VVSG 2.0
Human Factors Requirements

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September 19, 2019

How did we get here?

Baseline usability and accessibility requirements	• VVSG 1.1 • 2007 VVSG Recommendations
Updates and new requirements	• >10 years of voting & human factors research • Current practice in voting systems • Reports of problems in real elections
VVSG Human Factors Public Working Group	• Feedback and consensus from public working group calls

Where to find the Human Factors Requirements?

- The human factors requirements fall under Principles 5 through 8
- User-centered design under Principle 2
- Some minor overlaps with other principles where noted

	Principle
5	Equivalent and Consistent Voter Access
6	Voter Privacy
7	Marked, Verified, and Cast as Intended
8	Robust, Safe, Usable, and Accessible

	Principle
2	High Quality Implementation 2.2 User-Centered Design

Scope
VVSG 2.0 Human Factors Requirements

- Voter and election worker interaction with the voting system
- Usability, accessibility, privacy while voting
- All voter interfaces must meet ALL applicable human factors requirements
  - VVSG 1.0, 1.1 made a distinction between accessible and non-accessible electronic voting systems based on the products and state of the art in 2005

Overview
VVSG 2.0 Human Factors Requirements

- Harmonized with current federal accessibility standards
  - Section 508, Web Content Accessibility Guidelines, etc.
- Organized according to the widely-accepted accessibility POUR principles
  - Perceivable, Operable, Understandable, and Robust
- Addresses all **modes** of interaction
  - Visual, enhanced visual, audio, tactile, non-manual, limited dexterity control
- Paper as part of the voting system process
  - e.g., accessibility of verifying, not paper ballot design per se)

Principle 5
Equivalent and Consistent Voter Access

All voters can access and use the voting system regardless of their abilities, without discrimination.

- 12 requirements
- Ensure that all voters have the ability to cast their votes easily and accurately, regardless of any disabilities they may have. HAVA Section 301(a)(3)
- Consistent: same mode of presentation throughout the voting process
- Equivalent across modes, without bias

Principle 5 (Continued)
Equivalent and Consistent Voter Access

- All modes of interaction and presentation applied throughout the voting session, fully supporting accessibility for voters with a wide range of disabilities
  - Session: Mark, Review, Verify, Cast
  - Modes:
    - Visual
    - Enhanced visual
    - Audio
    - Tactile
    - Non-manual
    - Limited dexterity control

Guideline 5.1

Voters have a consistent experience throughout the voting process within any method of voting.

5.1-A – Interaction modes

5.1-B – Languages

5.1-C – Vote records

5.1-D – Accessibility features

5.1-E – Reading paper ballots

5.1-F – Accessibility documentation

Guideline 5.1

5.1-A – Interaction modes All interaction modes including audio, tactile, enhanced visual, and non-manual must have the same capabilities as the visual interaction mode including ballot activation, voting, verification, and casting.

5.1-E – Reading paper ballots If the voting system generates a paper record (or some other durable, human-readable record) that can be the official ballot or determinative vote record, then the voting system must allow the voter to verify that the paper record uses the same access features they used to mark the ballot, including audio, tactile, enhanced visual, and non-manual.

Guideline 5.2

Voters receive equivalent information and options in all modes of voting.

5.2.A – No bias

5.2-B – Presenting content in all languages

5.2-C – Information in all modes

5.2-D – Audio synchronized

5.2-E – Sound cues

5.2-F – Preserving votes

Guideline 5.2

5.2.A – No bias The voting system must not introduce bias for or against any of the contest options presented to the voter. In audio, tactile, enhanced visual, and non-manual modes, all ballot options are to be presented in an equivalent manner.

5.2-C – All information in all modes All instructions, warnings, messages, notifications of undervotes or overvotes, and contest options must be presented to voters in all interaction modes for all functions. This includes ballot activation, voting, verification, and casting.

5.2-E – Sound cues Sound and visual cues must be coordinated so that:

- Sound cues are accompanied by visual cues unless the system is in audio-only mode.
- Visual cues are accompanied by sound cues, unless the system is in visual-only mode.

Principle 6
Voter Privacy

Voters can mark, verify, and cast their ballot privately and independently.

- 5 requirements
- Distinguishes voter privacy from ballot secrecy
- Privacy for voters refers to the property of a voting system that is designed and deployed to enable voters to obtain a ballot, and mark, verify, and cast it without revealing their ballot selections or selections of language, display, and interaction modes to anyone else.

Guideline 6.1

The voting process preserves the privacy of the voter's interaction with the ballot, modes of voting, and vote selections.

6.1-A – Preserving privacy for voters

6.1-B – Warnings

6.1-C – Enabling or disabling output

6.1.D – Audio privacy

Guideline 6.1

6.1-A – Preserving privacy for voters Privacy for voters must be preserved during the entire voting session including ballot activation, voting, verifying, and casting the ballot.

6.1-B – Warnings The voting system must issue all warnings in a way that preserves privacy for voters and the confidentiality of the ballot.

6.1-C – Enabling or disabling output The voting system must make it possible for the voter to independently enable or disable either the audio or the video output and be notified of the change, resulting in a video-only or audio-only presentation.

6.1.D – Audio privacy Audio during the voting session must be audible only to the voter.

Guideline 6.2

Voters can mark, verify, and cast their ballot or other associated cast vote record without assistance from others.

6.2-A - Voter Independence Voters must be able to mark, verify, and cast their ballot or other associated cast vote record independently and without assistance from others.

Principle 7
Marked, Verified, and Cast as Intended

Ballots and vote selections are presented in a perceivable, operable, and understandable way and can be marked, verified, and cast by all voters.

- 50 requirements
- Core requirements for the voter interface
- Derived from Federal laws
  - Help America Vote Act (HAVA)
  - Section 508
  - Web Content Accessibility Guidelines (WCAG)
  - Voting Rights Act

Principle 7 (Continued)
Marked, Verified, and Cast as Intended

- Updates to font, text size, audio, interaction control and navigation, scrolling, and ballot selections review
- Ballot presentation settings
  - Voters can adjust the voting system to meet their needs or preferences
  - Includes using color and contrast, adjusting font size, and ensuring audio settings result in understandable speech
- Navigation and control of the ballot during voting
  - Scrolling though the electronic ballot
  - Use of audio and touch controls, and simple gestures
  - Need for adequate space for those who use wheelchairs
  - Both voters and election workers can use controls accurately

Principle 7 (Continued)
Marked, Verified, and Cast as Intended

- Ability of the voter to understand all information on the ballot as it is presented, including instructions and messages from the system
- Preventing contest layouts that can cause confusion
- Making clear the maximum number of choices a voter has, notifying the voter of any errors on the ballot (such as overvotes) before it is cast
- Letting the voter know when they have successfully voted
- Ensuring that instructions for election workers are understandable

Guideline 7.1

The default voting system settings present a ballot usable for the widest range of voters, and voters can adjust settings and preferences to meet their needs.

7.1-A – Reset to default settings
7.1-B – Reset by voter
7.1-C – Default contrast
7.1-D – Contrast options
7.1-E – Color conventions
7.1-F – Using color
7.1-G – Text size (electronic display)
7.1-H – Scaling and zooming (electronic display)
7.1-I – Text size (paper)
7.1-J – Sans-serif font
7.1-K – Audio settings
7.1-L – Speech frequencies
7.1-M – Audio comprehension
7.1-N – Tactile keys
7.1-O – Toggle keys
7.1-P – Identifying controls

Guideline 7.1

7.1-G – Text size (electronic display) A voting system's electronic display must be capable of showing all information in a range of text sizes that voters can select from, with a default text size at least 4.8 mm (based on the height of the uppercase I), allowing voters to both increase and decrease the text size.

The voting system may meet this requirement in one of the following ways:

1. Provide continuous scaling with a minimum increment of .5 mm that covers the full range of text sizes from 3.5 mm to 9.0 mm.
2. Provide at least four discrete text sizes, in which the main ballot options fall within one of these ranges.
    a. 3.5-4.2 mm (10-12 points)
    b. 4.8-5.6 mm (14-16 points)
    c. 6.4-7.1 mm (18-20 points)
    d. 8.5-9.0 mm (24-25 points)

Guideline 7.1

7.1-H – Scaling and zooming (electronic display) When the text size is changed, all other information in the interface, including informational icons, screen titles, buttons, and ballot marking target areas, must change size to maintain a consistent relationship to the size of the text. Informational elements in the interface do not have to be scaled beyond the size of the text.

1. When the text is enlarged up to 200% (or 7.1 mm text size), the ballot layout must adjust so that there is no horizontal scrolling or panning of the screen.

2. When the text is enlarged more than 200%, there may be horizontal scrolling or panning if needed to maintain the layout of the ballot and a consistent relationship between the text for ballot options and associated marking targets.

Guideline 7.1

7.1-L – Speech frequencies The voting system's audio format interface must be able to reproduce frequencies over the audible speech range of 315 Hz to 10 KHz.

7.1-P – Identifying controls

Buttons and controls that perform different navigation or selection functions must be distinguishable by both shape and color for tactile and visual perception.

Well-known arrangements of groups of keys may be used only for their primary purpose. For example, a full alphabetic keyboard is acceptable for entering a write-in candidate name, but individual keys cannot be used for navigation or selection.

Guideline 7.2

Voters and election workers can use all controls accurately, and voters have direct control of all ballot changes and selections.

7.2-A – Display and interaction options
7.2-B – Navigation between contests
7.2-C – Voter control
7.2-D – Scrolling
7.2-E – Touchscreen gestures
7.2-F – Voter speech
7.2.G – Voter control of audio
7.2-H – Accidental activation
7.2.-I – Touch area size
7.2-J – Paper ballot target areas
7.2-K – Key operability
7.2-L – Bodily contact
7.2-M – No repetitive activation
7.2-N – System response time
7.2-O – Inactivity alerts
7.2-P – Floor space
7.2-Q – Physical dimensions
7.2-R – Control labels visible

Guideline 7.2

7.2-B – Navigation between contests The electronic ballot interface must provide navigation controls that allow the voter to advance to the next contest or go back to the previous contest before completing their vote.

Guideline 7.2

7.2-C – Voter control An electronic ballot interface must give voters direct control over making or changing vote selections within a contest:

1. In a vote-for-one contest, selecting a candidate may deselect a previously selected candidate, but the system must announce the change in audio and visual display.
2. In a vote-for-N-of-M contest, the system must not deselect any candidate automatically.
3. In a vote-for-N-of-M contest, the system must inform the voter that they have attempted to make too many selections and offer an opportunity to change their selections.
4. Ballot options intended to select a group of candidates, such as straight-party voting, must provide clear feedback on the result of the action of selecting this option.
5. Ballots with preferential or ranking voting methods must not re-order candidates except in response to an explicit voter command.

Guideline 7.2

7.2-D – Scrolling If the number of candidates or length of the ballot question means that the contest does not fit on a single screen using the voter's visual display preferences, the voting system must provide a way to navigate through the entire contest.

1. The voting system may display the contest by:
   - Pagination - Dividing the list of candidates or other information into "chunks," each filling one screen and providing ways for the voter to navigate among the different chunks, or
   - Scrolling – Keeping all of the content on a single long display and providing controls that allow the voter to scroll continuously through the content.

Guideline 7.2 (Scrolling, continued)

2. For either display method, the voting system interface must:

- have a fixed header or footer that does not disappear so voters always have access to navigation elements, the name of the current contest, and the voting rules for the contest,
- include easily perceivable cues in every interaction mode to indicate that there is more information or there are more contest options available, and
- include an option for an audio format and visual presentation that sync during scrolling.

Guideline 7.2 (Scrolling, continued)

3. The navigation method must ensure that the voting system:
   - meets all requirements for providing feedback to the voter,
   - accurately issues all warnings and alerts including notifications of undervotes and overvotes,
   - meets all requirements for control size and interaction, and keeping all controls visible,
   - does not rely only on conventional platform scroll bars, and
   - provides an opportunity to review and correct selections before leaving the contest.

Guideline 7.2

7.2-E – Touchscreen gestures Voting systems with a touch screen may use touchscreen gestures (physical movements by the user while in contact with the screen to activate controls) in the interface if the following conditions are met:

1. Gestures are offered as another way of interacting with a touch screen and an optional alternative to the other interaction modes.
2. Gestures are limited to simple, well-known gestures.
3. Gestures do not include navigation off the current contest.
4. Gestures are used in a way that does not create accidental activation of an action through an unintended gesture.
5. Gestures work consistently across the entire voting interaction.
6. Gestures do not require sequential, timed or simultaneous actions.

Guideline 7.2

7.2-Q – Physical dimensions The physical dimensions of the voting station must meet the U.S. Access Board requirements in Appendix A to Part 1194 – Section 508 of the Rehabilitation Act: Application and Scoping Requirements, Chapter 4: Hardware, Section 407.8 Operable Parts: Reach Height and Depth.

7.2-R – Control labels visible Control labels must be placed:

1. on a surface of the voting system where voters can see them from a normal seated or standing posture, and
2. within the dimensions required in 7.2-Q – Physical Dimensions.

Guideline 7.3

Voters can understand all information as it is presented, including instructions, messages from the system, and error messages.

7.3-A – System-related errors

7.3-B – No split contests

7.3-C – Contest information

7.3-D – Consistent relationship

7.3-E – Feedback

7.3-F – Correcting the ballot languages

7.3-G – Full ballot selections review

7.3-H – Overvotes

7.3-I – Undervotes

7.3-J – Notification of casting

7.3-K – Warnings, alerts, and instructions

7.3-L – Icon labels

7.3-M – Identifying languages

7.3-N – Instructions for voters

7.3-O – Instructions for election workers

7.3-P – Plain language

Guideline 7.3

7.3-A – System-related errors The voting system must help voters complete their ballots effectively, ensuring that the features of the system do not lead to voters making errors during the voting session.

Guideline 7.3

7.3-G – Full ballot selections review A voting system with an electronic voting interface must provide the voter with a function to review their selections before printing or casting their ballot that:

1. displays all of the contests on the ballot with:
   - the voter's selections for that contest, or
   - a notification that they have not made an election, or
   - a notification that they have made fewer selections than allowed, and
2. offers an opportunity to change the selections for a contest and return directly to the review screen to see the results of that change, and
3. allows the voter to continue to the function for casting the ballot without making a correction at any time in the review process.

The review function may also be provided on a scanner or other device where the voter casts a paper ballot.

Guideline 7.3

7.3-M – Identifying languages When presenting a list of languages to the voter:

1. the electronic ballot interface must use the native name of each language, and
2. the controls to identify or change language must be visible on the screen, not hidden in a help or settings feature.

7.3-P – Plain language Information and instructions for voters and election workers must be written clearly, following the best practices for plain language. This includes messages generated by the voting system for election workers in support of the operation, maintenance, or safety of the system.

Principle 8
Robust, Safe, Usable, and Accessible

The voting system and voting processes provide a robust, safe, usable, and accessible experience.

- 14 requirements
- Covers how the voting system performs in use, including physical safety and the usability and accessibility of the complete voting system.
- Refers to Federal standards for accessibility
- Includes testing for usability

Guideline 8.1

The voting system's hardware, software, and accessories are robust and do not expose users to harmful conditions.

8.1-A – Electronic display screens

8.1-B – Flashing

8.1-C – Personal Assistive Technology (PAT)

8.1-D – Secondary ID and biometrics

8.1-E – Standard audio connectors

8.1-F – Discernable audio jacks

8.1-G – Telephone style handset

8.1-K – Eliminating hazards

8.1-H – Sanitized headphones

8.1-I – Standard PAT jacks

8.1-J – Hearing aids

8.1-K – Eliminating hazards

Guideline 8.1

8.1-B – Flashing If the voting system emits lights in flashes, there must be no more than three flashes in any one-second period.

8.1-C – Personal Assistive Technology (PAT) The support provided to voters with disabilities must be intrinsic to the voting system. This means a voter's personal assistive devices will not be necessary to operate the voting system correctly. This does not apply to personal assistive technology required to comply with 5.1-A.

8.1-F – Discernable audio jacks The audio jack must be in a location that voters can easily discover, discernable by touch while sitting or standing in front of the unit, and not located near a sharp edge.

Guideline 8.1

8.1-J – Hearing aids Voters who use assistive hearing devices must be able to use voting devices as intended:

1. The voting device must not cause electromagnetic interference with assistive hearing devices that would substantially degrade the performance of those devices.
2. The voting device, measured as if it were a wireless device, must achieve at least a category T4 rating as defined by American National Standard [ANSI01] for Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids, ANSI C63.19.

8.1-K – Eliminating hazards Devices associated with the voting system must be certified in accordance with the requirements of UL 60950-1, Information Technology Equipment – Safety – Part 1 by a certification organization accredited by the Department of Labor, Occupational Safety and Health Administration's Nationally Recognized Testing Laboratory program.

Guideline 8.2

The voting system meets currently accepted federal standards for accessibility.

8.2-A – Federal standards for accessibility Voting systems must meet federal standards for accessibility, including the current version of Section 508 of the Rehabilitation Act, in effect as of January 18, 2018, and the WCAG 2.0 Level AA checkpoints included in that standard.

Guideline 8.3

The voting system is evaluated with a wide range of representative voters, including those with and without disabilities, for effectiveness, efficiency, and satisfaction.

8.3-A – Usability tests with voters

1. The manufacturer must conduct usability tests on the voting system, including all voter activities in a voter session from ballot activation to verification and casting.

   The test participants must include voters who represent the following:

   - General population, using the visual interface
   - Voters who speak all supported languages as their primary language
   - Blind voters, using the audio format plus tactile controls
   - Voters with low vision, using the enhanced visual features with or without audio
   - Voters with limited dexterity, using the visual-tactile interface

2. The manufacturer must submit a report of the results of their usability tests as part of the Technical Data Package (TDP) using the version of the Common Industry Format modified for voting systems (CIF-for-Voting Systems).

Guideline 8.4

The voting system is evaluated for usability for election workers.

8.4-A – Usability tests with election workers Voting system setup, polling, and shutdown, as documented by the manufacturer, must be reasonably easy for the typical election worker to learn, understand, and perform.

1. The manufacturer must conduct usability tests on the voting system using individuals who are representative of election workers and report the test results as part of the Technical Data Package, using the Common Industry Format.
2. The tasks to be covered in the test must include:
   - Setup and opening for voting
   - Operation during voting
   - Use of assistive technology or language options that are part of the voting system
   - Shutdown at the end of a voting day during a multi-day early voting period, if supported by the voting system
   - Shutdown at the end of voting including running any reports

Principle 2/Guideline 2
High Quality Implementation

The voting system is implemented using best practice user-centered design methods that consider a wide range of representative voters, including those with and without disabilities, and election workers.

2.2-A – User-centered design process The manufacturer must submit a report providing documentation that the system was developed following best practices for a user-centered design process.

The report must include, at a minimum:

- A listing of user-centered design methods used
- The types of voters and election workers included in those methods
- How those methods were integrated into the overall implementation process
- How the results of those methods contributed to developing the final features and design of the voting system

Questions?

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