIR 7537: Guidelines for using color in voting systems. Consider including this as part of the requirement, not just a note in the discussion section.
- Line 10 3.2.5.i: Strike the word “station” and replace with “system” so that it reads “...of a voting system”. This is to maintain consistency throughout the document. If another term is preferred, use it consistently throughout the document to avoid confusion.
- Line 23 3.2.5.ii: Strike the word “station” and replace with “system” so that it reads “A voting system with an electronic display screen...” This is to maintain consistency throughout the document. If another term is preferred, use it consistently throughout the document to avoid confusion.

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3.2.6 Voter-interface interaction

Recommend including a guideline for orientation/angle of the touch screen (30-45 degrees is generally recommended).

- Line 9 3.2.6.a: This is true for 95% of the type of contests out there. However, there may be some situations where the number of candidates for a contest is so large that they cannot all fit onto one page. Scrolling, while not ideal, is still better (from a cognitive-load perspective) than multiple page contests. According to a number of studies, as well as a study we conducted at GTRI, research suggests, that users prefer single column to be multi-column presentation and scrolling to multiple pages. If clear instructions are provided, and if the only alternative is to go to multiple pages, it is recommended that scrolling be allowed. May want to add a similar statement to discussion box.
Additionally, this requirement (as a **shall** statement) may force vendors to crowd more content on one page than is acceptable. Consider rewording requirement to allow for events that would prevent acceptable readability or increase error rates by having to jump back and forth between pages.
- Line 10 Discussion box: Consider rewording first sentence to avoid vendors from cluttering the display with excessive text. Change sentence to read, “*The displayed information must fit completely within the physical screen presenting it, while meeting minimum font size and line spacing requirements.*”
- Line 16 3.2.6.b: The point of this requirement is to provide feedback to the voter, confirming their candidate selection. Therefore, strike “unambiguous” (not measurable) from the sentence and reword to read, “*The voting system shall provide feedback regarding the voter’s selection, confirming their selection, such as displaying a checkmark beside the selected option or conspicuously changing its appearance.*”
- Line 27–30 3.2.6.c.i: Suggest reducing maximum threshold for touch screen sensitive areas. Consider the following suggestions for minimum and maximum as specified in HFDS Section 9.4.2.4:
- *MIN touch panel responsive area dimensions: 0.75” square and 0.13” separation of elements (center to center distance is not informative to the designer)*
 - *MAX touch panel responsive area dimensions: 1.5” square and 0.25” separation of elements*
- General Additionally, recommend including a requirement ensuring consistency of button/target sizes. Suggest the following: “*Maintain uniform element size of text, targets, and touch areas across pages.*” Per HFDS, Section 5.2.1.7, variation should not be more than 10% regardless of its location within the display.

Page 59

3.2.6.1 Timing

- Line 3 3.2.6.1.a: HFDS 2003 (2009 update), Section 9.4.2.5 states that action feedback for touch panels should not exceed 0.25 seconds. Suggest replacing 0.5 seconds with 0.25 seconds to read, *“The initial system response time of the electronic ballot interface shall be no greater than 0.25 seconds.”*
- Line 9 3.2.6.1.b: 5 seconds to wait for feedback seems excessive between each contest. Consider voters using the audio ballot as well. They may begin selecting/deselecting due to the long wait. Suggest reducing this maximum threshold to no greater than one second.
From Usability Engineering, ch 5, 1993: www.nngroup.com/articles/response-times-3-important-limits/
- **0.1 second** is about the limit for having the user feel that the system is reacting instantaneously, meaning that no special feedback is necessary except to display the result.
 - **1.0 second** is about the limit for the user's flow of thought to stay uninterrupted, even though the user will notice the delay. Normally, no special feedback is necessary during delays of more than 0.1 but less than 1.0 second, but the user does lose the feeling of operating directly on the data.
- 10 seconds** is about the limit for keeping the user's attention focused on the dialogue. For longer delays, users will want to perform other tasks while waiting for the computer to finish, so they should be given feedback indicating when the computer expects to be done. Feedback during the delay is especially important if the response time is likely to be highly variable, since users will then not know what to expect.
- Line 24 3.2.6.1.d: Based on HFDS Section 9.4.2.5, suggest replacing 0.5 with 0.25 to read, *“If the electronic ballot interface has not completed its visual response within one second, it shall present to the voter, within 0.25 seconds of the voter’s action, some indication that it is preparing its response.”*
- Line 17-36 3.2.6.1 c-f: A requirement for auditory response is NOT specified within this set of guidelines. Recommend including auditory feedback for voters using auditory assistance. For example, system may respond with, *“please wait while the system processes your vote”* (at the same timing thresholds used for visual display feedback). This applies to 3.2.6.1c-f.

Page 60

3.2.7 Alternative languages

- General Is there a state by state requirement for VSTLS to test specific languages? Are VSTLS required to be able to test at minimum, X number of languages?
- Line 12 Remove the following sentence: *“Ideally every voter would be able to vote independently and privately, regardless of language.”* This does not impact the guidelines, therefore, is not necessary.
- Line 18 *“While the following requirements support this process, it should be noted that they are requirements only for voting systems to be certified.”* What does this mean? Suggest deleting it or providing a statement as to its relevance.
- General Where is the requirement to present the ballot aurally to accommodate voters with vision impairments and other disabilities? If it is in another section, it needs to be referenced in this chapter under usability and accessibility.
Within this section, there is no mention of using a native language speaker to present the

alternative languages aurally. Recommend including a guideline such as the following, "Alternative languages shall be presented aurally to accommodate voters with vision impairments. Additionally, alternative languages shall be recorded by native speakers of each language provided."

Line 28 *Why are "unwritten languages" also subject to this rule? If it is an "unwritten language" then it is highly unlikely that individuals who speak that language would be able to understand the language if it was written on the visual display. It makes sense for an audible system, but does not make sense for a visual system.*

General Again, referring back to the definition section, suggest providing a clear distinction between a "voting system" and an "electronic ballot interface." In some places within the document, the words "voting system" are implied to be the "electronic ballot interface" and in other place it is not. This may lead to confusion on part of the reader.

Page 61-62

3.2.8 Usability for poll workers

Line 2, 3.2.8a: Poll worker interfaces do not have to meet the standards that voter-interaction pages
pg 62 must meet. Why are vendors only required to adhere to Section 3.2.4 "Cognitive Issues". Why must they not adhere to Section 3.2.5-3.2.6 as well?

Page 62

3.2.8.1 Operation

Line 16 Need to break out the instructions, and put a bullet point after "and" so that "*routine hardware operations...*" has its own bullet point. Need to add the word "perform" to the start of that bullet point so that it reads "*perform routine hardware operations...*"

Line 20 The requirement "reasonably easy for the typical poll worker to learn, understand and perform" is not quantifiable without performing human subjects testing. There is no definition of what a "typical poll worker" is. If this is going to be a **shall** requirement, then it is necessary to at least specify what constitutes a "typical poll worker." For example, *Characteristic poll workers should be able to complete all tasks associated with their responsibilities after completing the required training within the time specified by the manufacturer without requiring assistance.*

Page 64

3.3 Accessibility requirements

Line 32 Be consistent in usage of accessible voting station and the more global term of "voting system". Currently, this is not consistent.

General Is it correct to make the assumption that, in this document, usability of a voting system by people with disabilities is a considered a SUBSET of the general concept of usability? If so, that is not clearly stated in Chapter 3.

General Is the intent of the VVSG to apply these accessibility requirements to general population voting systems, or only to the single Acc-VS required at each polling location?

Page 65

3.3.1 General accessibility

State the goal of this section. Suggest something like this: "*Goal: Ensure voters with disabilities can vote independently from the time they enter the voting booth until they cast their ballot.*"

Line 24-27 3.3.1.b: This sentence does not follow the "if/then" theme with which all other **shall** statements are worded. Propose for consistency that it says the following, "*When the*

provision of accessibility for the Acc-VS involves an alternative format for ballot presentation, then all information shall be presented in the alternative format to non-disabled voters, including instructions, warnings, error and other messages and contest choices.”

Line 29-30 3.3.1.c: The wording format is inconsistent. Suggest *“Personal assistive devices of the voter shall not be necessary to operate the Acc-VS correctly.”*

Page 66

Line 18 3.3.1.e: Change “vote the ballot” to *“cast the ballot”* for consistency. Where paper handling is necessary, an accessible alternative shall be provided. (e.g., Automark, VVPAT)

Line 27 Change “poor vision issues” to “low vision issues” for consistency.

Page 67

3.3.2 Enhanced visual interfaces

Line 14 Sentence references “Requirement 3.2.5.j” for use of color combinations with good contrast. No such requirement exists in VVSG 1.1 draft for public comment. Perhaps this reference is now 3.2.5.h.ii, where high contrast mode shall use at least one of the following color combinations...black text on a white background, white text on a black background, yellow text on a black background, light cyan text on a black background.

Line 23 3.3.2.a: This paragraph, particularly the 2nd sentence, does not fit with remainder of this section. Requirements for vendor report submissions should be included in a separate section and not within the design requirements. Recommend moving this sentence to a more appropriate location (such as recommended in Section 3.2.1 of this comments document).

Page 68

Line 17 The statement “This feature may also assist voters with cognitive disabilities” is an open-ended general comment. How does it help people with cognitive disabilities?

3.3.3 Audio-tactile interfaces

Line 19 Intro paragraph: This paragraph also applies to 3.3.2.d. Recommend moving intro paragraph to 3.3.2 intro section. Additionally, recommend providing a definition of Audio-tactile interfaces and their uses at the beginning of this section.

Line 24 3.3.3.a: This paragraph, particularly the 2nd sentence, does not fit with remainder of this section. Requirements for vendor report submissions should be included in a separate section and not within the design requirements. Recommend moving this sentence to a more appropriate location (such as recommended in Section 3.2.1 and 3.3.2.a of this Comments document).

Line 35 3.3.3.b: Discussion box: Examples of settings and options include “volume control and repetition”. How is repetition a setting or an option? Describe how it works either here or under Requirement 3.3.3.b.ii.

Page 69

Line 10 3.3.3.b.ii: Describe a repetition capability. Assume this would be different from a “rewind” concept, but it needs to be better described here.

Line 14 3.3.3.b.iii: If voter can pause and resume audio presentation, this will need to be synchronized with the display presentation. Suggest rewording similar to the following, *“The ATI shall allow the voter to pause and resume the audio presentation in synchronicity with the electronic display presentation.”* This allows voters who use the audio as support to the electronic display to be able to both see and hear the same presentation of information synchronously.

Line 27 3.3.3.c: Consistency in wording. Change “Voting Station” either to “Voting System” or “Acc-VS” since these are defined terms.

Page 71

Line 29 Reference to Requirement 3.2.5c should actually be 3.2.6c.

Page 72

3.3.4 Enhanced input and control characteristics

Line 4 3.3.4.a: This paragraph does not fit with remainder of this section. Requirements for vendor report submissions should be included in a separate section and not within the design requirements. Recommend moving this sentence to a more appropriate location (such as recommended in Section 3.2.1 of this comments document).

Line 10 3.3.4.b: Reword this requirement to be consistent with others in the document. It should read, *“This jack shall allow only switch data to be transmitted to the voting system.”*

Page 73

3.3.5 Design for mobility aids

Line 5 Include motorized or power wheelchair requirements where applicable. (See General comment on Page 1 of this document.)

Page 74

3.3.5.1 Controls within reach

Line 12 3.3.5.1.iv: Consider power wheelchair clearances in the requirements throughout this section.

Page 75

3.3.6 Enhanced auditory interfaces

Line 6 3.3.6.c: Strike “substantially”. This needs to be more specific. Recommend including specific degradation limits. Recommend rewording to say, *“No voting device shall cause electromagnetic interference with assistive hearing devices that would degrade the performance of those devices by more than 10%.”*

Page 151

7.8.6 VVPAT Usability

Line 15 As prescribed in HFDS 5.1.8, recommend defining font size by minutes of arc, not mm. (See subsection 3.2.5d-e comments for details).

Intro paragraph: This paragraph also applies to 3.3.2.d. Recommend moving intro paragraph to 3.3.2 intro section. Additionally, recommend providing a definition of Audio-tactile interfaces and their uses at the beginning of this section.