

National Institute of Standards and Technology:  
Work Supporting the Roadmap for Usability and Accessibility  
of Future Voting Systems

## **Draft Report**

# **Organizing Requirements by Principles: Exploring a revised structure for usability and accessibility in the VVSG**

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## Introduction

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Since its adoption in 2005, the Voluntary Voting System Guidelines (VVSG) have helped ensure better usability and accessibility of elections by providing system designers and voting officials with requirements for voting systems.

These requirements in Chapter 3, are separated into two sections:

- Section 3.2 has usability requirements for all voting systems.
- Section 3.3 has additional requirements for accessibility.

In Chapter 7-Security Requirements, there are three requirements for VVPAT records. It might be appropriate to move these into Chapter 3 as they refer to requirements in Section 3.2 and 3.3.

- 7.8.5 Preserving Voter Privacy
- 7.8.6 VVPAT Usability
- 7.8.7 VVPAT Accessibility

Voting systems intended to be used as the accessible voting system mandated in the Help America Vote Act must meet all of the requirements of both sections 3.2 and 3.3.

This document begins to explore ways to meet Objective 5.1 of the *NIST Roadmap for Usability and Accessibility of Future Voting Systems*<sup>1</sup> which calls for the chapter to be re-organized into a single set of requirements, creating a universal standard. The goal of a universal standard is to meet the usability and accessibility needs of people with the widest range of capabilities in a single product, rather than by creating alternatives. An example of this from architecture is the difference between a separate entrance with a ramp, or having the main access to the door be accessible.

This objective “acknowledged the overlap between usability and accessibility, especially for flexibility for voter preferences such as choice of text size and contrasts, or audio reading of text, which benefits many voters.”

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<sup>1</sup> The most recent version is available from <http://civicdesign.org/projects/roadmap/>

This work began with an analysis of the current VVSG 1.1. The requirements in the VVSG were originally written for electronic interfaces, called “voting machines” in many of the requirements. The scope quickly expanded to include additional features of election systems such as paper ballots, VVPAT records, and telephone-based voting system. These new areas for requirements were sometimes grouped in their own section, such as the VVPAT requirements, which are in Chapter 7 of the VVSG.

Although there is often a need for separate detailed requirements to address specific interactions (such as paper or electronic displays), the structure of the standard by interface style or feature makes it harder to understand the principles and broader guidelines that the requirements support.

This document proposes a structure for the chapter based on the principles for accessibility in the Web Content Accessibility Guidelines (WCAG 2.0) and presents a first draft of how the requirements now in Chapter 3 could be reorganized into this structure.

This is exploratory work and will require review and discussion by the Election Assistance Commission (EAC), the Technical Guidelines Development Committee (TGDC), the NIST-EAC Public Working Groups, and NIST. We present this report as input for this discussion.

## Project Goals

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The purpose of this project was to explore ways to organize the VVSG that would meet Objective 5.1 and 5.2 of the *NIST Roadmap for Usability and Accessibility of Future Voting Systems*.

- Objective 5.1 - Apply both usability and accessibility to all systems in VVSG and other guidance.
- Objective 5.2 - Simplify guidance by focusing on principles.

To meet these objectives, we are seeking to identify a new structure that would allow for the two sections of the current Chapter 3 to become a single set of requirements with clear requirements for accessibility. In the first phase, described in this report, we are creating a proof-of-concept new structure without having to alter the content of the requirements themselves. The idea was to enhance the guidelines not by rewriting them, but by framing them in an alternative hierarchical structure that provides greater support and direction for the user.

Our goals for this exploration are to:

- Support universal design<sup>2</sup> that will make all voting systems accessible.
- Clearly identify requirements necessary to meet legal accessibility requirements in HAVA and the ADA.
- Make the VVSG more usable by organizing the requirements around clear principles.
- Show how detailed requirements and other guidance can be organized to meet these principles.

### **Benefits of universal design**

Encouraging the use of universal design in voting systems has the potential to benefit all voters. Systems that are more accessible are often inherently more usable, and systems designed with strong usability can often be easier to use for people with disabilities.

When all voters use a single accessible system, voters who would not normally opt for an accessible system can still make use of its features

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<sup>2</sup> The Center for Universal Design at NC State University says that “Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. The intent of universal design is to simplify life for everyone by making products, communications, and the built environment more usable by as many people as possible at little or no extra cost. Universal design benefits people of all ages and abilities” [http://www.ncsu.edu/ncsu/design/cud/about\\_ud/about\\_ud.htm](http://www.ncsu.edu/ncsu/design/cud/about_ud/about_ud.htm)

(e.g. larger text). Conversely, allowing voters with disabilities to use the same system as everyone else may provide greater voter access, as poll workers do not always know how to set-up the accessible systems, and may not have them ready when a voter with disabilities arrives.

### **The need for clear accessibility requirements**

Although the human factors design requirements for usability and accessibility are closely related, accessibility has a distinct legal meaning. Because of this, it is important that requirements for meeting legal accessibility regulations are also clearly identified.

### **Organizing the chapter around principles**

The VVSG's extensive list of requirements can be cumbersome and difficult to use for those with limited technical experience or knowledge of human factors. By organizing these requirements around basic principles, the specifications are put into context, making them easier to understand.

## Our Process

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To better inform our decisions about how to best restructure the VVSG, we turned our attention to another well established set of accessibility guidelines: the Web Content Accessibility Guidelines (WCAG) 2.0<sup>3</sup> (see appendix for full WCAG 2.0 guidelines). WCAG became a full recommendation of the W3C in 2008, so it is a well-known and long-standing set of requirements. The U.S. Access Board is currently refreshing the Section 508 accessibility guidelines and proposes to incorporate WCAG 2.0 Level A and AA in the updated regulation.

After analyzing the VVSG 1.1 (approved March 31, 2015)<sup>4</sup> and WCAG 2.0 guidelines in detail, we began the following process to develop a new organizational structure:

- Understand the principles that form the structure of WCAG 2.0
- Identify the principles underlying the current VVSG Chapter 3 requirements
- Match WCAG success criteria to existing VVSG requirements

### The structure of WCAG 2.0

WCAG 2.0 is organized in a strict hierarchical structure of:

- *Principles* – four basic principles that make up the foundation of web accessibility
- *Guidelines* – basic accessibility goals within each principle
- *Success Criteria* – testable criteria to be used for conformance testing for each guideline, with three levels of conformance: A, AA, AAA (highest)

The four guiding principles are that web content must be:

- **Perceivable**  
Ensuring that users can either see or hear the content by making text easier to read, and by providing equivalent alternatives to non-text content.
- **Operable**  
Ensuring users are able to navigate to and access all content.
- **Understandable**  
Ensuring that content, and the process of navigating to or interacting with content, is clear, unambiguous, and comprehensible.

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<sup>3</sup> <http://www.w3.org/TR/WCAG20/>

<sup>4</sup> <http://www.eac.gov/assets/1/Documents/VVSG.1.1.VOL.2.FINAL.pdf>

- **Robust**  
Ensuring content is compatible with current and future user agents, such as assistive technologies.

The organization of WCAG 2.0 allows its users to focus on achieving these accessibility principles, while providing them with the necessary guidelines and success criteria to help meet these goals.

### **Principles in the VVSG chapter 3**

Chapter 3 of the VVSG also contains principles that motivate its goals and requirements. The VVSG's three basic principles, in Section 3.1.1-Purpose, are:

**1. All eligible 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 polling place, instructions on how to vote, initiating the voting session, making ballot selections, review of the ballot, final submission of the ballot, 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.

### **Comparing WCAG and VVSG principles**

Though WCAG and the VVSG aim to achieve the same overall goal of accessibility for people with disabilities, the principles behind the two sets of requirements differ, both in their purpose and structure.

WCAG uses broad principles and guidelines to provide general guidance for websites. These principles inform WCAG's hierarchical structure, so that each requirement becomes a method of achieving the goals inherent to that principle. Unlike WCAG, the VVSG's principles are used as an



introduction to the goals of the requirements, and are not an active part of the document's structure or guidance.

Although written for the Web, WCAG's broad principles are also applicable to a wide range of systems and interactions<sup>5</sup> and are relevant to the VVSG principle concerning a voter's ability to mark and cast a ballot. However, the VVSG's principles specifically address voting issues, such as privacy and secrecy, and are not as widely applicable.

However, the WCAG POUR principles provide a good organizing structure that addresses the different challenges to usability and accessibility, and, in many cases, the guidelines address the same issues covered in the VVSG requirements. The biggest difference is at the level of the detailed requirements and success criteria, largely because of differences in the technologies the two standards address.

### **Matching WCAG success criteria to VVSG requirements**

The next step in our process was to map WCAG's success criteria to the VVSG requirements to see how well they matched up. As we expected from the analysis of the principles:

- The VVSG includes many requirements specific to voting that are not in WCAG.
- The VVSG does not have requirements for WCAG success criteria that are written specifically for the web platform and how programs interact with assistive technology.
- The VVSG requirements for display and interaction often match WCAG success criteria either by addressing the same issue, or by having the same requirements.
- Though there are many requirements that address the same barrier, WCAG success criteria provide more general guidance, whereas VVSG requirements are detailed and specific.

### **Different approaches. Same goal.**

The differences between these guidelines stem from their unique approaches to achieving accessibility, as well their underlying assumptions concerning technology and the context of its use.

The VVSG strives to create a testable standard for accessibility through the use of detailed requirements. These requirements specifically apply to stand-alone, self-contained systems.

The WCAG applies to web sites and web applications that rely on Internet platform protocols, where users generally have access to their own

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<sup>5</sup> The Web Accessibility Initiative (WAI), which manages WCAG, has several projects that demonstrate the applicability of WCAG to general information and computer technology (ICT)

personal assistive technology. As such, WCAG takes a more general self-certification approach to creating accessible sites.

Yet despite their differences, WCAG and the VVSG do share the same basic goal of ensuring that people can use a system to complete a task with efficiency and accuracy.

By organizing the VVSG in line with the WCAG accessibility standard, we can make it easier for developers, testers, election officials, and voter advocates to understand the goals of the VVSG requirements.

### **Requirements for next generation voting systems**

As next generation voting systems begin to use off-the-shelf (COTS) devices with standard software platforms, the VVSG must also be able to set requirements for voting systems on a variety of platforms. If, for example, online ballot marking systems are seen as part of a voting system to be certified under the VVSG, they must work in this more open technological environment.

In order to address this issue in our revised structure, rather than proposing that the VVSG write separate requirements, we suggest that it incorporate WCAG 2.0 (or the anticipated update to Section 508) by reference, so that that any voting system that uses a browser-based interface with HTML or native apps, will also have to meet WCAG AA guidelines.

## Future Work

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This document is a first draft, a first step to address Objective 5.1 of the *NIST Roadmap for Usability and Accessibility of Future Voting Systems*. This is an exploratory study, additional work is needed to truly understand the feasibility and impact of restructuring the VVSG into a single set of voting system requirements.

The next steps for this project include:

- Carefully reviewing the requirements to ensure they are accurately presented.
- Reviewing the structure to ensure that it makes sense to those who will use it.
- Potentially reorganizing the requirements under each guideline for maximum clarity.
- Designing the standard so that it is easy to read and understand.
- Figuring out how to either place or cross-reference requirements that seem to belong to more than one principle.
- Finding the best way to present accessibility legal requirements that have approximate matches within the VVSG.

Achieving these next steps, will require feedback from a variety of sources, such as the newly-formed NIST-EAC Public Working Groups. Those who are familiar with the VVSG and have worked with it intensively will be critical in this feedback, as will those coming to voting system standards for the first time.

Keeping with the work plan suggested by the TDGC, we are not looking to start over in regards to the VVSG, but rather make the document more usable through re-organization.

## Future Work

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## Proposed Structure for VVSG Chapter 3

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In this exploration, we re-organized the requirements in the VVSG into a structure that starts with principles and groups the detailed requirements under them, organized by guidelines that explain their goal in supporting voters.

The proposed structure includes:

- Principles
- Guidelines
- Requirements

### Principles

The principles proposed in this document are drawn primarily from the 3.1.1 *Purpose* and 3.2.1 *General Usability* sections of the VVSG, which are derived from HAVA legal requirements and set the highest goals for the chapter. They are:

- **Equivalent and consistent:** All voters have access to mark and cast their ballot without discrimination.
- **Cast as marked:** Ballots are cast as marked, both secretly and privately.
- **Marked as intended:** Ballots are presented in a clear, understandable way, and is operable by all voters.
- **Usability testing:** Meets performance standards for usability and accessibility.
- **Meet web accessibility standards:** Browser-based systems meet web accessibility standards, in addition to voting standards.

### Guidelines

Much like WCAG guidelines, here we use guidelines as broad statements of goals that meet the principles.

### Requirements

Requirements provide specific and testable statements that are to be followed in order to meet the required guidelines.

All VVSG usability and accessibility requirements from Chapter 3 and Chapter 7 have been included in the list below. While the requirements are summarized for the sake of brevity, we are not proposing, in this white paper, to alter the content of the requirements in any way.

For any VVSG requirement that had an approximate match in the WCAG guidelines, the corresponding success criteria number is located in the column to the right of the VVSG requirement number. Few requirements matched exactly across WCAG and the VVSG, (in some cases the VVSG accessibility requirement actually exceeded that of the WCAG requirement) so we instead matched requirements when they addressed the same accessibility need.

In instances where a VVSG requirement did not have a match in WCAG, but had an appropriate match in another well-known accessibility standard (i.e. current Section 508 standards or ADA Accessibility Guidelines), we listed the relevant requirement in place of a WCAG test criteria.

This section presents the analysis for principles, guidelines, and the organization of the requirements in the VVSG. It is in two sections.

- **Principles and Guidelines**

The proposed principles and guidelines for usability and accessibility in the VVSG are listed on the following page

- **Requirements**

The pages after that show the analysis of how the requirements of VVSG 1.1 could be organized to support these principles and guidelines.

# Principles and Guidelines

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## **PRINCIPLE 1: EQUIVALENT AND CONSISTENT**

**All voters have access to mark and cast their ballot as intended, regardless of their abilities, without discrimination.**

- 1.1: Provide voters with a consistent experience of the voting process in all modes of voting
- 1.2: Provide voters with equivalent information and options in all modes of voting.

## **PRINCIPLE 2: CAST AS MARKED**

**Ballots are cast as marked, both secretly and privately.**

- 2.1: The voting process shall preserve the secrecy of the ballot.
- 2.2: The voting system must ensure that ballot selections, interface options, voter identity and information about voters are kept private.
- 2.3: The voting system supports the voter in marking the ballot accurately
- 2.4: The voting process helps voters avoid errors that invalidate their ballot, including blank ballots, undervotes, overvotes, and marginal marks.

## **PRINCIPLE 3: MARKED AS INTENDED**

**Ballots are presented in a clear, understandable way, and is operable by all voters.**

- 3.1: Perceivable - The default system settings for displaying the ballot work for the widest range of voters, and voters can adjust settings and preferences to meet their needs.
- 3.2: Operable - Voters and poll workers must be able to use all controls accurately, and all ballot changes are made with the direct control of the voter.
- 3.3: Understandable – Voters can understand all information as it is presented.
- 3.4: Robust - The voting system's hardware and accessories support usability and accessibility requirements while protecting voters from harmful conditions.

## **PRINCIPLE 4: TESTED FOR USABILITY**

**Meets performance standards for usability and accessibility.**

- 4.1: Conduct summative usability tests using a wide range of voters and poll workers, including those with and without disabilities.

## **PRINCIPLE 5: MEETS WEB ACCESSIBILITY STANDARDS**

**Browser-based systems meet web accessibility standards in addition to voting standards.**

- 5.1: When a voting system uses standard web software platforms (HTML or native apps), the voting system meets all requirements in VVSG 2.0 Level AA any applicable requirements in the VVSG.

## Requirements Analysis

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In this analysis, VVSG requirements under each guideline are listed in the order of their paragraph number to make it easier to see their source in VVSG 1.1.

### PRINCIPLE 1: EQUIVALENT AND CONSISTENT

All voters have access to mark and cast their ballot as intended, regardless of their abilities, without discrimination.

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Requirement	VVSG	Accessibility Standard
All voters have access without discrimination	3.1.1.a	[ voting specific ]
Voting is accessible to people with disabilities	3.1.1.a.i	[ voting specific ]

#### GUIDELINE 1.1: Provide voters with a consistent experience of the voting process in all modes of voting

Requirement	VVSG	Accessibility Standard
Presentation in all languages supported	3.2.7.a	[ voting specific ]
Records support auditing in English	3.2.7.a.ii	[ voting specific ]
Acc-VS integrated into complete voting system	3.3.1.a	[ voting specific ]
If a Acc-VS system produces a paper ballot, the Acc-VS needs to be able to read it	3.3.1.e	[ voting specific ]
All modes must have same capabilities as visual interface	3.3.3.b.i	[ voting specific ] Related to 508: 1194.31
Provide ballot activation for blind voters	3.3.3.d	[ voting specific ] Related to 508: 1194.31
Provide ballot submission/verification for blind voters	3.3.3.e	[ voting specific ] Related to 508: 1194.31
Mode of non-manual input equivalent to tactile mode	3.3.4.b	[ voting specific ] Related to 508: 1194.31
Documentation of access functions	3.3.1.a.i	[ voting specific ]
VVPAT in same language as ballot	7.8.6.c, i, ii	[ voting specific ]
VVPAT meets all accessibility requirements	7.8.7.a	[ voting specific ]



**GUIDELINE 1.2: Provide voters with equivalent information and options in all modes of voting.**

<b>Requirement</b>	<b>VVSG</b>	<b>Accessibility Standard</b>
Verify paper record with access features	3.2.2.1.g	[ voting specific ]
Paper records support low vision	3.2.5.g	[ voting specific ]
Present all content/warnings in other languages	3.2.7.a.ii	[ voting specific ]
Acc-VS must also present all instructions, warnings, error and other messages, and contest choices to voter	3.3.1.b	[ voting specific ] Related to 508: 1194.31
Audio synchronized to visual display with same information	3.3.2.c	[ voting specific ] Related to 508: 1194.31
Audio synchronized to visual display	3.3.2.c.ii	[ voting specific ] Related to 508: 1194.31
All sound cues accompanied by visual cue	3.3.6.b	508: 1194.31.c
VVPAT additional requirements	7.8.6.a	[ voting specific ]
VVPAT provides accessibility for visual impairments and non-written language	7.8.7.b	[ voting specific ]

## PRINCIPLE 2: CAST AS MARKED

### Ballots are cast as marked, both secretly and privately.

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GUIDELINE 2.1: The voting process shall preserve the secrecy of the ballot.

Requirement	VVSG	Accessibility Standard
Protect secrecy of the ballot	3.1.1.c	[ voting specific ]
No receipt that provides proof of how voted	3.2.3.1.e	[ voting specific ]
No recording of use of alternative language	3.2.3.2.a	[ voting specific ]
No recording of access features	3.2.3.2.b	[ voting specific ]
VVPAT Secrecy on spooled paper	7.8.5.b	[ voting specific ]
VVPAT no recording of order of voters	7.8.5.c	[ voting specific ]
VVPAT unique identifies not memorable	7.8.5.f	[ voting specific ]
VVPAT protected as a ballot box	7.8.5.g	[ voting specific ]

GUIDELINE 2.2: The voting system must ensure that ballot selections, interface options, voter identity and information about voters are kept private.

Requirement	VVSG	Accessibility Standard
No ability to determine content, with or without voter's cooperation	3.1.1.c.i	[ voting specific ]
Prevent other from determining content of ballot	3.2.3.1.a	[ voting specific ]
Privacy in marking and casting ballot	3.2.3.1.b	[ voting specific ]
Audio audible only to voter	3.2.3.1.c	508: 1194.25.e
Warnings preserve privacy of voter and confidentiality of ballot	3.2.3.1.d	[ voting specific ]
Voter can disable visual or audio output	3.3.2.c.i	[ voting specific ] or related to WCAG 1.1
VVPAT preserve voter privacy during recording, verifying, auditing	7.8.5.a	[ voting specific ]
VVPAT stored to preserve privacy	7.8.5.d	[ voting specific ]
VVPAT preserves privacy of alternative languages	7.8.5.e	[ voting specific ]

## GUIDELINE 2.3: The voting system supports the voter in marking the ballot accurately

Requirement	VVSG	Accessibility Standard
Each ballot shall accurately capture selections made by the voter	3.1.1.b	[ voting specific ]
Support voters in completing their ballots	3.2.1.a	[ voting specific ]
The voting system does not contribute to errors	3.2.1.b	[ voting specific ]
Voting system provides instructions	3.2.3.a	[ voting specific ]
Ballot designed with clarity	3.2.4.e	[ voting specific ]
No contest across 2 pages or columns	3.2.4.e.i	[ voting specific ]
Indicate maximum number of choices in a contest	3.2.4.e.ii	[ voting specific ]
Consistent relationship between name and voting mechanism	3.2.4.e.iii	[ voting specific ]
Provide unambiguous feedback on voter choices	3.2.6.b	[ voting specific ]
Prevent selection of more than allowed (overvotes)	3.2.2.1.a	WCAG 3.3.1, 3.3.3-4

## GUIDELINE 2.4: The voting process helps voters avoid errors that invalidate their ballot, including blank ballots, undervotes, overvotes, and marginal marks.

### Requirements for Notification and Warnings

Requirement	VVSG	Accessibility Standard
Notification of casting	3.2.2.d	WCAG 3.3.1, 3.3.3-4
Screen: Notification of failure to cast	3.2.2.1.f	WCAG 3.3.1, 3.3.3-4
PCOS: Notification of failure to cast	3.2.2.2.g	WCAG 3.3.1, 3.3.3-4
PCOS: Notification of blank ballot	3.2.2.2.c	WCAG 3.3.1, 3.3.3-4
Notification of effect of overvoting	3.2.2.a	WCAG 3.3.1, 3.3.3-4
PCOS identifies number of overvoted contests	3.2.2.2.a	WCAG 3.3.1, 3.3.3-4
PCOS identified specific contests (optional)	3.2.2.2.b	WCAG 3.3.1, 3.3.3-4
Provide feedback on undervoted contests	3.2.2.1.b	WCAG 3.3.1, 3.3.3-4

### Requirements for Error Correction

Requirement	VVSG	Accessibility Standard
Can cast an undervoted ballot without correction	3.2.2.b	WCAG 3.3.1, 3.3.3-4
Allow correction of a undervote or overvote	3.2.2.c	WCAG 3.3.1, 3.3.3-4
Opportunity to correct	3.2.2.1.c	WCAG 3.3.1, 3.3.3-4
Allow to change a vote within a contest	3.2.2.1.d	WCAG 3.3.1, 3.3.3-4
PCOS allows voter to correct ballot	3.2.2.2.d	WCAG 3.3.1, 3.3.3-4
Correct or submit ballot with marginal marks	3.2.2.2.e, i-iii	WCAG 3.3.1, 3.3.3-4

## PRINCIPLE 3: MARKED AS INTENDED

**Ballots are presented in a clear, understandable way, and is operable by all voters.**

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GUIDELINE 3.1: Perceivable - The default system settings for displaying the ballot work for the widest range of voters, and voters can adjust settings and preferences to meet their needs.

Requirement	VVSG	Accessibility Standard
Ballot shall be presented to the voter in a manner that is clear and usable	3.1.1.b.i	WCAG 1

### Requirements for Custom Settings

Requirement	VVSG	Accessibility Standard
Set customization to default between participants	3.2.5.b	[voting specific]. Related to 1194.25.f
Voter should be able to reset their own customized settings	3.2.5.c	[voting specific]. Related to 1194.25.f
Selection of languages	3.2.7.a.i	[ voting specific ]

### Requirements for All Visual Interfaces

Requirement	VVSG	Accessibility Standard
Text contrast ratio no less than 10:1 (optical scan)	3.2.2.2.f.ii	WCAG 1.4.3 (exceeds)
Minimum contrast for figure to ground of 10:1	3.2.5.h.i	WCAG 1.4.3 (exceeds)
Use color in conventional ways	3.2.4.f	WCAG 1.4.1
Text displayed in a readable font (as specified in 3.2.5.d.i-iii)	3.2.5.d	WCAG 1.4.8 (AAA)
Use sans serif font	3.2.5.f	n/a
No information communicated with color alone	3.2.5.i	WCAG 1.4.1

### Requirements for Electronic Visual Interfaces

Requirement	VVSG	Accessibility Standard
Must show all information in a minimum of two text sizes (as specified in 3.2.5.e.i-ii)	3.2.5.e	WCAG 1.4.4
High contrast view either as initial screen or option	3.2.5.h.ii	WCAG 1.4.3 and 1.4.6
Voters can adjust color, contrast	3.3.2.a	WCAG 1.4.8

Minimum two contrast/color options	3.3.2.a.i	WCAG 1.4.3 and 1.4.6
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#### Requirements for Print Interfaces

Requirement	VVSG	Accessibility Standard
Printed ballot available in at least two font sizes	3.2.5.g.i	WCAG 1.4.4, 1.4.8 (AAA)
System may provide optical or electronic magnification for paper ballots	3.2.5.g.ii	WCAG 1.4.8 (AAA)
VVPAT font sizes	7.8.6.b	WCAG 1.4.4, 1.4.8 (AAA)

#### Requirements for Audio Interfaces

Requirement	VVSG	Accessibility Standard
Initial volume between 60 and 70 dB SPL	3.3.3.c.iv	Related to 508: 1194.25.e and f
Voter can control volume	3.3.3.c.v	WCAG 1.4.2, 508: 1194.25.f
System reproduces audible speech frequencies	3.3.3.c.vi	WCAG 1.4.2
Audio comprehensible w/ good hearing and language skills	3.3.3.c.vii	Related to 508: 1194.25.f
Voter can control rate of speech	3.3.3.c.viii	n/a
Acc-VS shall incorporate audio features listed under Requirement 3.3.3.c	3.3.6.a	[ voting specific ]
For voters with low reading proficiency in English, use audio interface requirement 3.3.3 b	3.3.8.a	[ voting specific ]

#### Requirements for Mechanical or Tactile Controls

Requirement	VVSG	Accessibility Standard
Controls differentiate by shape and color	3.3.2.b	WCAG 1.3.3
Mechanical keys tactilely discernable w/o activation	3.3.3.f	508: 1194.23.k(1)
Status of toggle keys discernable through touch or sound	3.3.3.g	508: 1194.23.k(4)

#### Requirements for Alternative Languages

Requirement	VVSG	Accessibility Standard
Allow voter to change language and preserve votes at any time. Present language name/label in native language.	3.2.7.a.i	[ voting specific ]
Record all voter records in English	3.2.7.a.iii	[ voting specific ]

**GUIDELINE 3.2: Operable - Voters and poll workers must be able to use all controls accurately, and all ballot changes made with the direct control the voter.**

**Requirements for All Interface Controls**

Requirement	VVSG	Accessibility Standard
Navigation between contests in all modes	3.2.2.1.e	[ voting specific ] Related to WCAG 2.4.5
No voter speech required for operation	3.3.9.a	508: 1194.31.e
Mechanisms designed to prevent accidental activation	3.2.6.c	Related to 508: 1194.31.f and 508: 1194.23.k(1)

**Controls within reach**

Requirement	VVSG	Accessibility Standard
Minimum clear floor space	3.3.5.a	ADAAG <sup>6</sup>
Allow room for an assistant to the voter	3.3.5.b	ADAAG
Labels, keys, etc all visible from wheelchair height	3.3.5.c	ADAAG
Requirements for forward approach without reach obstruction	3.3.5.1.a	ADAAG
Requirements for forward approach with reach obstruction	3.3.5.1.b	ADAAG
Requirements for parallel approach without obstruction reach	3.3.5.1.c	ADAAG
Requirements for parallel approach with obstruction reach	3.3.5.1.d	ADAAG
VVPAT usable in same position	7.8.6.d	[ voting specific ]

**Requirements for Print Interfaces**

Requirement	VVSG	Accessibility Standard
Optical scan - Target areas at least 3 mm	3.2.2.2.f.i	508: 1194.31.f
VVPAT allows voter to see whole record	7.8.6.e	[ voting specific ]
VVPAT page numbers	7.8.6.f	[ voting specific ]

<sup>6</sup> ADA Accessibility Guidelines (ADAAG) contains requirements for accessibility to buildings and facilities by individuals with disabilities under the Americans with Disabilities Act (ADA) of 1990. <https://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/background/adaag>

### Requirements for Electronic Interface Controls

Requirement	VVSG	Accessibility Standard
Electronic ballot interface shall not require page scrolling	3.2.6.a	[ voting specific ]
Minimum sizes of touch areas	3.2.6.c.i	Related to 508: 1194.31.f

### Requirements for Controls

Requirement	VVSG	Accessibility Standard
Provide an Audio Tactile Interface (ATI)	3.3.3.b	[ voting specific ] Related to 508: 1194.25 and 508:1194.23.k.1-4
Keys operable with one hand and reduced dexterity	3.3.4.c	508: 1194.23.k.1
No controls that require voter's body to complete circuit	3.3.4.d	Related to 508: 1194.24.d
No repetitive effect as a result of holding down button	3.2.6.c.ii	508: 1194.23.k(3)

### Requirements for Audio Controls

Requirement	VVSG	Accessibility Standard
Voter can repeat audio	3.3.3.b.ii	WCAG 1.4.2
Voter can pause and resume audio	3.3.3.b.iii	WCAG 1.4.2
Voter can skip audio reading of contest	3.3.3.b.iv	WCAG 1.4.2
Voter can skip audio reading of referendum	3.3.3.b.v	WCAG 1.4.2

### Requirements for System Response to Voter Actions

Requirement	VVSG	Accessibility Standard
Maximum initial system response time	3.2.6.1.a	WCAG 2.2.1
Maximum completed system response time to record a single vote	3.2.6.1.b	WCAG 2.2.1
Maximum completed system response time during voter interaction with the visual display	3.2.6.1.c	WCAG 2.2.1
Warn about long response times	3.2.6.1.d	WCAG 2.2.1
Warn about voter inactivity	3.2.6.1.e	WCAG 2.2.1
Alert after expiration of voter activity	3.2.6.1.f	WCAG 2.2.1



## GUIDELINE 3.3: Understandable – Voters can understand all information as it is presented.

### Requirements for all instructions, alerts and warnings

Requirement	VVSG	Accessibility Standard
Warnings and alerts must be distinguishable from other information.	3.2.4.c.i	WCAG 3.3.1, 3.3.3-4
Separate text instructions visually, and temporally for audio	3.2.4.c.iv	WCAG 3.3.1, 3.3.3-4
No bias in instructions	3.2.4.d	[ voting specific ]
Instructions should be located near where needed	3.2.4.e.iv	WCAG 3.3.2
Icons must have labels	3.2.4.g	WCAG 1.1, 2.4.6
Include clear, complete, and detailed instructions for setup, polling, and shutdown.	3.2.8.1.c	[ voting specific] Related to 508:1194.41
Verification instructions on the voting machine	7.8.6.g	[ voting specific ]

### Requirements for Plain Language

Requirement	VVSG	Accessibility Standard
Provide instructions for all operations	3.2.4.a	WCAG 3.3.2
Provide means to get help from system at any time	3.2.4.b	WCAG 3.3.5 (AAA)
Write instructions in plain language	3.2.4.c	WCAG 3.1.3-5 - 3.1.6 (AAA)
State condition first, then action to be performed	3.2.4.c.ii	n/a
Use familiar words, avoid technical words	3.2.4.c.iii	WCAG 3.1.3-4, 3.1.5-6 (AAA)
Tell voters correct action, not what to avoid	3.2.4.c.v	n/a
Address voter directly (no passive voice)	3.2.4.c.vi	n/a
Avoid gender-based pronouns	3.2.4.c.vii	n/a
Poll worker instructions in plain language	3.2.8.a	n/a

## GUIDELINE 3.4: Robust - The voting system's hardware and accessories support usability and accessibility requirements while protecting voters from harmful conditions.

### Requirements for Electronic Displays

Requirement	VVSG	Accessibility Standard
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Electronic display screen technical requirements	3.2.5.a, 3.2.5.a.ii-vii	n/a
Flicker frequency	3.2.5.a.i	508: 1194.25.i

#### Requirements for Personal Assistive Technology (PAT)

Requirement	VVSG	Accessibility Standard
PAT not necessary to operate Acc-VS	3.3.1.c	508: 1194.25
Secondary method for identification is necessary if biometrics are used	3.3.1.d	508: 1194.25d
ATI audio uses standard jack	3.3.3.c.i	508: 1194.25.e
Requirements if ATI uses a telephone style handset	3.3.3.c.ii	508: 1194.23.h
Standard jack for PAT, allow it to work like an ATI	3.3.4.a	Related to 508: 1194.25.e

#### Safety Requirements

Requirement	VVSG	Accessibility Standard
Voting system designed to eliminate hazards to personnel or equipment	3.2.8.2.a-b	UL 60950
Sanitized headphones for each voter	3.3.3.c.iii	n/a
Voting system shall not cause EM interference with hearing aids	3.3.6.c	508: 1194.23.h 508: 1194.23.i

## PRINCIPLE 4: TESTED FOR USABILITY

### Meets performance standards for usability and accessibility.

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GUIDELINE 4.1 – Conduct summative usability tests using a wide range of voters and poll workers, including those with and without disabilities.

#### Requirements for usability testing

Requirement	VVSG	Accessibility Standard
High level of usability	3.2.a	n/a
Vote effectively, efficiently, comfortably	3.2.b	n/a
Conduct summative usability tests with individuals of the general population to test system setup, operation, and shutdown	3.2.7.a.iv	n/a
The voting system's setup, operation, and shutdown is relatively easy to use for poll workers to learn, understand, and perform	3.2.8.1.a	[ voting specific ]
Usability for poll workers	3.2.8.1.b	[ voting specific ]
Submit usability report of machine for general population.	3.3.10.a	n/a
Conduct summative usability tests for all languages.	3.2.7.a.iv	[ voting specific ]
Conduct summative usability tests with blind users.	3.3.3.a	n/a Related to 508: 1194.31
Submit usability report of Acc-VS tested with low vision voters	3.3.10.b	n/a Related to 508: 1194.31
Submit usability report of Acc-VS tested with low dexterity voters	3.3.10.c	n/a Related to 508: 1194.31
Provide support to voters with cognitive disabilities	3.3.7.a	n/a Related to 508: 1194.31

## **PRINCIPLE 5: MEETS WEB ACCESSIBILITY STANDARDS**

### **Browser-based systems meet web accessibility standards in addition to voting standards.**

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GUIDELINE 5.1: When a voting system uses standard web software platforms (HTML or native apps), the voting system meets all requirements in VVSG 2.0 Level AA in addition to those in the VVSG.

The complete text of WCAG Level AA is included in the following section. The WCAG success criteria that do not appear in the VVSG are listed below. In most cases, the success criteria address web platform technologies, general HTML content requirements, or interactions with personal assistive technology such as screen readers, that do not match the types of presentation or interaction covered in the VVSG.

- 1.2 – Time Based Media
- 1.3.1 – Info and Relationships
- 1.3.2 – Meaningful Sequence
- 1.4.5 – Images of Text
- 2.1.2 – No Keyboard Trap
- 2.4 – Navigable
- 3.2 – Predictable
- 4.1 – Compatible

## **Appendix: Requirements Text**

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In a separate document, the full text of the VVSG usability and accessibility requirements organized into principles, guidelines and requirements as outlined in this white paper.

See the file: **Principles-Structure for VVSG Chap3-Requirements.docx**

## Appendix: WCAG 2.0 Guidelines

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WCAG 2.0 is organized into 4 principles and 12 guidelines. For each guideline, there are also success criteria, at three levels of conformance from A to AAA.

The pages that follow contain the principles guidelines, and success criteria for WCAG 2.0 levels A and AA. A small set of AAA success criteria which are relevant to voting systems is included<sup>7</sup>. Notes in the text and links to additional details on how to meet the requirements have been omitted for space.

### **1 Perceivable**

- 1.1 Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.
- 1.2 Provide alternatives for time-based media.
- 1.3 Create content that can be presented in different ways (for example simpler layout) without losing information or structure.
- 1.4 Make it easier for users to see and hear content including separating foreground from background.

### **2 Operable**

- 2.1 Make all functionality available from a keyboard.
- 2.2 Provide users enough time to read and use content.
- 2.3 Do not design content in a way that is known to cause seizures.
- 2.4 Provide ways to help users navigate, find content, and determine where they are.

### **3 Understandable**

- 3.1 Make text content readable and understandable.
- 3.2 Make Web pages appear and operate in predictable ways.
- 3.3 Help users avoid and correct mistakes.

### **4 Robust**

- 4.1 Maximize compatibility with current and future user agents, including assistive technologies.

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<sup>7</sup> The AAA success criteria are included because current VVSG addresses them directly or indirectly. They are: 1.4.6, 1.4.8, 3.1.5, 3.1.6 and 3.3.5

## **WCAG Principle 1: Perceivable - Information and user interface components must be presentable to users in ways they can perceive.**

WCAG Guideline 1.1 Text Alternatives: Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.

**1.1.1 Non-text Content:** All non-text content that is presented to the user has a text alternative that serves the equivalent purpose, except for the situations listed below. (Level A)

WCAG Guideline 1.2 Time-based Media: Provide alternatives for time-based media.

**1.2.1 Audio-only and Video-only (Prerecorded):** For prerecorded audio-only and prerecorded video-only media, the following are true, except when the audio or video is a media alternative for text and is clearly labeled as such: (Level A)

**1.2.2 Captions (Prerecorded):** Captions are provided for all prerecorded audio content in synchronized media, except when the media is a media alternative for text and is clearly labeled as such. (Level A)

**1.2.3 Audio Description or Media Alternative (Prerecorded):** An alternative for time-based media or audio description of the prerecorded video content is provided for synchronized media, except when the media is a media alternative for text and is clearly labeled as such. (Level A)

**1.2.4 Captions (Live):** Captions are provided for all live audio content in synchronized media. (Level AA)

**1.2.5 Audio Description (Prerecorded):** Audio description is provided for all prerecorded video content in synchronized media. (Level AA)

## WCAG Guideline 1.3 Adaptable: Create content that can be presented in different ways (for example simpler layout) without losing information or structure.

**1.3.1 Info and Relationships:** Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text. (Level A)

**1.3.2 Meaningful Sequence:** When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined. (Level A)

**1.3.3 Sensory Characteristics:** Instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, size, visual location, orientation, or sound. (Level A)

## WCAG Guideline 1.4 Distinguishable: Make it easier for users to see and hear content including separating foreground from background.

**1.4.1 Use of Color:** Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element. (Level A)

**1.4.2 Audio Control:** If any audio on a Web page plays automatically for more than 3 seconds, either a mechanism is available to pause or stop the audio, or a mechanism is available to control audio volume independently from the overall system volume level. (Level A)

**1.4.3 Contrast (Minimum):** The visual presentation of text and images of text has a contrast ratio of at least 4.5:1, except for the following: (Level AA)

- **Large Text:** Large-scale text and images of large-scale text have a contrast ratio of at least 3:1;
- **Incidental:** Text or images of text that are part of an inactive user interface component, that are pure decoration, that are not visible to anyone, or that are part of a picture that contains significant other visual content, have no contrast requirement.
- **Logotypes:** Text that is part of a logo or brand name has no minimum contrast requirement.

**1.4.4 Resize text:** Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality. (Level AA)



**1.4.5 Images of Text:** If the technologies being used can achieve the visual presentation, text is used to convey information rather than images of text except for the following: (Level AA)

- **Customizable:** The image of text can be visually customized to the user's requirements;
- **Essential:** A particular presentation of text is essential to the information being conveyed.

**1.4.6 Contrast (Enhanced):** The visual presentation of text and images of text has a contrast ratio of at least 7:1, except for the following: [large text, incidental, logotypes] (Level AAA)

**1.4.8 Visual Presentation:** For the visual presentation of blocks of text, a mechanism is available to achieve the following: (Level AAA)

1. Foreground and background colors can be selected by the user.
2. Width is no more than 80 characters or glyphs (40 if CJK).
3. Text is not justified (aligned to both the left and the right margins).
4. Line spacing (leading) is at least space-and-a-half within paragraphs, and paragraph spacing is at least 1.5 times larger than the line spacing.
5. Text can be resized without assistive technology up to 200 percent in a way that does not require the user to scroll horizontally to read a line of text on a full-screen window.

## WCAG Principle 2: Operable - User interface components and navigation must be operable.

WCAG Guideline 2.1 Keyboard Accessible: Make all functionality available from a keyboard.

**2.1.1 Keyboard:** All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes, except where the underlying function requires input that depends on the path of the user's movement and not just the endpoints. (Level A)

**2.1.2 No Keyboard Trap:** If keyboard focus can be moved to a component of the page using a keyboard interface, then focus can be moved away from that component using only a keyboard interface, and, if it requires more than unmodified arrow or tab keys or other standard exit methods, the user is advised of the method for moving focus away. (Level A)

## WCAG Guideline 2.2 Enough Time: Provide users enough time to read and use content.

**2.2.1 Timing Adjustable:** For each time limit that is set by the content, at least one of the following is true: (Level A)

- **Turn off:** The user is allowed to turn off the time limit before encountering it; or
- **Adjust:** The user is allowed to adjust the time limit before encountering it over a wide range that is at least ten times the length of the default setting; or
- **Extend:** The user is warned before time expires and given at least 20 seconds to extend the time limit with a simple action (for example, "press the space bar"), and the user is allowed to extend the time limit at least ten times; or
- **Real-time Exception:** The time limit is a required part of a real-time event (for example, an auction), and no alternative to the time limit is possible; or
- **Essential Exception:** The time limit is essential and extending it would invalidate the activity; or
- **20 Hour Exception:** The time limit is longer than 20 hours.

**2.2.2 Pause, Stop, Hide:** For moving, blinking, scrolling, or auto-updating information, all of the following are true: (Level A)

- **Moving, blinking, scrolling:** For any moving, blinking or scrolling information that (1) starts automatically, (2) lasts more than five seconds, and (3) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it unless the movement, blinking, or scrolling is part of an activity where it is essential; and
- **Auto-updating:** For any auto-updating information that (1) starts automatically and (2) is presented in parallel with other content, there is a mechanism for the user to pause, stop, or hide it or to control the frequency of the update unless the auto-updating is part of an activity where it is essential.

## WCAG Guideline 2.3 Seizures: Do not design content in a way that is known to cause seizures.

**2.3.1 Three Flashes or Below Threshold:** Web pages do not contain anything that flashes more than three times in any one second period, or the flash is below the general flash and red flash thresholds. (Level A)

WCAG Guideline 2.4 Navigable: Provide ways to help users navigate, find content, and determine where they are.

**2.4.1 Bypass Blocks:** A mechanism is available to bypass blocks of content that are repeated on multiple Web pages. (Level A)

**2.4.2 Page Titled:** Web pages have titles that describe topic or purpose. (Level A)

**2.4.3 Focus Order:** If a Web page can be navigated sequentially and the navigation sequences affect meaning or operation, focusable components receive focus in an order that preserves meaning and operability. (Level A)

**2.4.4 Link Purpose (In Context):** The purpose of each link can be determined from the link text alone or from the link text together with its programmatically determined link context, except where the purpose of the link would be ambiguous to users in general. (Level A)

**2.4.5 Multiple Ways:** More than one way is available to locate a Web page within a set of Web pages except where the Web Page is the result of, or a step in, a process. (Level AA)

**2.4.6 Headings and Labels:** Headings and labels describe topic or purpose. (Level AA)

**2.4.7 Focus Visible:** Any keyboard operable user interface has a mode of operation where the keyboard focus indicator is visible. (Level AA)

**2.4.10 Section Headings:** Section headings are used to organize the content. (Level )

**WCAG Principle 3: Understandable - Information and the operation of user interface must be understandable.**

WCAG Guideline 3.1 Readable: Make text content readable and understandable.

**3.1.1 Language of Page:** The default human language of each Web page can be programmatically determined. (Level A)

**3.1.2 Language of Parts:** The human language of each passage or phrase in the content can be programmatically determined except for proper names, technical terms, words of indeterminate language, and words or phrases that have become part of the vernacular of the immediately surrounding text. (Level AA)

**3.1.5 Reading Level:** When text requires reading ability more advanced than the lower secondary education level after removal of proper names and titles, supplemental content, or a version that does not require reading ability more advanced than the lower secondary education level, is available. (Level AAA)

**3.1.6 Pronunciation:** A mechanism is available for identifying specific pronunciation of words where meaning of the words, in context, is ambiguous without knowing the pronunciation. (Level AAA)

## WCAG Guideline 3.2 Predictable: Make Web pages appear and operate in predictable ways.

**3.2.1 On Focus:** When any component receives focus, it does not initiate a change of context. (Level A)

**3.2.2 On Input:** Changing the setting of any user interface component does not automatically cause a change of context unless the user has been advised of the behavior before using the component. (Level A)

**3.2.3 Consistent Navigation:** Navigational mechanisms that are repeated on multiple Web pages within a set of Web pages occur in the same relative order each time they are repeated, unless a change is initiated by the user. (Level AA)

**3.2.4 Consistent Identification:** Components that have the same functionality within a set of Web pages are identified consistently. (Level AA)

## WCAG Guideline 3.3 Input Assistance: Help users avoid and correct mistakes.

**3.3.1 Error Identification:** If an input error is automatically detected, the item that is in error is identified and the error is described to the user in text. (Level A)

**3.3.2 Labels or Instructions:** Labels or instructions are provided when content requires user input. (Level A)

**3.3.3 Error Suggestion:** If an input error is automatically detected and suggestions for correction are known, then the suggestions are provided to the user, unless it would jeopardize the security or purpose of the content. (Level AA)

**3.3.4 Error Prevention (Legal, Financial, Data):** For Web pages that cause legal commitments or financial transactions for the user to occur, that modify or delete user-controllable data in data storage systems, or that submit user test responses, at least one of the following is true: (Level AA)

- **Reversible:** Submissions are reversible.
- **Checked:** Data entered by the user is checked for input errors and the user is provided an opportunity to correct them.
- **Confirmed:** A mechanism is available for reviewing, confirming, and correcting information before finalizing the submission.

**3.3.5 Help:** Context-sensitive help is available. (Level AAA)

## **WCAG Principle 4: Robust - Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies.**

### **WCAG Guideline 4.1 Compatible: Maximize compatibility with current and future user agents, including assistive technologies.**

**4.1.1 Parsing:** In content implemented using markup languages, elements have complete start and end tags, elements are nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique, except where the specifications allow these features. (Level A)

**4.1.2 Name, Role, Value:** For all user interface components (including but not limited to: form elements, links and components generated by scripts), the name and role can be programmatically determined; states, properties, and values that can be set by the user can be programmatically set; and notification of changes to these items is

available to user agents, including assistive technologies. (Level A)

## Appendix: NIST Proposed Principles

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**Ballot Presentation:** The ballot must be presented in a manner that allows voters to vote independently, regardless of their abilities.

- a. Provide equivalent information to all voters in a manner they can understand, including:
  - Appropriate language
  - Instructions, warnings, messages, and ballot choices in all implemented interfaces and ballot formats.
- b. Provide voters with a consistent experience of the voting process, including:
  - Default interface settings at the beginning of each voting session
  - Functionality and access, regardless of the interface
  - Key voting operations such as ballot activation and submission
- c. Consistently incorporate common conventions into their design, such as:
  - Common color conventions
  - Industry standards for connecting assistive audio devices, handsets, and headphones

**Voter Comprehension:** A voter must be able to independently and easily understand the ballot presentation regardless of their abilities.

- a. Present information to voters in ways that makes it easy for them to understand:
  - Information in languages they understand
  - Delivered so it may be understood through hearing, vision, and touch, where appropriate.
- b. Present all relevant contest and choice information to voters:
  - Consistently
  - Without bias
- c. Always be able to provide voters with:
  - Help in using the system as it was designed to be used
  - Warnings and messages that encourage voter understanding and appropriate voter responses
  - Notification of important conditions, such as time-sensitive conditions
  - Clear navigation through the ballot to ensure they do not miss important information and make progress to completion of the ballot

**Voter Interaction:** A voter must be able to independently mark and cast their ballot as intended, regardless of their abilities.

- a. Provide voters with means by which they can make choices and navigate the system with minimal risk of error , ensuring that:
- b. All ballot changes are initiated intentionally by the voter
- c. Voters are provided feedback showing the results of their actions
- d. Enable the voter to:
  - Adjust interface settings so as to maximize the quality of their interaction
  - Reset adjustable settings to default values

**Voter Protection:** A voter and their vote must be protected during the entire voting process, including protection from physical discomfort, physical harm, loss of privacy or loss of confidentiality.

- a. Ensure that a voter can carry out the voting process in more than one way, without:
  - Requiring significant voter strength or effort
  - Having to face single points of failure when performing their voting tasks
- b. A voter should be able to:
  - Freely navigate or change selections
  - Always be made aware of the meaning of conditions, such as over- and under-voting
  - Be assured that any actions a voter takes are never accidental and always intentional
- c. Protect a voter against known harmful conditions which could ever result in:
  - Seizures
  - Interference with assistive devices
  - Lack of appropriate or sanitary accessories needed for voting with a system
- d. Ensure that the following are kept private at all times:
  - Voter ballot selections
  - Voter interface interactions
  - Voter identity
  - Voter information

**Accessibility for voters with disabilities:** Principles 1 through 4 above apply to all voters, including those with disabilities.



## Appendix: NASED Principles

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The National Association of State Election Directors (NASED) has been a strong proponent of principle-based guidelines, arguing that they have the potential to benefit a wider range of users at an appropriate level of technical complexity. For example: elected officials who need to understand what the standard does and what is required for elections can rely on principles. Guidelines inform election directors what the system must do, and requirements tell designers and testers how the system must meet the guidelines.

NASED has adopted the following principles for election system standards:

1. To assess the ability of the election systems to correctly execute secure, usable and accessible elections in the jurisdictions in order to provide assurance to voters that the election is an accurate reflection of the voters' will.
2. To enable, not obstruct or impede, innovation and needed response to changing statutes, rules, or jurisdictional and voters' needs.
3. To provide deployable systems and system modifications in a timely manner based on generally recognized elections calendars and schedules.
4. To provide an open and transparent process that allows voters and election jurisdictions to assess the performance and capability of the election systems.
5. To provide a set of testable requirements that jurisdictions can understand and use to procure and evaluate the performance of election systems.