Remote Ballot Marking Systems:
Designing for usability, accessibility, and security

Principles and guidelines for remote ballot marking systems

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Visit the project website for more information: **http://civicdesign.org/projects/remote-ballot-marking/**

Executive Summary

This project proposes principles and guidelines for the design and development of remote ballot marking systems, considering them in their entirety, including:

- The accessibility features and communications needed to support all voters
- The election administration procedures to deploy a remote ballot marking system
- The technical systems that make up a remote ballot marking system

We chose to work on remote ballot marking systems because they are a new addition to election options, but are similar to polling place ballot marking systems. They use new technology, and so also address how new technologies can be part of elections.

For the purposes of this report, we defined a remote ballot marking system as:

> **Part of a voting system that allows voters to mark their ballots outside of a voting center or polling place. These systems allow a voter to receive a blank ballot to mark electronically, print, and then cast by returning the printed ballot to the elections office.**

This report defines principles and guidelines for the design of remote ballot marking systems, based on a review of current literature and existing standards for voting systems and accessibility and input from experts in the field.

The principles support the development of systems that are usable, accessible, and secure, addressing the perceived conflict accessibility and strong election integrity. **We believe that security and accessibility can co-exist in a well-designed system, and in many cases they support each other.**

Strong principles and guidelines that provide clear direction for designing and deploying a remote ballot marking system can help election officials choose (or develop) systems that meet the needs of election integrity as well as making it easier for everyone to vote.

The nine principles for remote ballot marking systems are

Principle 1: Trusted and transparent

Principle 2: Consistent with other voting options

Principle 3: Access for all voters

Principle 4: Minimizes privacy and security risks

Principle 5: Supports accurate and secret ballot marking

Principle 6: Enables easy review, printing, and packing of the ballot

Principle 7: Supports election administration procedures

Principle 8: Tested for usability for all voters

Principle 9: Robust and reliable

How we ran this project

The principles and guidelines recommended in this report are based on a review of current literature and existing standards for voting systems and accessibility and input from experts in the field.

As part of the work to develop these recommendations, we convened a meeting of stakeholders, developers, and advocates to explore benefits, barriers, and requirements for remote ballot marking systems[1]. At the end of the meeting, we were pleased to discover that there was little conflict between the goals of accessibility and election integrity.

How to read this report

This report starts by listing the recommended principles and general guidelines

- The **principles** are a high level view of the requirements for remote ballot marking systems. They are first listed in an overview, with their short title and a brief explanation of the result of the principle being effectively implemented.

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[1] The meeting notes are available at the Center for Civic Design website: **http://civicdesign.org/projects/remote-ballot-marking/**.

- For each principle, **general guidelines** provide further detail about what a remote ballot system must do, or the voters must be able to do using it, to meet the principles. Where the guidelines are related to a requirement in the VVSG, WCAG 2.0, or a set of draft requirements proposed by the National Federation of the Blind, that information is shown with the requirement.

In addition, two sections of material support the principles and guidelines, providing information about the task analysis and discussion that led to the recommendations:

- **The voter journey for remote ballot marking** looks at the voter experience and election administration requirements specific to using a remote ballot marking system. It lists the voter activities by stage or step of the process, and further refines the journey by identifying the benefits and risks in each activity.
- **Discussion notes for some of the guidelines** provide explanatory information about the rationale, source, or implications of the guidelines.

The principles and guidelines in this report can become normative requirements when included in a standard and used as the basis for testing specific systems.

Remote ballot marking systems are one of a number of ways in which new technologies can be used in election systems. The principles and guidelines can also be used as input to developing requirements for other, similar systems including blank ballot delivery or ballot pre-marking systems.

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Principles and guidelines for remote ballot marking systems

Principle 1: Trusted and transparent

Voters need to trust and understand how to use the remote ballot marking process in order to accept the results of the election.

1.1   The system protects voter privacy and the secret ballot.

1.2   The system is transparent, making it easy for voters to understand the process, and to confirm that their ballot has been successfully cast.

1.3   The system and supporting election procedures have fail-safes and redundancy to protect votes.

1.4   The system minimizes the difficulty of obtaining a ballot by offering voters alternatives, including via a website or on media delivered to the voter.

Principle 2: Consistent with other voting options

The remote ballot marking option should not have special rules that make it inconsistent with the overall election process.

2.1   The availability of the remote ballot marking system matches the standard vote-by-mail period: It begins at the same time, and ends at the last time for returning (or postmarking) a vote-by-mail ballot.

Principle 3: Access for all voters

Remote ballot marking systems can be used by all voters without discrimination.

3.1   The remote ballot marking system can be used by any voter, including voters with disabilities.
Source: VVSG 1.1 3.1.1

3.2   All information, forms, and the ballot itself are accessible to people with disabilities, meeting Section 508 and WCAG guidelines for digital technology.
Source: NFB 4.0.2, NFB 3.4.1

3.3   Voters can test the system with their own technology and accessibility options (using a practice or sample ballot) before starting to mark their official ballot.
Source: NFB 3.2.1-3.2.4 and 3.1.3

3.4   The system meets all VVSG requirements for alternative languages.
Source: VVSG 1.1 3.2.7

Principle 4: Minimizes privacy and security risks

Remote ballot marking systems minimize privacy risks by carefully designing the use of personal information that can identify voters, throughout the system.

4.1   Voters can use the system without initial authentication. They are authenticated as legitimate, registered voters when the cast ballot is received in the elections office.

4.2   Voters can identify their correct ballot type using neutral information such as district, residence address or party, rather than requiring the voter to be authenticated or to provide sensitive personal information.

4.3   Voters can choose how to access the system, as the system provides more than one way to obtain a ballot, including a web address, or media delivered directly to voters.
Source: NFB 3.1.1

4.4   The system does not include features or communication that can link the voter's identity to ballot selections, directly or indirectly. This includes communication with a server that includes choices and server logs that record information that can identify a voter.

4.5   The online system does not use communication methods (such as email) that contains personally identifiable information (PII). The communication it uses is clear and can be verified in various ways, such as by typing in a simple web site address instead of relying on clicking on a link.

4.6   The system does not communicate any ballot choices or other voter actions to a server, or any other device outside of the control of the voter

Principle 5: Supports accurate and secret ballot marking

Remote ballot marking systems support voters in marking their ballot without error, and protect the secret ballot.

5.1   The system meets all VVSG requirements for handling blank ballots, undervotes, and overvotes.
Source: VVSG 1.1 3.2.1, 3.2.2, 3.3.6.b

5.2   The system meets all VVSG requirements for display of voting instructions, messages, display of contests and voting choices, and navigation through the ballot.
Source: VVSG 1.1 3.2.4, 3.2.5.b-f, h, 3.2.6.b-c, and 3.2.6.1

5.3   Allows the voter to review all voting choices through the electronic interface before printing the ballot.
       Source: HAVA 301.a.1.A

Principle 6: Enables easy review, printing, and packing of the ballot

Remote ballot marking systems support voters in the activities such as review, printing, signing, and packing the ballot and related materials to enable the ballot to be cast when received at the election office.

6.1   Voters can review their ballot before and after printing.
       Source: HAVA 301.a.1.A

6.2   The printed ballot lists the voter's selections (or undervotes) in summary form (for example: "For Governor, you voted for Jane Doe").

6.3   The printed ballot is designed to be readable by voters using assistive technology such as optical character/word recognition tools, so they can independently verify their ballot.

6.4   Any encoding of the ballot contents (such as a bar code or QR code) is nonproprietary and can be meaningfully read and interpreted by an independent system

6.5   The order of the printed pages supports privacy by communicating the order of the pages, helping voters with visual disabilities hide their ballot.
       Source: NFB 3.4.2, 3.4.3

6.6   The system does not require any special paper or pre-printed forms.

6.7   The system provides all materials voters need for returning the ballot, but permits alternatives.

6.8   The instructions for packing the ballot and requirements for a valid ballot are clearly communicated to the voter, and are available in an accessible format.

Principle 7: Supports election administration procedures

Remote ballot marking systems support election officials in managing returned ballots for election integrity.

7.1   The system produces a ballot that can be the official ballot, and read by the tabulation system without being copied (or "remade").

7.2   Voters are validated by an election official comparing an actual signature (ink on a page) and not a digital representation of a signature.

7.3   Ballots from the remote ballot marking system are formatted so they can be included in post-election audits and recounts.

7.4   Voters can track the receipt of their ballot by the elections office.

Principle 8: Tested for usability for all voters

Remote ballot marking systems meet performance standards for usability and accessibility for all voters.

8.1   The system supports a wide range of voters, including those with and without disabilities.
Source: VVSG 1.1 3.2.1, 3.2.7.a.iv, 3.3.3.a, 3.3.10, and NFB 4.1

8.2   The system passes usability requirements for the display of the ballot choices and interaction with the ballot in the VVSG, especially those not covered in the Web Content Accessibility Guidelines (WCAG 2.0).
Source: VVSG 1.1 3.2.5.h, 3.2.6, 3.3.2, 3.3.7

Principle 9: Robust and reliable

Remote ballot marking systems are designed and maintained to ensure the integrity of the election

9.1   The system is robustly tested at all phases of development and deployment to ensure that requirements are met.

9.2   The system is designed so voters and election officials can trust that it works as documented.

9.3   The system is compatible with the broadest possible range of voter computer hardware, operating systems, and browsers.

9.4   The system is compatible with the broadest possible range of assistive technology, including screen readers, screen magnifiers, and input devices.
Source: NFB 4.0.3

9.5   The system includes information about how to contact official technical support resources if voters have difficulty using the system.
Source: NFB 3.2.5 and 3.5

Background for this project

For the purposes of this report, we defined a remote ballot marking system as:

> **An election system for voters to mark their ballots outside of a voting center or polling place. These systems allow a voter to receive a blank ballot to mark electronically, print, and then cast by returning the printed ballot to the elections office.**

Remote ballot marking systems (and blank ballot delivery systems) have been deployed as a way to meet requirements for military and overseas voters under the Military and Overseas Voter Empowerment (MOVE) Act. They are also used as a way to improve accessibility for voters with disabilities, by providing an electronic means of marking a ballot outside of a polling place.

The trend toward the use of vote-by-mail is on the increase. For example, Oregon and Washington conduct elections almost entirely by mail (with exceptions for people who cannot use the paper vote-by-mail ballots). Colorado's new voting system includes a paper ballot mailed to each voter. In California, and Utah districts with few people, voters are required to vote by mail. Several states also conduct some elections—often smaller local elections—entirely by mail.

Similarly, the move to vote centers and reduced numbers of polling places in states like Arkansas, Arizona, Indiana, New Mexico, Tennessee, Texas Utah, and Wyoming[2] can make it more difficult for people with disabilities that affect their mobility to get to a polling place on Election Day. An accessible remote ballot marking system can expand options for those voters. Remote ballot delivery systems also allow some voters, such as the deaf-blind, to vote privately and independently as never before by using their own assistive technology such as refreshable Braille.

If remote ballot marking systems are not designed well, there can be a conflict between providing access for all voters and a system that preserves election integrity for privacy and anonymity of the voter, the secret ballot, and security of the process.

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[2] NSCL "**Vote Centers**" updated October, 2015 (http://www.ncsl.org/research/elections-and-campaigns/vote-centers.aspx)

Importance

Remote ballot marking systems are an important area for work on election system principles because:

- There is a growing number of these systems, originally intended for overseas voters, but expanding to be used by voters with disabilities or even any voter who wishes to use them.
- There are advantages for all voters in electronic ballot marking for usability and accuracy.
- There is a need for guidance about how to make these systems accessible.
- There is disagreement about how to create these tools in a way that supports best practices in election integrity coupled with ease of use.
- They are similar in function to ballot marking devices covered by the Voluntary Voting System Guidelines (VVSG).

Benefits

If designed well, remote ballot marking systems offer several benefits to both voters and election administrators:

- They are part of a goal for convenient ("anytime") voting.
- They make it possible for voters to receive the correct ballot instantly.
- The electronic interface offers prevention of overvotes and warnings about undervotes.
- They can provide accessibility for remote voting methods.
- They can provide access to elections for voters who may find it difficult or impossible to travel to a polling place or vote center, and maintain a secret ballot for those voters.

Remote ballot marking systems are also a way to improve the accessibility of vote-by-mail and vote centers. These two forms of voting are in increasing use around the country, sometimes at the expense of local polling places where voters with disabilities can find HAVA-mandated accessible voting systems. For example, Oregon and Washington conduct elections almost entirely by mail (with exceptions for people who cannot use the paper vote-by-mail ballots). Colorado's new voting system includes a paper ballot mailed to each voter. In California and Utah districts with few people, voters are required to vote by mail. Some states also conduct some elections—often smaller local elections—entirely by mail.

Similarly, the move to vote centers and reduced numbers of polling places in states like Arkansas, Arizona, Indiana, New Mexico, Tennessee, Texas Utah, and Wyoming[3]

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[3] NSCL "**Vote Centers**" updated October, 2015 (http://www.ncsl.org/research/elections-and-campaigns/vote-centers.aspx)

can make it more difficult for people with disabilities that affect their mobility to get to a polling place on Election Day. An accessible remote ballot marking system can expand options for those voters.

Risks

Although there are benefits to both voters and election administration, there are also risks. For examples, voters may encounter barriers to marking a traditional paper ballot may be placed at further disadvantage if vote-by-mail systems are not accessible.

Like any other technical system or procedure added to election administration, the risks in using remote ballot marking systems are increased by the use of the public Internet.

Some of the issues that a successful implementation must address include:

- **Communication**: Voters must be able to learn when and how to use these systems to cast a valid ballot.
- **Technology:** These systems rely on using voters' own computer and assistive technology, without the control possible with custom polling place technology, introducing potential risks for malware on the voter's equipment.
- **Privacy and the secret ballot:** As with any voting system, voters must be able to mark and review their ballot independently and privately. All of the requirements for voter privacy must be managed across a remote system, without exposing any voter's *personally identifiable information*[4] (PII) or allowing the voter identity to be linked to ballot choices through electronic transmission.
- **Security** The system must allow eligible voters to accurately and privately record their ballot choices, it must protect the confidentiality and integrity of those choices, and it must guard against attacks that seek to disrupt, damage or hijack the election process, especially through the features of the remote communication.

Legal and legislative background

Federal laws are important for considering remote ballot marking systems, especially the accessibility of these systems.

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[4] "The term 'personally identifiable information' refers to information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, etc. alone or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as a date of birth, mother's maiden name, etc." in *Safeguarding Against and Responding to the Breach of Personally Identifiable Information,* Office of Management and Budget, M-07-16, May 22, 2007

The **Help America Vote Act (HAVA)** requires that voting systems be accessible to people with disabilities. The Voluntary Voting Systems Guidelines (VVSG) provide details on how to meet those requirements for voters, including those with disabilities.

The **Americans with Disabilities Act (ADA) Title II** includes all election offices as "covered entities." The legal ADA requirements can be met by meeting the Web Content Accessibility Guidelines (WCAG) 2.0 Level AA

The first blank ballot delivery systems and remote ballot marking systems were created to meet requirements of the **Military and Overseas Voter Empowerment (MOVE) Act**.

Current and recent lawsuits in Maryland, Ohio, and San Mateo County, California seek to expand the use of these systems to voters with disabilities as a way to make vote-by-mail accessible. Other states including Utah, have moved towards their use through legislation. In Maryland, a remote ballot marking system was used in the November 2014 election, under court order. The National Federation of the Blind, for example, endorsed what they called online ballot marking in a resolution in 2014[5].

Standards for remote ballot marking systems

Because remote ballot marking systems are new, there are few standards or certification programs for them.

The recommended principles and guidelines in this report build on the requirements for voting systems in the VVSG and for general accessibility in the Web Content Accessibility Guidelines (WCAG 2.0).

Many of the VVSG requirements can apply to a remote ballot marking system just as they would to a polling place ballot marking system. The VVSG includes detailed requirements to ensure that systems support voters in marking their ballot accurately and efficiently. The VVSG requirements for the display, instructions, and interaction with the ballot are already testable requirements that apply to other voting systems. In general, remote ballot marking systems should meet these requirements, after reviewing them to ensure that they address the remote context.

The most important differences between requirements for polling place and remote ballot marking systems is in the type and range of assistive technology considered. In the polling place, the system itself must provide all assistive features (such as audio output) or hardware (for example, headsets). Remote ballot marking systems, in contrast, assume that voters will use their own, familiar, assistive technologies, including screen readers, Braille systems, display customizations, or specialized

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[5] **National Federation of the Blind Endorses Online Ballot Marking**, posted at EveryoneCounts on August 4, 2014. (http://www.everyonecounts.com/in-the-news/nfb-endorses-online-ballot-marking)

keyboards, or similar features built into the ballot marking software. The system must be designed to support assistive technology with correct coding and common accessibility support, but does not have to provide the specialized hardware or software, as polling place systems do.

Future use of these principles and guidelines

Remote ballot marking systems are one of a number of ways in which new technologies can be used to improve election systems.

The features of remote ballot marking systems are closely related to other future systems currently being considered or used by election jurisdiction. These include:

- **Pre-marking.** Systems that allow voters to mark their selections remotely, with an easy way to transfer the selections to a polling place voting system to cast the ballot.
- **Blank ballot delivery.** Systems that deliver a blank ballot, but without any functionality to mark the ballot.
- **Electronic return.** Systems that allow voters to cast their ballot using remote ballot return.

These applications are not considered for this report. These principles and guidelines stand alone. They can be considered a prerequisite for developing requirements for those systems as well as for remote ballot marking systems.

Future research

The challenges of using new technologies while protecting election integrity, voter privacy and ballot anonymity are critical. These challenges are not unique to election systems, but are one of the large problems of widespread use of technology and the Internet while protecting both individuals and social, civic, and commercial systems.

In this work, we focused on practices or technologies that are currently in common use, so that the principles and guidelines do not rely on future research or systems that are not yet proven for the widespread use needed in elections.

Creating secure, usable, and accessible systems is a rich area for research.

About this Project

This project aimed to bridge the perceived conflict between security and accessibility by identifying principles and guidelines that would meet all of the needs of good election administration. It is a collaboration between the National Institute of Standards and Technology and the Center for Civic Design, working with the Verified Voting Foundation.

This project addressed several objectives of the NIST *Roadmap for Usability and Accessibility in Future Voting Systems*.[6]

3.2. Create a risk model that includes human factors and security.
3.3. Enable "anywhere voting."
4.2. Enable the use of personal devices and assistive technology to vote.
4.4. Create guidance for election systems outside of the "voting system."

Goals

Our goal was to investigate and propose principles and guidelines for remote ballot marking systems, considering them in their entirety, including the entire "voter journey." We considered:

- The accessibility features and communications needed to support all voters
- The election administration procedures to deploy a remote ballot marking system
- The technical systems that make up a remote ballot marking system

We chose to work on remote ballot marking systems because they are a new addition to election options, but are similar to polling place ballot marking systems. They use new technology, and so also address how new technologies can be part of elections.

To understand the context in which remote ballot marking systems are used, we worked to develop a voter journey map that extends the one published with the NIST Roadmap. In this part of the work, our goal was to identify aspects of the voter experience and election administration requirements *specific to* using a remote ballot marking system.

Starting from principles

Following the lead of work at the Election Assistance Commission (EAC) and its Technical Guidelines Development Committee (TGDC), we started by identifying important principles that support election integrity.

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[6] The roadmap was developed through a collaboration between NIST and the Center for Civic Design. The final report, journey map, and project history are online: **http://civicdesign.org/projects/roadmap/**

By starting from principles, we can suggest requirements for both federal and state certification programs that can fit into local election laws and practices.

The principles and guidelines recommended here are intended to help voting system designers, certification programs, and election officials design, test, and deploy remote ballot marking systems that support voters, election administration, and the integrity of the elections in which they are used.

Principles are not necessarily testable, but are expanded into guidelines and then further explained in technical requirements and test assertions. This document contains principles and guidelines, which can become **normative requirements** when included in a standard and used as the basis for testing specific systems.

As part of future work, these principles and guidelines can be expanded to a testable standard by writing **test assertions** or **detailed technical requirements**.

Please see the appendix for a list of sources and the process of developing the principles and guidelines.

Voter journey for remote ballot marking systems

We approached this work by considering the voters' process – or "journey" – to use a remote ballot marking system. It is important to understand the that for a voter, this journey starts before they interact with the system, and continues after it. The diagram below shows a high level view of the journey to use a remote ballot marking system:
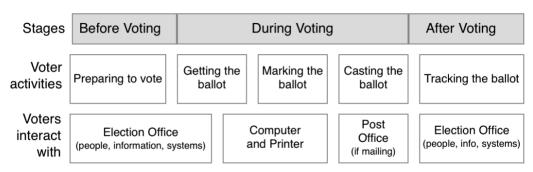
Figure: The voter journey for remote ballot marking

Stages	Before Voting	During Voting			After Voting
Voter activities	Preparing to vote	Getting the ballot	Marking the ballot	Casting the ballot	Tracking the ballot
Voters interact with	Election Office (people, information, systems)	Computer and Printer		Post Office (if mailing)	Election Office (people, info, systems)

This voter journey extends the more general version in the "Roadmap for Usability and Accessibility of Elections"[7] and looks at the voter experience and election administration requirements specific to using a remote ballot marking system.

An analysis of the voter journey for remote ballot marking can help make decisions in designing and developing a system. It can identify benefits that the system can support and risks that the system must avoid or prevent. By showing detailed events throughout the process, it maps the relationships between the people, policy, processes, and products that take place during an election.

It can also identify activities or steps in the process that are different from other voting methods that will need careful instructions to avoid usability or accessibility problems that can occur if voters do not understand what they have to do, the implications of their actions, and how they can interact with the system.

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[7] The roadmap was developed through a collaboration between NIST and the Center for Civic Design. The final report, journey map, and project history are online: **http://civicdesign.org/projects/roadmap/**

Steps in the voter journey specific to remote ballot marking

Step	Activities
Before voting	**Preparing to vote in an election** • Discovering the voting option called remote ballot marking and learning what it is about, in general. • Checking that your local election office supports remote ballot marking for the next election. • Checking deadlines to make sure ballot will be delivered to election office on time. • Identifying postage requirements and locations of drop boxes • Learning what technology is needed and checking that what you have (including assistive technology) is compatible. Doing a "test run" of the entire process with a sample ballot using your current technology. Installing any additional software that may be needed. • Reviewing the checklist of steps to vote using remote ballot marking.
During voting	**Getting the ballot** • Requesting a ballot for remote marking or access it from a website • Downloading the proper ballot for your voting address and registration status (such as party affiliation) • Opening the ballot to confirm you are able to mark it. Resolve any technical issues • Reviewing candidates and issues on the ballot
(Voting continues)	**Marking the ballot** • Making selections for individual races, issues, etc. Getting feedback on possible errors. • Pausing to learn more about candidates or issues, as needed. Returning to mark the ballot. • Resolving technical issues if they arise. • Reviewing choices and make any corrections to finalize the marking process with your choices

Step	Activities
(Voting continues)	**Casting the ballot** • Printing the completed ballot. • Checking for errors in the printed ballot and resolve as needed • Printing additional forms (and envelopes) as needed. Signing, if needed. Finding additional paper material from your elections office, such as a special envelope. • Assembling paperwork into proper order and putting it in envelope(s). • Adding postage and mail, or putting it in a drop box at a special location.
After voting	• Tracking that the ballot has been received and counted. • Correcting the ballot package, such as correcting a signature or other errors, if there are problems and time permits.

Benefits and risks of remote ballot marking

Step	Benefits	Risks
Overall	• Another voting option to meet individual needs • Uses current technology • Better informed voter because of time to research candidates and issues while voting • New option may motivate voters and increase turnout	• Voting system can be hacked, spoofed and disrupted, with the risks of any computer system, but the added risks of remote communication • Lack of technical support • Requires access to technology and ability to use it • Risk of unsupervised voting (as for all remote or absentee voting) • Reliance on postal system (as for all vote-by-mail)

Step	Benefits	Risks
Before voting	• Sample ballot in accessible electronic format	• A new process and option for voters to learn
During voting	**Getting the ballot** • Vote when convenient • Not required to travel to a polling place • Avoid lines at polling place • Potentially voting experience overall, because voters have a choice of when and where to vote • Use of familiar technology	**Getting the ballot** • Complexity in ensuring voters get the correct ballot • Requires access to internet if ballot is downloaded
(Voting continues)	**Marking the ballot** • Use of personal assistive technology to vote privately and independently • More accurate marking with immediate feedback can increase confidence over a paper ballot with no feedback • Automated checks for overvotes and undervotes	**Marking the ballot** • Poor design and implementation can make ballot difficult to mark efficiently and accurately • Incompatibility with older computers or personal assistive technology • Issues caused by voter's lack of familiarity with technology
(Voting continues)	**Casting the ballot** • Paper is familiar and verifiable	**Casting the ballot** • Challenges reviewing a paper ballot, especially for voters with visual disabilities. • Challenges handling the paper ballot for voters with dexterity disabilities or limitations in the use of their hands.

Step	Benefits	Risks
After voting	• Tracking receipt of ballot (if this is available as part of the larger election system)	• Resolving "lost ballots" (as with any tracking system)
For election administration	• Provides accessible option for vote by mail	• A new process and option for election administrators to learn • More ballots that might need to be duplicated into machine readable form ("remade") to tabulate accurately • Checking voter identity (as for all vote-by-mail, but with the additional risks of voter-printed forms) • Increased technical support capacity needed

Discussion notes on the principles and guidelines

This section contains discussion and explanatory information about the rationale, source, or implications of the guidelines.

Discussion for Guideline 1.3

The system and supporting election procedures have fail-safes and redundancy to protect votes.

What do we mean by "fail-safes and redundancy to protect votes" in the process?

As with any remote election process, voters have less support for solving problems or fixing mistakes than with an in-person method. Both the technology and election administration processes for remote ballot marking systems must be designed to allow voters to recover from simple mistakes or from system failures. For example:

- Voters should be able to get a new ballot in case there is a problem downloading the ballot, they make a mistake marking the ballot, or there is a problem printing the ballot.
- Election administrators should be able to accept any valid ballot received from a voter, as long as it has the required elements.

Making it easy to create a duplicate ballot is also protection against coercion, allowing a voter to make a new ballot (as long as the first one has not been cast).

Any function that stores ballot selections over multiple marking sessions must be designed to preserve privacy and secrecy.

Discussion for Guideline 3.1

The remote ballot marking system can be used by any voter, including voters with disabilities.

Why is it important to make accessible remote ballot marking available to any voter?

Many of the current remote ballot marking systems have been made available only to specific groups of users, most often overseas voters. They are also important as a way to make vote-by-mail accessible to voters with disabilities.

We suggest that remote ballot marking systems be designed to be used by all voters as a matter of policy. This simplifies election administration because officials do not have to evaluate or certify a voter's need, but can simply ensure the system is available to anyone who seeks it out.

Whatever the local policy, there are strong reasons to ensure that they are accessible:

- Voters do not have to self-identify as having a disability to use the system.
- Many accessibility features, such as the ability to set display preferences, can make the system more usable to all voters.
- The need for technical support is reduced when a system is usable, and includes clear, accurate instructions written with accessibility issues in mind.

The other implication of these guidelines is that the system is designed from the start to be used by large numbers of voters. Current remote ballot marking systems are used by relatively few voters, and may not scale up well for wider use.

Discussion for Guideline 3.2

All information, forms, and the ballot itself are accessible to people with disabilities, meeting Section 508 and WCAG guidelines for digital technology.

What general accessibility standards should the system meet?

One of the easiest ways to identify technical requirements for remote ballot marking systems is to incorporate the international standard, the W3C's Web Content Accessibility Guidelines (WCAG 2.0) to Level AA. This standard is the basis for the proposed update to the federal Section 508 and many state regulations, and is used by the Department of Justice as a basis for accessibility compliance. It is a mature, well-known standard that does not introduce new or untested requirements to election systems.

What information and interactions must be accessible?

All of the information must be accessible, including instructions for how to print the ballot and package it for return. For example, instructions for how to fold the ballot must be given in an accessible format, not simply printed on the ballot or a signature page. It must be possible to follow the instructions and submit a valid ballot without vision or assistance by a sighted person.

For cases when a voter prints multiple ballots, the National Federation of the Blind guidelines also suggest that "each version of the ballot printed by the voter have a unique" identifier" to help voters ensure that they select the correct version to return. (NFB 3.4.4)

How and why is it important that voters can test the system?

In many jurisdictions, voters are mailed sample ballots. They may also have the opportunity to practice marking their ballot at an election center or polling place before receiving their ballot. Remote ballot marking systems should also have this capability, for example, by providing a range of ways to learn about and test the system:

- An explanation or demonstration of the system in an accessible format.

- A simple demonstration process that includes all of the steps in the process so that voters can confirm that it works with their computer and with any custom or assistive technology.
- During live election period, a sample of voters' actual ballot, so that they can see all of the contests on their ballot, and practice if they wish before completing their official ballot.
- Between elections, a practice ballot designed for a mock election.

A practice ballot is also helpful in general voter education throughout the year, providing access to the process for community, good government, and get-out-the-vote groups.

Discussion for Guideline 3.3

Voters can test the system with their own technology and accessibility options (using a practice or sample ballot) before starting to mark their official ballot.

How should the system handle unsupported technology?

The NFB guidelines also suggest that the remote ballot marking system does not allow access by unsupported browsers or other software, to help ensure that voters can use the system accurately and without fear of technical problems that can affect the integrity of the ballot (NFB 3.1.1).

Discussion for Guideline 4.1

Voters can use the system without initial authentication. They are authenticated as legitimate, registered voters when the cast ballot is received in the elections office.

When should users be authenticated as registered, legitimate voters?

This guideline suggests both a technical approach and policy decision that provides several benefits:

- Election administrators save time by not having to decide who is a legitimate voter at the front-end of the process, but only checking returned ballots.
- It streamlines the number of steps in the system for voters.
- The remote ballot marking system does not need to access the voter registration system or send personal information across the internet.
- It facilitates the voter's ability to obtain as many ballots as needed to successfully complete the marking process.

More importantly, because any ballot must be authenticated when it is received in the elections office, it is not clear what value requiring authentication to receive a ballot offers.

Identifying the correct ballot type by address is less burdensome than being required to sign in to a system or being required to submit personal information that might be stored in a way the compromises their privacy.

This guideline does not mean the system has to use an address as the only way to identify the ballot style. For example, voters might be provided with the code for a ballot style to enter.

The goal of this guideline is to minimize the personal information collected from voters that might be inadvertently or maliciously used to compromise privacy and anonymity.

How should the election office handle multiple ballots?

Only one ballot can be counted, so each jurisdiction must set policy about how vote-by-mail ballots (including those marked on a remote ballot marking system) are counted. If two ballots from the same voter are received at the elections office, there must be a clear policy for determining which one will be counted.

Do human-detection methods have to be accessible?

Any feature intended to confirm that the ballot is being accessed by a human (for example, a CAPTCHA or other "Turing test') must be accessible – provide the challenge in accessible media, assure the interaction is accessible, and the instructions understandable. These features should only be used if they add a meaningful benefit to election integrity.

Discussion for Guideline 4.2

Voters can identify their correct ballot type using neutral information such as district, residence address or party, rather than requiring the voter to be authenticated or to provide sensitive personal information.

How is the correct ballot style provided to a voter?

This recommendation is to identify the correct ballot style for a voter by their address or party, so that only minimal personal identifiable information (PII) is required. The risk to this approach is that the user might provide information that does not match their voter registration, potentially invalidating the ballot or some of the contests on the voted ballot.

An alternative that provides a closer connection between the remote ballot marking system and the voter registration file might be to provide a ballot style code, which the voter could enter as part of the process of accessing the ballot, rather than having to type in an address. This code could be used directly, or matched to an address entered by the voter to validate the ballot style.

Discussion for Guidelines 4.4 and 4.6

4.4 The system does not include features or communication that can link the voter's identity to ballot selections, directly or indirectly. This includes communication with a server that includes choices and server logs that record information that can identify a voter.

4.6 The system does not communicate any ballot choices or other voter actions to a server, or any other device outside of the control of the voter

How can the system avoid making ballot choices public?

These two recommendations provide two sides to ensuring a secret ballot: by avoiding any communication of either ballot choices or PII over the network. In combination, they ensure that the system does not make it possible (legitimately nor by hacking the system) to link voters with their ballot choices.

The system should not transmit vote choices to a remote server in order to mark and print ballot. To safeguard privacy and security, any communication function should be disconnected or disabled while marking the ballot. This applies to functions of the system. It also suggests that good practice when systems supplied by the elections office are used, for example in programs that bring a voting system to long-term care facilities or home-bound voters, would be to avoid having an open internet connection during ballot marking.

Another important difference from polling place ballot marking systems is that a remote ballot marking system has an extra responsibility for ensuring voter privacy and ballot secrecy, even when communicating with a voter over a network, because they are not a closed system. Like a polling place ballot marking system, a remote ballot marking system should allow voters to mark their ballots without any connectivity or communication with a server—in technical terms, with no packet transmitted. This helps ensure the secret ballot in a way that a fully connected system cannot.

This recommendation that there be no communication with a server once the ballot is downloaded ensures that the ballot is under the control of the voter while marking and returning the ballot and under control of the election office when it is received, with no intermediary systems involved.

Discussion for Guidelines 5.1-5.3

5.1 The system meets all VVSG requirements for handling blank ballots, undervotes, and overvotes.

5.2 The system meets all VVSG requirements for display of voting instructions, messages, display of contests and voting choices, and navigation through the ballot.

5.3 Allows the voter to review all voting choices through the electronic interface before printing the ballot.

What is the relationship to the VVSG requirements?

The VVSG provides tested requirements already in use to certify voting systems that can apply to a remote ballot marking system just as they would to a polling place ballot marking system. In other cases, the specific requirement in the VVSG will need to be adapted to apply to remote ballot marking, where the hardware and some aspects of the design are not controlled by the system[8]. They include requirements (including special requirements for accessibility) for:

- Handling errors in marking a ballot
- The display of ballot choices and other visual display characteristics
- Interaction with the ballot
- Voter instructions, plain language, and information presentation

The VVSG includes requirements for timing in 3.2.6.1, designed for polling place systems. The NFB guidelines suggest longer time-out limits that follow the same general outline (NFB 3.3.1-5).

Discussion for Guideline 6.2

The printed ballot lists the voter's selections (or undervotes) in summary form (for example: "For Governor, you voted for Jane Doe").

Why list voter choices in summary form?

The overall security and reliability of outcome is enhanced when voters review ballots for correct capture of intent.

Using plain text in summary format helps voters review their ballot accurately. It also facilitates the use of text readers for voters with print disabilities (that is visual and dexterity disabilities that affect voters' ability to use printed material), and helps ensure that the ballot will be cast as intended.[9]

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[8] For example, VVSG 1.1 3.2.5.a, which sets requirements for the display screen brightness and flicker, addresses an aspect of the design not under the control of the remote ballot marking system. On the other hand, requirements such as 3.2.5.h (contrast) can be adapted to apply to the design default settings.

[9] This format is used in the Oregon Alternative Ballot, and is proposed in the current work in the Los Angeles County Voting System Assessment Project (VSAP).

Discussion for Guideline 6.5

The order of the printed pages supports privacy by communicating the order of the pages, helping voters with visual disabilities hide their ballot.

Why is it important to know the order in which the pages are printed?

Voters with print disabilities need to know the order in which the pages are printed, so they can get help signing their ballot without revealing their votes. The NFB guidelines offer specific requirements:

- The signature page prints before the ballot
- A blank page separates the ballot from the signature page for ballot secrecy
- A final blank page (for printers that dispense paper face up

Discussion for Guideline 6.7

The system provides all materials voters need for returning the ballot, but permits alternatives.

How can the system support voters in printing and packing their ballot to return?

Voters should be able to choose how to pack their ballots, and receive instructions for all options:

- In an envelope they print and assemble
- Using standard mailing envelopes
- or, using the official ballot return envelopes (for example, available from the elections office, or mailed to all voters in some election administrations).

Discussion for Guideline 6.8

The instructions for packing the ballot and requirements for a valid ballot are clearly communicated to the voter, and are available in an accessible format.

Why are instructions important?

Clear instructions support voters, as required in the VVSG. It supports election integrity by increasing the chance that every ballot can be counted. They also support election officials by helping them authenticate voter without having to go back to voter for additional information.

Voters need to know that their ballot package includes several elements (as required by local election law):

- The ballot
- Completed voter declaration or other form
- Voter signature

- The correct address for returning the ballot to the elections office

Discussion for Guideline 7.1

The system produces a ballot that can be the official ballot, and read by the tabulation system without being copied (or "remade").

Why should the voting system read the ballot as returned by the voter?

The remote ballot marking system should work with the tabulation system to minimize the number of ballots that cannot be read directly, as returned by the voter to be cast. Ideally,

- The ballot is designed so that the tabulation system can accept and read the ballot even if the paper is a non-standard size or weight, or if the print is minimally distorted.
- The ballot and voter choices can be read directly from text, rather than interpreting either filled-in bubbles or other positional marks.
- The tabulation system can be read using OCR/OWR rather than relying on a bar code, QR code, or other encoding system.

By minimizing the need for remaking, or duplicating, ballots, the system maintains transparency, eliminates transcription errors, saves election administrators time. The voter and tabulation system are reading the same information.

Discussion for Guideline 7.2

Voters are validated by an election official comparing an actual signature (ink on a page) and not a digital representation of a signature.

Why is a hand-written signature important?

Hand-written ("wet") signatures are the most reliable means for authentication for voters who are physically absent from the polling place, and are the standard for vote by mail. Remote ballot marking systems should require a "wet" signature for authenticating voters, rather than a digital signature or a graphical image of a signature attached to a ballot.

Another issue in using a signature for authentication is that they change over time. Election administrators are more easily able to authenticate a voter via signature when multiple sources for the signature are available (not just one version signed many years prior).

Discussion for Guideline 7.3

Ballots from the remote ballot marking system are formatted so they can be included in post-election audits and recounts.

Why is it important to include RBM ballots in audits and recounts?

Election audits, recounts, and other validity checks are improved and election integrity increased if no one mode of balloting is exempt from post-election checks on the voting system. As a policy recommendation, it ensures that all ballots are treated equally.

Discussion for Guideline 7.4

Voters can track the receipt of their ballot by the elections office.

Why is ballot tracking important?

Voters are more confident in the system if they can track their ballot and know that it was received and counted. They may be more likely to participate in future elections if the process worked.

If there is a problem, voters may still have opportunity to obtain a second ballot or request additional support from an election official to ensure participation.

Online tracking systems reduce the number of calls to the elections office.

Discussion for Guideline 8.1

The system supports a wide range of voters, including those with and without disabilities.

Why is usability testing important?

The VVSG requires usability testing of voting systems to ensure that they work well in practice, because it is possible to meet technical requirements with a system designed poorly.

Because remote ballot marking systems are designed for all voters, it is important to include voters with disabilities in any usability testing.

The development of remote ballot marking systems should include the best practice of iteratively designing and improving the system until they demonstrate that they can pass a usability test. We recommend that a test that focuses on voters' tasks be created or adapted for the purpose[10].

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[10] The NIST Modified CIF Template for Voting System Manufacturers and associated instructions are a good template for reporting on a usability test
Template: **http://www.nist.gov/itl/vote/upload/CIF_Template_Manufacturers-VVSG-1-1.docx**
Guidelines: **http://www.nist.gov/itl/vote/upload/Guidelines_CIF_Template_Manufacturers-VVSG-1-1.doc**

Discussion for Guideline 9.1

The system is robustly tested at all phases of development and deployment to ensure that requirements are met.

How are the technical requirements for remote ballot marking systems different from polling place ballot marking systems?

The focus of the accessibility and usability of a remote ballot marking system is on how easily and effectively voters can complete the entire process from opening the ballot to returning it. This includes all aspects of the interaction:

- The software application must be both usable and accessible, meeting legal standards for digital accessibility.
- Because a remote ballot marking system uses voters own computer and assistive technology, it must be compatible with the wide range of computer or device hardware, operating systems and browsers in common use.

This is different from polling place accessible ballot marking systems, where both the hardware and software are supplied as part of the system.

Discussion for Guidelines 9.3 and 9.4

9.3 The system is compatible with the broadest possible range of voter computer hardware, operating systems, and browsers.

9.4 The system is compatible with the broadest possible range of assistive technology, including screen readers, screen magnifiers, and input devices.

Why is support for a broad range of technology important?

Voters should not have to upgrade their computer systems or make changes to their assistive technology in order to use a remote ballot marking system. The system should work with most commonly used browsers and operating systems. It should be clear to voters how to set up and use the system with their technology (see guideline 3.3).

What assistive technology should the system be compatible with?

Voters with disabilities may use a variety of assistive technologies and specific models, including screen reading software, screen magnification software, refreshable Braille displays, and voice recognition. They may also interact with the web using only keyboard (or keyboard emulators) or may require captions or transcripts as alternatives to audio output.

Discussion for Guideline 9.5

The system includes information about how to contact official technical support resources if voters have difficulty using the system.

How can the system support voters who have problems using the system?

It is inevitable that some voters will have difficulties with the system that they cannot resolve on their own or through using the instructions and help built into the system. The deployment of a remote ballot marking system must include a way for the elections office to support these voters, such as a help line.

- The staff at the help line should be prepared to answer questions about using the system with assistive technology
- The contact for the help line and the hours that it is available should be easily found, for example, by including this information on the system screens and other communications.
- The system should also provide information about other voting options.

Appendix: Principles for remote ballot marking systems

Principle 1: Trusted and transparent
Voters need to trust and understand how to use the remote ballot marking process in order to accept the results of the election.

Principle 2: Consistent with other voting options
The remote ballot marking option should not have special rules that make it inconsistent with the overall election process.

Principle 3: Access for all voters
Remote ballot marking systems can be used by all voters without discrimination.

Principle 4: Minimizes privacy and security risks
Remote ballot marking systems minimize privacy risks by carefully designing the use of personal information that can identify voters throughout the system.

Principle 5: Supports accurate and secret ballot marking
Remote ballot marking systems support voters in marking their ballot without error, and protect the secret ballot.

Principle 6: Enables easy review, printing, and packing of the ballot
Remote ballot marking systems support voters in the activities such as review, printing, signing, and packing the ballot and related materials to enable the ballot to be cast when received at the election office.

Principle 7: Supports election administration procedures
Remote ballot marking systems support election officials in managing returned ballots for election integrity.

Principle 8: Tested for usability for all voters
Remote ballot marking systems meet performance standards for usability and accessibility for all voters.

Principle 9: Robust and reliable
Remote ballot marking systems are designed and maintained to ensure the integrity of the election

Appendix: Sources of input for the recommendations

Input for this project came from a wide variety of sources, including the current general accessibility standards and the requirements for voting systems in the Voluntary Voting System Guidelines (VVSG 1.1) adopted in 2015, and two unpublished reports:

- A summary of current ballot delivery systems and remote ballot marking systems from the Verified Voting Foundation
- Draft recommendations for remote ballot marking systems provided by the National Federation of the Blind[11].

We also reviewed other reports on online election systems to understand the background and the kinds of issues reported about these systems' security, accessibility, or usability:

- **Security Best Practices for the Electronic Transmission of Election Materials to UOCAVA Voters**, NISTIR 7711 by Regensheid and Beier, September 2011
- **A Threat Analysis on UOCAVA Voting Systems**, NIST IR 7551 by Regensheid and Hastings, December 2008
- **Accessibility and Usability Considerations for UOCAVA Remote Electronic Voting Systems**, Working paper for TGDC/NIST, January 14, 2011
- **The Relationship Between Trust and Usability in Systems**, Claudia Z. Acemyan and Phillip Kortum in Proceedings of the HFES, 2012
- **Usability Test Report on Maryland Online Ballot Marking Tool**, Kathryn Summers, and others at University of Baltimore for the State Board of Elections, January 2014
- **Access Denied: Barriers to online voter registration for citizens with disabilities**, ACLU and the Center for Accessible Technology, February 2015
- **City of Toronto Internet Voting Project: Web Accessibility (WCAG 2.0) Evaluations of Voter-Facing Demonstration Sites,** Jan Richards, Inclusive Design Research Centre (IDRC) at OCAD University for the City of Toronto, January 2014
- **Final report by Utah's iVote Advisory Committee**, (2015)
- **The Future of Voting: End-to-End Verifiable Internet Voting**, US Vote Foundation (The executive summary has a good description of security requirements, although this project was specifically focused on internet voting)

We consulted with experts in election administration, technology, systems design, access for people with disabilities, and election integrity at a working meeting held on October 9, 2015 at the National Federation of the Blind. All had some experience

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[11] The draft guidelines have not been published but the NFB has made them available for this project. They are included at the end of this report.

working with election systems in general or remote systems specifically. The participants were:

- Jennifer Morrell, Arapahoe County, Colorado
- John Dziurlaj, Ohio Secretary of State's Office
- Ricky Hatch, Weber County, Utah
- Steve Booth and Lou Ann Blake, National Federation of the Blind
- Ted Jackson, Centers for Independent Living
- Claudia Acemyan, Rice University (STAR Vote)
- John Schmidt, Five Cedars (Oregon Alternative Ballot)
- Jared Marcotte (former Pew and Voting Information Project)
- Ron Bandes, Carnegie Mellon University
- Joe Kiniry, Galois
- Susannah Goodman, Common Cause
- Susan Greenhalgh, Verified Voting
- Jessica Myers, Election Assistance Commission
- Andy Regensheid, NIST
- Ben Long, NIST

During the meeting, we used small group exercises and discussions to first identify the benefits and obstacles to implementing remote ballot marking, and where they occur in the voter journey. The group then worked to identify solutions to the obstacles that would maximize the benefits while reducing risks. Finally, we identified possible principles or broad requirements embodied in the solutions.[12]

Our discussions mentioned the following systems:

- Oregon's Alternative Ballot Format
- Maryland's Online Ballot Marking Tool
- Democracy Live, LiveBallot Online
- Demtech, Ballot DNA
- Dominion, ImageCast Remote
- Everyone Counts, eLect
- Konnech, ABVote
- Scytl, eBallot
- Prime III
- Galois (prototype)

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[12] A report on the meeting and the materials used as input for the work are available on the Center for Civic Design website: **http://civicdesign.org/projects/remote-ballot-marking/**

Appendix: NFB Draft Electronic Ballot Delivery System Accessibility/Usability Guidelines

December 2, 2015

1.0   Introduction
2.0   Key Terms
3.0   Technical Standard
The electronic ballot delivery system web pages shall conform to the WCAG 2.0 AA with the following clarifications, additions, and/or exceptions:

3.1   User Access
  3.1.1   In general, electronic ballots shall be accessed through a web site. Electronic ballots may be delivered by email at the discretion of election officials.
  3.1.2   For security reasons, access to electronic ballot delivery systems via unsupported browsers and other software shall be denied.
  3.1.3   Any authentication used to confirm that content is being accessed by a human rather than a computer shall be accessible.

3.2   Testing for compatibility with voter's computer system and software.
  3.2.1   After the user has logged in, but before the user accesses the ballot, the electronic ballot delivery system should test the user's computer system and software for compatibility.
  3.1.4   When incompatibility is discovered, the electronic ballot delivery system should identify the incompatible components to the user.
  3.1.5   The electronic ballot delivery system should prevent access to the ballot by users with incompatible hardware and software.
  3.1.6   Instructions on how user can upgrade incompatible hardware and software should be provided.
  3.1.7   Instructions on how user can contact the board of elections for other voting options should be provided.

3.3   Time limit before system times out--warning that system is about to time out.
  3.3.1   Electronic ballot delivery systems that include a time limit may time out after 15 minutes of user inactivity.
  3.3.2   A notice must be provided to the user at the top of each page that the system will time out after 15 minutes of inactivity by the user.
  3.3.3   Additional warnings that the system will time out must be provided to the user when the user has been inactive for 10 minutes and 14 minutes.
  3.3.4   Following the second warning at 14 minutes, the user can extend the time limit with a simple action.If the system times out, the time out page must provide the user instructions on how to return to the ballot.

3.4   Printing of ballot
    3.4.1   Printing instructions shall be in an accessible media and shall be usable without vision.
    3.4.2   Printing instructions shall include a list of the order in which pages are printed.
    3.4.2   Signature page shall print before the ballot. At least one page shall separate the signature page and ballot to ensure secrecy.
    3.4.4   Each generation of the ballot shall have a unique number.

3.5   Provision of help line voters can call if they are not able to resolve problems on their own.
    3.5.1   The board of elections shall provide a help line that voters can call when they experience problems while using the system.
    3.5.2   The contact information for the help line and the hours that it is available shall be displayed on each page of the electronic ballot delivery system.

4.0   User testing by people with disabilities
    4.0.1   Usability testing of the electronic ballot delivery system shall include testing by voters with disabilities. Testers shall have a broad range of experience using computers and assistive technology.
    4.0.2   Testing shall demonstrate the compliance of the electronic ballot delivery system web pages with WCAG 2.0 AA and these guidelines.
    4.0.3   The assistive technology used for usability testing shall consist of the technology commonly used by individuals with disabilities at the time of the testing, and shall include, but not be limited to, screen reading software, screen magnification software, refreshable Braille displays, keyboard only, and voice recognition.