HP Hardware Accessibility Testing Guide

Version 2.0

HP Office of Aging & Accessibility with Renfro Consulting, Inc.

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Overview

As many businesses shift to a focus on accessibility web standards for their websites, online storefronts, and software applications, hardware testing could continue to become increasingly less common. And yet, the community of people with disabilities relies on technology that adheres to accessibility hardware standards for much of their critical work, communication, and personal technology needs.

Integral to HP's mission is our commitment to making HP products and services easier to access and simpler to use for individuals with disabilities and age-related limitations. In fact, we know that many HP customers view accessibility as an important factor in their purchasing decision. Therefore, our business and reputation rely on transparent, repeatable, and accurate accessibility testing and reporting.

Performing a quality test necessitates both a command of product detail and comprehensive insight into the worldwide policy landscape, including the U.S. Revised Section 508 at minimum and additional world standards preferably (e.g., E.U. EN 301 549, U.S. ADA Accessibility Guidelines [ADAAG], and W3C WCAG 2.x).

HP has a dedicated team of professionals in the HP Office of Aging & Accessibility that closely coordinates with our businesses to ensure we produce consistent, high-quality tests for HP accessibility conformance reports (i.e., ACRs).

Introduction to hardware testing

Hardware ICT (information and communications technology) includes any part of a product that you can physically touch, pick up, hold, and/or move around a room. Hardware is any physical parts that compose the device (i.e., computer, printer, virtual reality headset, display, etc.). The hardware in scope for accessibility testing may be as simple as a monitor with no physical controls or as complicated as a multifunction printer with an integrated screen and keyboard, multiple paper trays, and additional accessories (e.g., HP LaserJet Enterprise M528).

As a tester, you are responsible for taking careful test notes, as well as writing detailed remarks and explanations. Strive to look at your work from the perspective of the end user, keeping in mind that individual experiences vary. Disability is diverse and individual, and may be temporary, acquired, or lifelong. Two individuals with the "same type" of disability—whether it be visual, auditory, physical, or cognitive—have different needs and preferences.

A quality accessibility test does not necessitate a comprehensive understanding of a hardware product's total functionality. If specific questions arise during the test process, consult a technical reference from the HP Business Unit or other expert sources (e.g., a user guide, technical manual, etc.).

A quality accessibility test paints a vivid picture of how people with disabilities interact with ICT (information and communications technology) in test. Include any insights that convey useful information about accessibility defects, workarounds, and/or limitations; they prove useful when reading the test results. At the forefront of your thoughts should be the common, everyday experiences that real people in real situations have with the hardware. Ask yourself: Can the device be positioned and configured such that someone with a mobility limitation has a frictionless customer experience? Do tactile indicators on buttons enable an individual with low vision to effortlessly turn on the product?

The results should be reported to the HP Business Unit that created the product with two goals in mind: 1) Defect remediation, and 2) Documentation of incremental progress through this evaluation process and across product lifecycles.

Finally, the significance of clarity in all testing protocols cannot be underemphasized. In your notes, precisely record what is tested, including: Official name, code name, version, date tested, technical lead giving information, firmware, software, documentation, and any video support. Notes and test results need to allow another accessibility tester to reproduce your results.

Hardware versus software testing

Clear communication will facilitate reproducible testing. Articulate the limitations and consistent rules that dictated what you included in the hardware versus software chapters respectively.

Scrutinize all aspects of the device when determining what HP considers “in scope” for an accessibility hardware test. First, determine which parts of the product are hardware, firmware, software, or added ICT. Then, carefully record this classification in the test protocol such that the results correspond with the correct success criteria. Do not record software results in the hardware chapter of any test record. When followed correctly, this procedure guarantees documentation of precisely “what was tested.”

Software can be anything from an integrated, installed operating system (e.g., Microsoft Windows) to a mobile device application used to operate the hardware. Each essential piece of software—whether web-based or locally-installed—must be tested. As with hardware evaluation, pay attention to the software version; software changes occur independently of hardware upgrades.

Firmware built into the hardware and present in a closed functionality environment (e.g., a print device) should be named with version number and tested with the hardware. Record these results in the hardware chapter; in your remarks, explicitly differentiate when the test was firmware-centric versus hardware-centric. Details matter, not least because significant changes can occur between versions. Mistakenly testing an incorrect firmware version could change the test results, thereby yielding outdated and/or misleading information to our customers.

Visually assessing equipment

When assessing a new piece of equipment for a test, the initial and successive visual inspections are critical:

- Document in writing and photos all technical information about the hardware. Many products belonging to the same “series” or “family” share similar characteristics. Make known exactly what was tested and the results of that test; this clarity will save headaches later when analyzing the results.
- Know the primary use case of the product (e.g., a thin client device can resemble a notebook PC yet have different functionality).
- Is there software that needs testing separately?
- Examine all ports, plugs, and inputs.
- Check color contrast on the hardware itself, including labels.
- Open latches, doors, covers, and bins.
- Does the device have a touch screen or other screen?
- Examine keyboard, on/off buttons, other buttons, and tactile indicators.
- Assess primary and secondary use of the hardware.
- Is it large or smaller—and do height and reach requirements apply?
- What functionality is part of normal, everyday use?
- Are maintenance items part of a user’s experience?
- Is color or lights the only method of visual information to user?
- What is the first-time use (i.e., out-of-box) experience?
- What is the signup, login, and/or registration experience (when required to use the hardware)?
- When any printed materials are included with the hardware, is equivalent information easily discoverable in an accessible digital (i.e., online) format?
- Is contact information for support easily discoverable in an accessible format?
- Are there glaring accessibility concerns?

At the beginning of the test, photograph and write down anything noteworthy. Ask technical questions early and often during the process. Seek feedback from the HP Business Unit as you go, sharing your observations, questions, and/or concerns about accessibility in particular and the user experience in general.

Tools for testing

Common hardware testing tools

Use testing tools to correctly identify the hardware's conformance to standards, including:

- Access to system components during testing, when needed
- Digital camera
- Force meter
- Tape measure
- User Manual or Technical Specifications Manual

Common software testing tools and assistive technologies

- Accessibility Insights
- ANDI, a U.S. federal government tool on GitHub
- JAWS, a screen reader for Microsoft Windows (demo version available)
- Microsoft Inspect Objects
- Microsoft Windows Ease of Access Color Contrast
- Microsoft Windows Ease of Access Magnifier
- NVDA, a free, open-source, portable screen reader for Microsoft Windows (recommended)
- The Colour Contrast Analyser, a free desktop application for Windows and Mac
- The Web Accessibility Toolbar, a free add-on for Internet Explorer
- VoiceOver, a built-in screen reader for Apple products
- ChromeVOX
- WAVE Toolbar
- W3C Nu markup HTML conformance checker

Note on testing tools

Preferred testing tools can change rapidly. Many are excellent and behave similarly. Any tools used during testing should be documented so the reader understands with which tools the test was performed.

Testing and reporting

Testing and reporting have a close relationship and serve many functions for HP, including meeting critical customer requirements for sales opportunities and lending insight into how we can bolster the value proposition of HP products. For many procurement opportunities, we submit an Accessibility Conformance Report (ACR) following the Information Technology Industry Council's (i.e., ITI) Voluntary Product Accessibility Template (i.e., VPAT). The accessibility testing completed for this ACR creates a valuable feedback loop with the HP Business Unit and can strengthen the case for more accessibility improvements in future product development. When we address known accessibility defects, it improves the product experience for all our customers.

All test evaluations and ACRs must be:

- Objective and unbiased
- Conducted by following a published and repeatable evaluation process
- Documented with accurate and detailed remarks

By statute, the scope of the U.S. Revised Section 508 standard encompasses all of the U.S. federal government. State agencies, K-12 public schools, universities, and other public sector entities have adopted the U.S. Revised Section 508 standard as a mandatory procurement requirement.[1] In addition, some private organizations have voluntary adopted the standard as a customer requirement, though they have no legal obligation to do so. HP continues to experience a steady increase in requests for ACRs from a range of customer segments.

As a company, it is vital that we accurately test according to a published test process and report the results in unbiased, technical language. This transparency best positions the customer to make an informed purchasing decision. A quality ACR sets clear expectations about the accessibility of a product, including its defects if applicable, by outlining the test results with detailed remarks.

As you follow the HP Accessibility Test Plan, define what accessibility criteria in test "does not support" and illustrate what happens with the product in question. Leave no room for confusion. When testing and reporting the results, all relevant information to a person with a disability ought to be communicated. This granularity makes for transparent, accurate reports that inspire confidence and trust in the report's consumer.

[1] Navigating VPAT 2.0: A Guide for Vendors, Level Access – Available at: https://www.levelaccess.com/navigating-vpat-2-a-guide-for-vendors-whitepaper/

Revised Section 508 requirements[2]

400 Hardware

401 General

Ensure the tester defines the scope for this test process and documents it so that it can be understood and duplicated by another tester. Documenting the test process in written and picture format is invaluable.

401.1 Scope

The requirements of Chapter 4 shall apply to hardware ICT where required by 508 Chapter 2 (Scoping Requirements), 255 Chapter 2 (Scoping Requirements), and where otherwise referenced in any other chapter of the Revised 508 Standards or Revised 255 Guidelines. The U.S. Access Board in Revised Section 508 defines hardware as "a tangible device, equipment, or physical component of ICT."

Hardware that is assistive technology shall not be required to conform to the requirements of this chapter. Examples of hardware that are not required to conform to the requirements of this chapter include, but are not limited to: hearing aids, refreshable braille displays, sip and puff technology, trackball and joystick mouse, etc.

402 Closed Functionality

Where ICT has closed functionality, that closed functionality shall be operable without requiring the user to attach, connect, or install assistive technology. Note that personal headsets and induction loops shall not be classified as assistive technology for the purpose of this clause. Closed functionality can be individualized to each product and its use.

Kiosks or automated teller machines (i.e., ATMs) are examples of closed functionality ICT. Any individual using an ATM should be able to fully access the machine without needing to alter the machine. Users who cannot read or have trouble reading text on the machine can have the text read aloud; however, they may need to use a personal headset to trigger the machine's text-to-speech mechanism.

Some items that enable software or accessories (e.g., peripherals) to be plugged into the hardware device may operate as both "open" and "closed." Record applicable instances in the remarks and test notes during hardware testing. Certain situations (e.g., security concerns) can create a closed functionality condition in testing.

[2] U.S. Revised Section 508 Requirements. Available at: https://www.access-board.gov/guidelines-and-standards/communications-and-it/about-the-ict-refresh/final-rule/text-of-the-standards-and-guidelines

402.2 Speech-Output Enabled

ICT with a display screen shall be speech-output enabled for full and complete use. Operating instructions and orientation, visible transaction prompts, user input verification, error messages, and all displayed information for full use shall be accessible to, and independently usable by, individuals with vision impairments. Speech output shall be delivered through;

- a mechanism that is readily available to all users, including but not limited to an industry standard connector or a telephone handset;
- recorded or digitized human or through synthesized speech output;
- speech output that is coordinated with information displayed on the screen

Speech output is not required for advertisements and similar communications unless they convey information used during the transaction being conducted. Likewise, audible tones shall be permitted instead of speech output where the content of user input is not displayed as entered for security purposes.

Specific ICT can be exempted from meeting 402.2. Variable message signs conforming to 402.5 shall not be required to be speech-output enabled. Likewise, speech output shall not be required where ICT display screens only provide status indicators and those indicators conform to 409. In another instance, ICT shall be permitted to conform to 409 in lieu of 402.2 where speech output cannot be supported due to constraints in available memory or processor capability. Lastly, speech output shall not be required for: the machine location, date and time of transaction, customer account number, and the machine identifier or label.

This speech output must be in the firmware of the hardware device to be tested and reported on in the hardware chapter of the report. Speech output that is part of an operating system or other software assistive technology is recorded in the software chapter.

Some examples of hardware with speech output include ATMs, kiosks, and print devices.

402.2.1 Information Displayed On-screen

Speech output shall be provided for all information displayed on-screen.

ICT with a display screen shall be speech-output enabled. Operating instructions and orientation, visible transaction prompts, user input verification, error messages, and all displayed information for full use shall be accessible to, and independently usable by, individuals with vision impairments. Speech output shall be delivered through a mechanism that is readily available to all users including, but not limited to: an industry standard connector or a telephone handset.[3] Speech shall be recorded human, digitized human, or synthesized. Speech output shall be coordinated with information displayed on the screen.

Speech output must provide auditory information about the user interface elements and states. It is not limited only to textual elements on the screen: text fields, dropdown menus, checkboxes, images, buttons, and other user interface elements must have speech output. Information about the states of user interface elements such as required fields and values of those fields must have speech output.

[3] Industry standard connectors include, but are not limited to 3.5 mm audio jack, USB, RJ-45, and RJ-11.

Speech output is not required for advertisements and similar communications unless they convey information that can be used for the transaction being conducted. Likewise, audible tones shall be permitted instead of speech output where the content of user input is not displayed as entered for security purposes.

Test Procedure:

1. Cover the screen(s) of the device under test and attempt to perform the same basic user scenarios as outlined in the main test specification(s) for the product.
    a. Example: For a self-contained, single-purpose retail point-of-sale kiosk (e.g., a cash register which is not simply a tablet or desktop computer with point-of-sale software), cover the main screen and perform all the basic functionality. Test for identifying items, applying discounts, totaling final cost, accepting payment, etc.

This speech output must be in the firmware when enabled due to the addition of assistive technology or a software operating system or application. The test results must be recorded in the software chapter; software can vary among hardware products and needs to be separated in the report for user clarity on essential functionality.

402.2.2 Transactional Outputs

Where transactional outputs are provided, the speech output shall audibly provide all information necessary to verify a transaction.

Speech output shall be provided where ICT is closed to visual access and provides receipts, tickets, or other outputs, including all information necessary to complete or verify the transaction. In the case of ticketing machines, printed copies of itineraries and maps shall not be required to be audible.

A transaction is any interaction where there is a sale and/or business deal, irrespective of whether a receipt was printed (i.e., may email or text a ticket). Examples include but are not limited to: a user buying a ticket, pumping gasoline, interacting with a banking kiosk, parking in a city, leasing a bicycle, riding a ferry, or completing self-checkout.

Test procedure:

1. Ensure that speech output provides all information necessary to verify the transaction.

402.2.3 Speech Delivery Type and Coordination

Speech output shall be delivered through a mechanism that is readily available to all users (e.g., an industry standard connector, a telephone handset, etc.). Speech shall be recorded or digitized human or synthesized. Speech output shall be coordinated with information displayed on the screen.

Where speech output is provided as non-visual access to closed functionality, speech output shall be in the same human language as the displayed content provided, 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.

Where content is externally created (i.e., not labelled HP) or contains unsupported languages this requirement shall not apply.

All ATMs are required to contain an industry standard audio headphone jack. When a user plugs in headphones to the 3.5 mm headphone jack on the ATM, the speech output will begin The audio produced shall match the information displayed on the screen.

This speech output must be in the firmware. If this is enabled because of added assistive technology or a software operating system or application, the test results are recorded in the software chapter. This is essential as software can vary from hardware product and needs to be separated for user clarity and understanding of essential functionality.

Test procedure:

1. Ensure that the system provides speech output in a way that is available to all users, such as an industry standard connector or a telephone handset.
2. Ensure that speech output from the system matches all displayed content on any view screens, touchscreens, or other mode of visual output.

402.2.4 User Control

Speech output for any single function shall be automatically interrupted when a transaction is selected. Speech output shall be capable of being repeated, interrupted, and paused.

This requirement may be met in part by ensuring that any presentation of options via audio provides an option to repeat the entire list after the list has been announced to the user (i.e., “select number 8 to repeat the options.”).

Interruption of speech output should be available through a standard element (e.g., the “cancel” button). Interruption of speech could also be a natural side effect of selecting an option to continue or cancel.

Test procedure:

1. Verify that hardware provides a means of pausing or repeating speech output.
2. Verify that speech output is interrupted when a transaction is selected by the user.

402.2.5 Braille Instructions

Where speech output is required by 402.2, braille instructions for initiating the speech mode of operation shall be provided. Braille shall be contracted and shall conform to 36 CFR part 1191, Appendix D, Section 703.3.1.[4] However, devices for personal use shall not be required to conform to 402.2.5. When a device can be a personal device and shared use device the personal use exemption does not apply.

Where ICT is designed for shared use and speech output is available, a tactile indication of the means to initiate the speech mode of operation shall be provided. The tactile indication could include braille instructions.

ATMs follow this guideline. A braille label that tells the user where the headphone jack is located, as well as a braille description of how to initiate speech mode, should be located near the headphone jack of the machine.

[4] Braille that is Unified English Braille (UEB) code meets contract braille requirement.

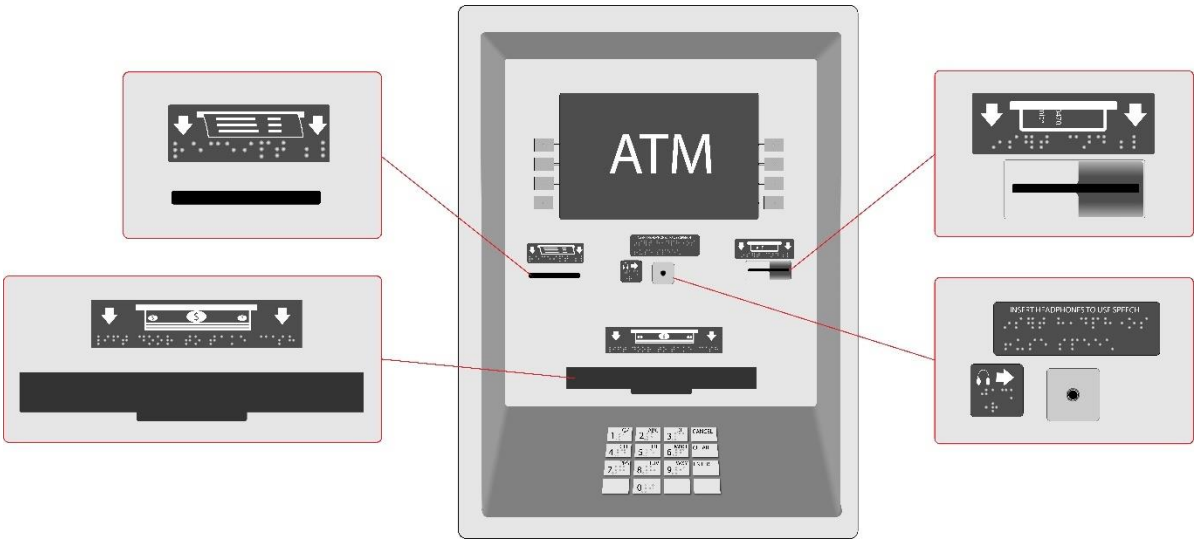

Figure 1 Braille instructions – ATM

It is imperative to document any defects for the benefit of the customer and the HP product teams. This means that in instances during test where the standard was met as a technicality, but the result is clearly not accessible in a real-life situation, it should be documented as not supported. For example, placing the braille instructions together in a single area as a sign apart from the kiosk would meet the standard as a technicality; however, it should be documented as a defect because it would not be accessible for a braille user and would not meet HP's usability goals.

Test procedure:

1. Ensure that braille instructions are provided that would allow the user to initiate speech output without any visual information.

402.3 Volume

Where sound (including speech output) is provided, it shall provide volume control and output amplification conforming to relevant 402 rules. ICT conforming to 412.2 shall not be required to conform to 402.3.

402.3.1 Private Listening

Where ICT provides private listening, it shall provide a mode of operation for controlling the volume. Where ICT delivers output by an audio transducer typically held up to the ear, a means for effective magnetic wireless coupling to hearing technologies shall be provided.

Examples that conform to this requirement:

1. A handset that is hearing aid compatible and has a volume control.
2. A telephone. However, individuals using hearing aids may find it difficult to use the telephone due to hearing aid "picking up sound" from the microphone. By including telecoils in hearing technologies, telephone receivers can magnetically couple with the hearing technology so that the telephone receiver can send sound information directly to the hearing technology allowing users to effectively hear the telephone conversation. A

volume control must be included in the telephone so users may alter the volume to a level of their choosing.

Test procedure:

1. Ensure that a method is provided for adjusting the volume.
2. Ensure that hardware has a method for wirelessly connecting to listening devices.

402.3.2 Non-private Listening

Where ICT provides non-private listening, incremental volume control shall be provided with output amplification up to a level of at least 65 decibels (i.e., dB). A function shall be provided to automatically reset the volume to the default level after every use.

Where auditory output is provided in closed functionality and is delivered through speakers on ICT, incremental volume control shall be provided with output amplification up to a level of at least 65 dB. A function shall be provided to automatically reset the volume to the default level after every use. For E.U. EN 301 549, this requirement does not apply if speech is provided as non-visual access to ICT.

Test procedure:

1. To ensure the audio circuits have the required gain, some modification of the ICT may be required to obtain access to testing points. Connect an audio test signal set at 1 KHz reference at 0 dB to the audio input (e.g., HP 209A Audio Oscillator). The audio input connection is generally after the audio has been decoded from the incoming signal or an equivalent signal that is an output of an internal facility, feature, or function within the ICT (i.e., output from an answering machine, output from a text to voice decoder, etc.). Typically, the audio architecture of the ICT can rapidly identify this connection point.

Figure 2 HP 209A Audio Oscillator

2. Disconnect the speaker from the ICT device and connect an audio analyzer (e.g., HP 8903b Audio Analyzer) to those connection points where the speaker was connected. Record a reference measurement at the lowest volume setting. Follow the instructions for the audio analyzer to set the proper impedance for the connection points. Lower the volume control

to its minimum point and subsequently increase the ICT volume control to the maximum and record the change in gain as the control is changed. The gain should increase in a linear manner.

Figure 3 HP 8903b Audio Analyzer

3. The gain also needs to be measured over frequency. To measure the gain over frequency, sweep the frequency of the Audio tone generator over the operating frequency of the ICT device. Record the gain over the frequency range using the steps above. The gain should not deviate by more than 1% over the entire frequency range (i.e., relatively flat).

   The designer should know the relative audio input levels that the audio circuits will be presented. For example, the text to voice converter may have a -5 dBm level and other features may have +1 dBm as their levels are presented as audio input. The testing should include this factor by adjusting the levels of the audio oscillator. It is important that the gain of at least 65 dB is satisfied at both the lowest and highest input levels.

4. Verify that audio volume gets reset to the default value after each use.

402.4 Characters on Display Screen

At least one mode of characters displayed on the screen shall be in a sans serif font. Where ICT does not provide a screen enlargement feature, characters shall be a minimum 3/16 inch (i.e., 4.8 mm) high based on the uppercase letter “I”. Characters shall contrast with their background with either light characters on a dark background or dark characters on a light background.

An example of a sans serif font is the font used in this document. Sans serif fonts lack the embellishment on the outer edges of the letters that serif fonts display. Refer to the example picture below for a side-by-side comparison of serif versus sans serif font.

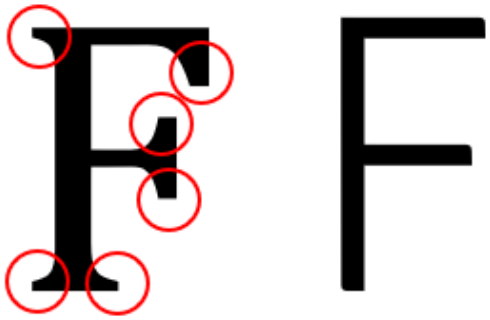

Figure 4 Characters on display screen – serif versus sans serif

Test procedure:

1. Verify that display screens all have at least one mode of characters using a sans serif font.
2. Verify that where ICT does not offer a screen enlargement feature, characters are at least 3/16 inch (i.e., 4.8 mm) high based on the uppercase letter "I."
3. Verify that all characters contrast with their backgrounds, light on dark or dark on light.

402.5 Characters on Variable Message Signs

Characters on variable message signs shall conform to Section 703.7 Variable Message Signs of ICC A117.1–2009 (incorporated by reference, see 702.6.1 of U.S. Revised Section 508).[5]

To achieve accessibility, a high-resolution variable message sign should follow the guidelines set forth in Section 703.2, as well as 703.7.12 through 703.7.14 of ICC A117.1-2009. Characters shall not be italic, oblique, script, highly decorative, or otherwise unusual. Characters shall:

1. Be uppercase, lowercase, or a combination of both.
2. Determine height by the uppercase “I” with respect to Table 703.2.4 – Visual Character Height.
3. Determine width by the uppercase “O,” with the width being 55% minimum and up to 110% maximum of the height of the uppercase “I.”
4. Determine stroke width of characters by the uppercase “I” with stroke being 10% minimum up to 30% maximum of the height of the uppercase “I”.
5. Have spacing of 10% minimum and up to 35% maximum of character height. Spacing between baselines of separate lines of text shall be 135% minimum and up to 170% maximum.
6. Have a baseline of 40 inches minimum above the floor of the viewing position.
7. Contrast with their background, and both character and their background shall have a non-glaring finish.
8. Automatically adjust to the brightness of the area. Full messages on a sign shall remain visible for 3 seconds minimum or 1 second minimum for every 7 characters on the screen, including spaces.

[5] ICC A117.1 – 2009 pages 70-72. Available at: https://ia800302.us.archive.org/29/items/gov.law.ansi.a117.1.2009/ansi.a117.1.2009.pdf

For low-resolution variable message signs, characters must be:

1. Uppercase.
2. Conventional in form, including sans serif font and without it being italic, oblique, script, highly decorative, or unusual in any other way.

For low-resolution variable message signs, character:

1. Height shall be based on the uppercase “I” with respect to Table 703.7.4 of ICC A117.1-2009. The uppercase “O” is used to determine the width of characters with respect to Table 703.7.5. Stroke width of characters is determined by the uppercase “I” with regards to Table 703.7.5.
2. Spacing shall be determined by the closest points of adjacent characters with regards to Table 703.7.5. Spacing between baselines of separate lines of text shall be 135% minimum and up to 170% maximum.
3. Baseline shall be 40 inches minimum above the floor of the viewing position and must comply with information in Table 703.7.4.

For low-resolution variable message signs, characters shall contrast with their background and both characters and background shall have a non-glare finish, including protective covers placed over the variable message sign. Variable message signs in exterior locations shall automatically adjust to the proper brightness. Full messages on a sign shall remain visible for 3 seconds minimum or 1 second minimum for every 7 characters on the screen including spaces.

Test procedure:

1. Review 2009 ICC A117.1 Accessible and Usable Buildings and Facilities. Follow Chapter 7: Communication Elements and Features rule as written. Note that character height is determined by the uppercase “I” and width is determined by the uppercase “O”. This standard aims to ensure that when a variable message sign is mounted on a wall, a low vision reader can indeed read the signage. There are specific formulas listed to use to determine compliance.

403 Biometrics

Where provided, biometrics shall conform to 403. Biometrics are biological characteristics that can be used to identify individuals. Examples of biometrics commonly used include: iris recognition, fingerprint recognition, and face recognition. Any ICT that is capable of biological identification must meet this requirement.

403.1 General

Where provided, biometrics shall not be the only means for user identification or control.

An exception to this rule occurs when two or more different biological characteristics can be used for identification. If two different biological characteristics are available for user identification (i.e., fingerprint identification and retinal identification), then biometrics can be used as the sole means of user identification.

Biometrics use biological characteristics for user identification or control. If restricted to a single biological characteristic, a significant barrier is posed to individuals that do not possess that biological characteristic.

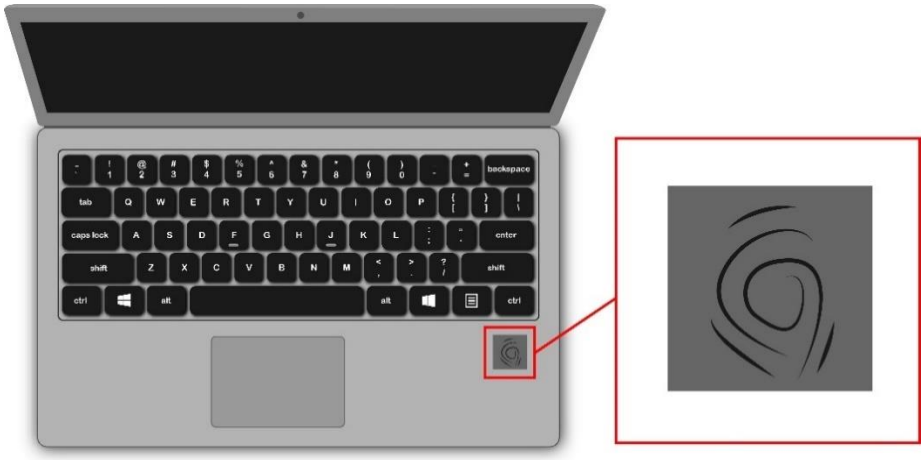

Figure 5 Biometrics – fingerprint scanner

Test procedure:

1. If a biometric method is used to identify users, verify that at least one of the following is true:
    a. A non-biometric method is also available, and/or
    b. Multiple biometric methods are available that rely on different biological characteristics.

404 Preservation of Information Provided for Accessibility

Where applicable, information shall be preserved (conforming to 404). When assistive technology is added to a system, if removed or interrupted, it should always be returned to the original user selections.

404.1 General

ICT that transmits or converts information or communication shall not remove non-proprietary information provided for accessibility or shall restore it upon delivery.

This provision applies to conversion techniques (e.g., encoding, signal compression, and format transformation). Examples of ICT that might encode, compress, or transform information include firewalls, routers, and gateways.

This provision does not require the addition or translation of information, simply its preservation.

1. Example: this provision would not require an agency to change a voicemail into text.

Test procedure:

1. On a system which utilizes the networking equipment under test, test devices which are already known to send captioning information according to testing outlined in HPAR (HP Accessibility Requirements) 5.01 Captioning Playback and User Selection and (for VoIP

phones) HPAR 4.16 RTT - Interoperability (PSTN, VoIP using SIP). [6] Ensure that no non-proprietary information is lost when this equipment is used.

405 Privacy

Where applicable, privacy shall be provided (conforming to 405).

The same degree of privacy of input and output shall be provided to all individuals. When speech output required by 402.2 is enabled, the screen shall not blank automatically.

Closed functionality machines will typically provide a 3.5mm headphone jack so that users can plug in headphones.

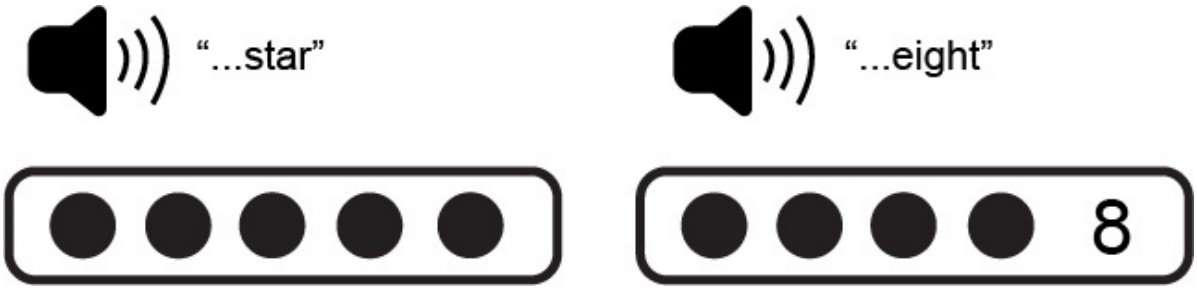

Figure 6 Privacy – speech output for private information

Test procedure:

1. Identify all aspects of the functionality of the product which require the user to provide or confirm passwords, financial information, health information, or personally identifiable information.
2. Enable speech functionality. Ensure the screen does not read "blank" while speech functionality is enabled, unless that is the functionality that is visually displayed on the screen.

406 Standard Connections

Where applicable, standard connections shall be provided (conforming to 406). In most cases, this is the default. Most hardware does have standard connections.

406.1 General

Where data connections used for input and output are provided, at least one of each type of connection shall conform to industry standard non-proprietary formats.

Where an ICT provides user input or output device connection points, the ICT shall provide at least one input and/or output connection that conforms to an industry standard non-proprietary format, directly or by using commercially available adapters.

[6] See: https://atk-production.herokuapp.com/requirements/rtt-interoperability-pstn-voip-using-sip

Non-proprietary industry standard connections include USB, USB-C, HDMI, 3.5 mm headphone jack, ethernet port, SD Card reader, and VGA ports.

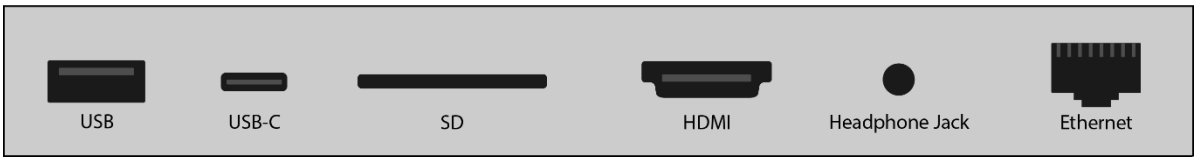

Figure 7 Non-proprietary industry standard connections

Test procedure:

1. In design review, locate all connections that are used to transmit data.
2. Ensure at least one non-proprietary industry standard connection is available for each type of connection.

407 Operable Parts

Where provided, operable parts used in the normal operation of ICT shall conform to 407. Operable parts consist of hardware that must be manipulated by the user for the ICT to operate.

407.1 General

Where provided, operable parts used in the normal operation of ICT shall conform to 407.

Normal operation (e.g., using keys to input data, create content, or operate ICT like a multifunction copier) is different from maintenance functions (e.g., changing toner on a printer).

An operable part of the hardware is used for activating, deactivating, or adjusting the ICT. An object is an “operable part” if the relationship is initiated, controlled, or part of the user process to complete a task. Think about opening a laptop to check your email or opening the manual page feeder drawer on a print device. Assess and put in scope the part that moves at the user’s control. Examples of operable parts include:

1. Notebook keyboards
2. Power button
3. Latch indention
4. Automatic document feeder guide walls on a print device
5. Scan glass door handle area on a print device

407.2 Contrast

Where provided, keys and controls shall contrast visually from background surfaces. Characters and symbols shall contrast visually from background surfaces with either light characters or symbols on a dark background or dark characters or symbols on a light background.

A color contrast analyzer can be used to assess the color ratio between the character or symbol and its background. The contrast should be no lower than 4.5:1 for normal text and 3:1 larger text that is greater than 18 pt. (i.e., 1.5em, 150%, 24px) or greater than bolded 14 pt. (i.e., 1.2em, 120%, 18.6px). Logos and purely decorative elements do not have to meet color contrast ratios.

Figure 8 Contrast – keyboard color contrast analyzed

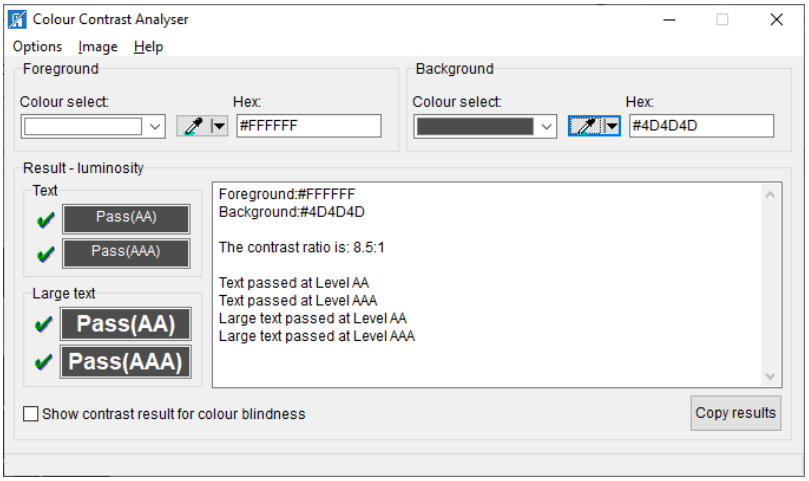

Figure 9 Contrast – Colour Contrast Analyser example

Figure 10 Contrast – failed color contrast

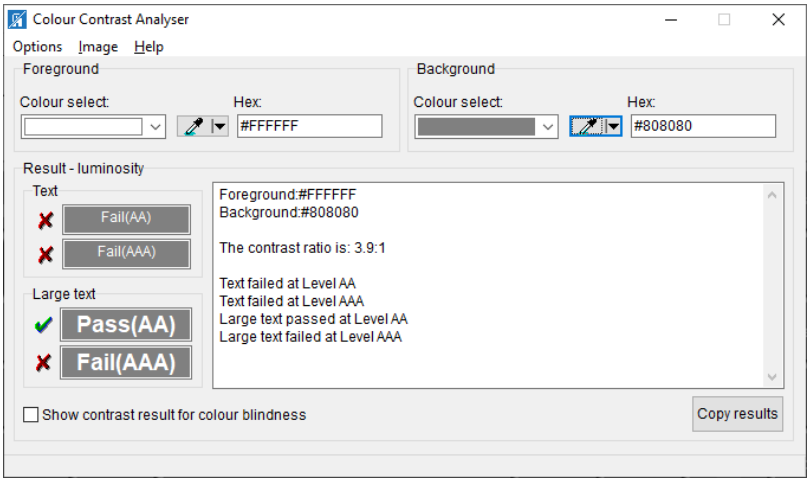

Figure 11 Contrast – failed Colour Contrast Analyser example

Test procedure:

1. Verify that all controls and keys contrast with their background surfaces, light on dark or dark on light.
2. Verify that text has a color contrast ratio of at least 4.5:1.
3. Verify that non-text elements has a color contrast ratio of at least 3:1.

407.3 Input Controls

At least one input control conforming to 407.3 shall be provided for each function. Devices for personal use with input controls that are audibly discernible without activation and operable by touch are exempt from this requirement; they are not required to conform to 407.3. Note that when a device functions both as a personal device and a “shared use” device the personal use exemption does not apply.

Ensure that each function has at least one input control that conforms to 407.3.1, 407.3.2 and 407.3.3, as applicable.

Element Type	Tactile indication is required	Either tactile or auditory indication is required	Example Image
Element is an input control	Yes	No	
Element shows the status of an operation	No	Yes	
Element is an input control that also shows the status of an operation	Yes	Yes	 

407.3.1 Tactilely Discernible

Input controls shall be operable by touch and tactilely discernible without activation.

Where ICT has tactilely operable parts, it shall provide a means to discern each operable part, without requiring vision and without performing the action associated with the operable part. An exception to this requirement is in U.S. Revised Section 255/508 for personal use devices with input controls that are audibly discernible without activation and operable by touch. Those devices shall not be required to conform. Only one control to perform a given function must meet this

requirement. In summary, input controls are to be tactilely discernible without activation, as well as operable by touch.

Key surfaces outside active areas of display screens are to be raised above their surrounding surfaces. By requiring raised key surfaces, it does not thereby intend to prohibit contouring of keys. Users with limited manual dexterity may prefer concave keys, for example, by providing keys with raised edges and concave centers, as is often used on computer keyboards and landline telephone keypads.

Figure 12 Tactilely discernible – on/off switch

Touch screen buttons present a problem for conformance to this standard. This type of button can be challenging to adjust without vision. The status of these buttons cannot be determined by touch, and any touch may adjust previously set settings.

Figure 13 Tactilely discernible – failing example

Test procedure:

1. Verify that if there is only one control available to perform a given function, that one control must be discernible by touch without activating the control.

407.3.2 Alphabet Keys

Where provided, individual alphabetic keys shall be arranged in a QWERTY-based keyboard layout, and the ‘‘F’’ and ‘‘J’’ keys shall be tactilely distinguishable from the other keys. Where the ICT provides an alphabetic overlay on numeric keys, the relationships between letters and digits shall conform to ITU-T Recommendation E.161.[7] Devices for personal use with input controls that are audibly discernible without activation and operable by touch shall not be required to conform to this clause. When a device can be a personal device and shared use device the personal use exemption does not apply.

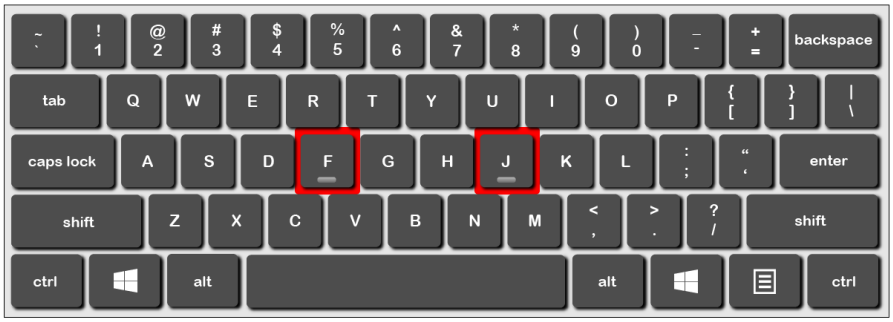

Figure 14 Alphabet keys – “F” and “J” keys are tactilely discernible

Test procedure:

1. Verify that the keyboard is arranged in a QWERTY-based layout.
2. Ensure that the "F" and "J" keys are tactilely distinguishable from other keys.
3. Where the ICT provides an alphabetic overlay on numeric keys, the relationships between letters and digits shall conform to ITU-T Recommendation E.161.

407.3.3 Numeric Keys

Where provided, numeric keys shall be arranged in a 12-key ascending or descending keypad layout. The number five key shall be tactilely distinct from the other keys. Where the ICT provides an alphabetic overlay on numeric keys, the relationships between letters and digits shall conform to ITU–T Recommendation E.161 (i.e., incorporated by reference, see 702.7.1).

[7] ITU-T Recommendation E.161 Available at: https://www.itu.int/rec/T-REC-E.161-200102-I/en

Figure 15 Numeric keys – tactilely discernible

Where provided, numeric keys shall be arranged in a 12-key ascending or descending keypad layout. The number five key shall be tactilely distinguishable from the other keys. Devices for personal use with input controls that are audibly discernible without activation and operable by touch shall not be required to conform to this clause. A number row on a QWERTY-based keyboard does not fail this requirement. When a device can be a personal device and shared use device the personal use exemption does not apply.

A telephone keypad and a keypad on a computer keyboard differ in one significant feature, ascending versus descending numerical order of the layout. Some keypads will have a double width zero key and decimal key instead of the asterisk and pound signs found on a telephone keypad.

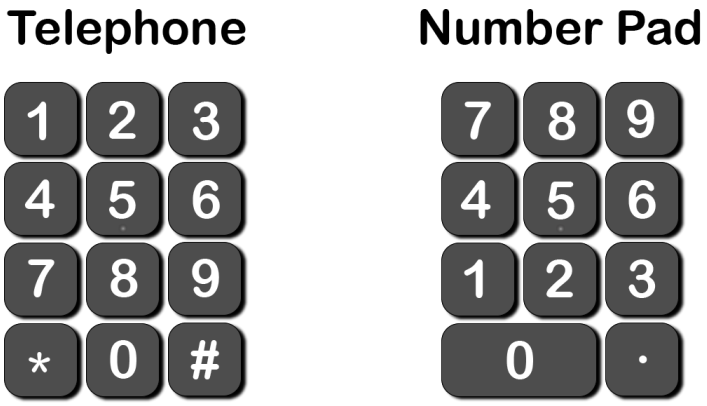

Figure 16 Numeric Keys - 12 Key ascending versus descending keypad layout

Test procedure:

1. Numeric keys shall be arranged in a 12-key ascending or descending keypad layout.
2. The number five key shall be tactilely distinct from the other keys.
3. Where the ICT provides an alphabetic overlay on numeric keys, the relationships between letters and digits shall conform to ITU-T Recommendation E.161.

407.4 Key Repeat

Where a keyboard with key repeat is provided, the delay before the key repeat feature is activated shall be fixed at, or adjustable to, 2 seconds minimum.

Where ICT includes a keyboard where key repeat is provided and the key repeat cannot be turned off, the delay before the key repeat shall be adjustable to at least 2 seconds and the key repeat rate shall be adjustable down to one character per 2 seconds.

Test procedure:

1. Verify that the key repeat feature is configured in one of the following ways:
    a. Key repeat is available, off by default, and can be turned on/off.
    b. The timing before the key repeat feature activates is fixed and 2 seconds minimum.
    c. The timing before key repeat activates is adjustable and can be adjusted to be 2 seconds minimum.

407.5 Timed Response

Where a timed response is required, the user shall be alerted visually, as well as by touch or sound, and shall be given the opportunity to indicate that more time is needed.

To test for this requirement, identify all tasks, workflows and/or user interfaces which have a timeout. Then, ensure that the timeout for each of these tasks. The user is alerted visually and through either sound or touch. Finally, verify that the user is provided with an accessible means to indicate that more time is needed (i.e., via a control which does not require sight or hearing to use).

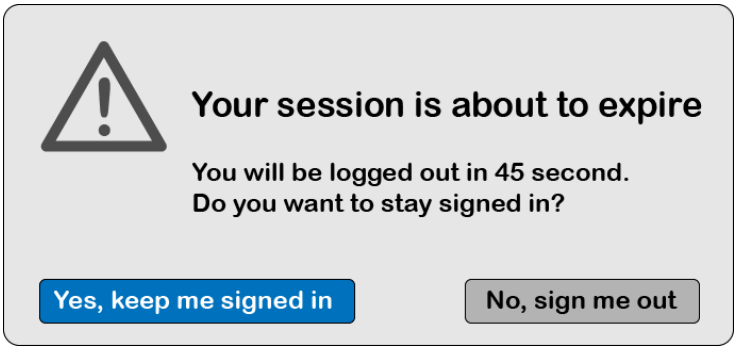

Figure 17 Timed response – session timeout

Test procedure:

1. Identify all tasks, workflows and/or user interfaces which have a timeout.

2. Ensure that the timeout for each of these tasks, the user is alerted visually and through either sound, touch, or vibration.
3. Verify that the user is provided with an accessible means to indicate that more time is needed (i.e., via a control which does not require sight or hearing to use).

407.6 Operation

At least one mode of operation shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds (i.e., 22.2 N) maximum.

Test procedure:

1. Identify all operations which potentially require fine motor skills like grasping, pinching, twisting, as well as actions like pushing and pulling which may engage larger limb and body movements.
2. Verify that all operations can be performed with one hand.
3. Ensure there is no tight grasping, pinching or wrist twisting actions required.
4. Use a force meter to measure all pushing, pulling or other actions that require more than an extremely light touch. To pass, operable parts must not exceed 5 pounds (i.e., 22.2N) maximum.

407.7 Ticket, Fare Cards, Key Cards

Where tickets, fare cards, or key cards are provided, they shall have an orientation that is tactilely discernible if orientation is important to further use of the ticket, fare card, or key card.

Any different number of physical discernments of a ticket, fare card, or key card is acceptable including braille labels, notches, off-centered holes, or irregular shapes. This will help the user identify the direction of the ticket or card. If a ticket, fare card, or keycard cannot be tactilely discerned, then this requirement is not met.

Test procedure:

1. The proper orientation for the ticket, fare card, or key card should be tactilely discernable.

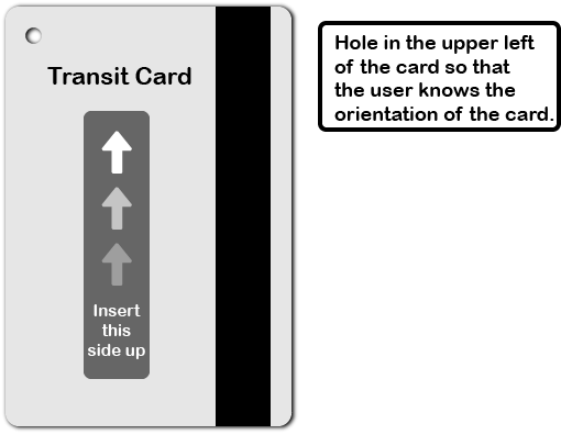

Figure 18 Ticket, fare cards, key cards - tactilely discernible

407.8 Reach Height and Depth (Stationary ICT Only)

At least one of each type of operable part of stationary ICT shall be at a height conforming to 407.8.2 or 407.8.3 according to its position established by the vertical reference plane specified in 407.8.1 for a side reach or a forward reach. Operable parts used with speech output required by 402.2 shall not be the only type of operable part complying with 407.8 unless that part is the only operable part of its type.

407.8.1 Vertical Reference Plane (Stationary ICT Only)

Operable parts shall be positioned for a side reach or a forward reach determined with respect to a vertical reference plane. The vertical reference plane shall be located in conformance to 407.8.2 or 407.8.3.

The vertical reference plane shall be centered on the operable part and placed at the leading edge of the maximum protrusion of the ICT within the length of the vertical reference plane. Where a side reach requires a reach over a portion of the ICT, the height of that portion of the ICT shall be 34 inches (i.e., 865 mm) maximum.

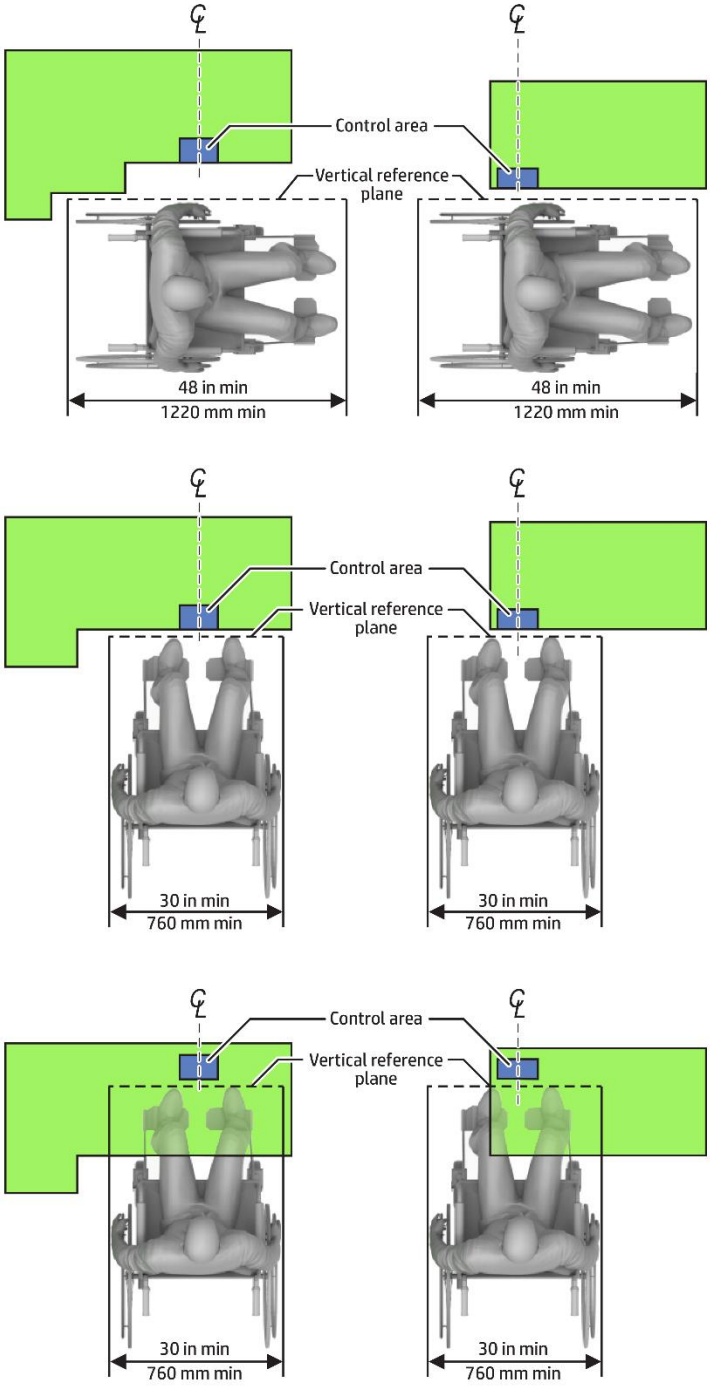

Figure 19 Vertical reference plane diagram

Test procedure:

1. If a side reach is required to reach all hardware controls, the vertical reference plane used to test the side reach should comply with 407.8.1.1.
2. If a forward reach is required to reach all hardware controls, the vertical reference plane used to test the side reach should comply with 407.8.1.2.

407.8.1.1 Vertical Plane for Side Reach (Stationary ICT Only)

Where a side reach is provided, the vertical reference plane shall be 48 inches (i.e., 1220 mm) long minimum.

Where the operable part is located 10 inches (i.e., 255 mm) or less beyond the vertical reference plane, the operable part shall be 48 inches (i.e., 1220 mm) high maximum and 15 inches (i.e., 380 mm) high minimum above the floor.

Test procedure:

1. Ensure that, when a side reach is required, the vertical reference plane should be at least 48 inches long.

407.8.1.2 Vertical Plane for Forward Reach (Stationary ICT Only)

Where a forward reach is provided, the vertical reference plane shall be 30 inches (i.e., 760 mm) long minimum.

Operable parts of ICT providing a forward reach shall conform to 407.8.3.1 Unobstructed Forward Reach or 407.8.3.2 Obstructed Forward Reach. The vertical reference plane shall be centered, and intersect with, the operable part. Where a forward reach allows a reach over a portion of the ICT, the height of that portion of the ICT shall be 34 inches (i.e., 865 mm) maximum.

Test procedure:

1. When a forward reach is required, ensure that the vertical reference plane is at least 30 inches long.

407.8.2 Side Reach (Stationary ICT Only)

Operable parts of ICT providing a side reach shall conform to 407.8.2.1 or 407.8.2.2. The vertical reference plane shall be centered on the operable part and placed at the leading edge of the maximum protrusion of the ICT within the length of the vertical reference plane. Where a side reach requires a reach over a portion of the ICT, the height of that portion of the ICT shall be 34 inches (865 mm) maximum.

Test procedure:

1. When testing a side reach with 407.8.2.1 or 407.8.2.2, ensure that the vertical reference plane meets the following specifications:
    a. Vertical reference plane should be at least 48 inches long.
    b. Vertical reference plane should be centered on the user control being tested.
    c. Vertical reference plane should be placed on the leading edge of the maximum protrusion of the ICT within the length of the reference plane.

d. If the user is required to reach over part of the ICT, that part should be no more than 34 inches high.

407.8.2.1 Unobstructed Side Reach (Stationary ICT Only)

Where the operable part is located 10 inches (i.e., 255 mm) or less beyond the vertical reference plane, the operable part shall be 48 inches (i.e., 1220 mm) high maximum and 15 inches (i.e., 380 mm) high minimum above the floor.

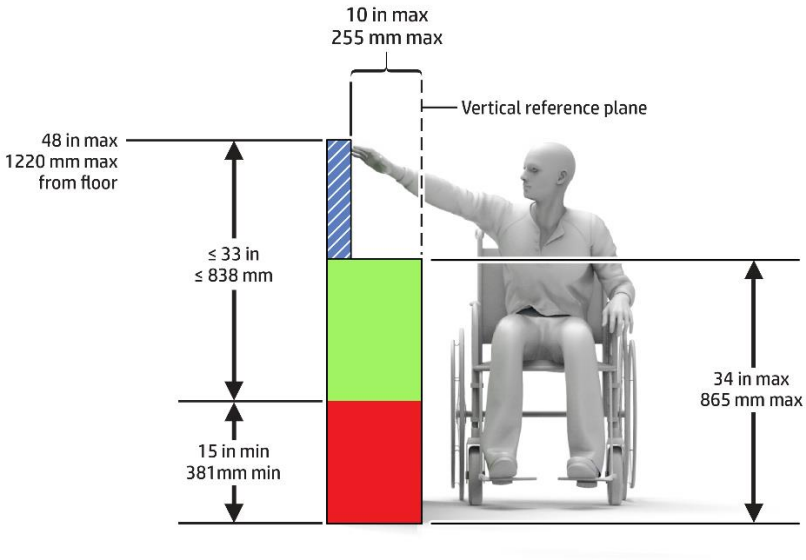

Figure 20 Unobstructed side reach diagram

Test procedure:

1. Establish a vertical reference plane for the ICT that complies with 407.8.2.
2. Verify that the control being tested is no more than 10 inches beyond the vertical reference plane.
    a. If the control is more than 10 inches beyond the reference plane, test using 407.8.2.2 instead.
3. Ensure that the operable part is at least 15 inches above the floor and no more than 48 inches high.

In the example image below, the user must reach over a portion of the print device to open and close the scanner lid. The scanner lid is located above the 34 inch (i.e., 865 mm) maximum height requirement causing the printer to fail this requirement. Some users may have difficulties operating the print device's scan feature because the scanner lid cannot be easily accessed.

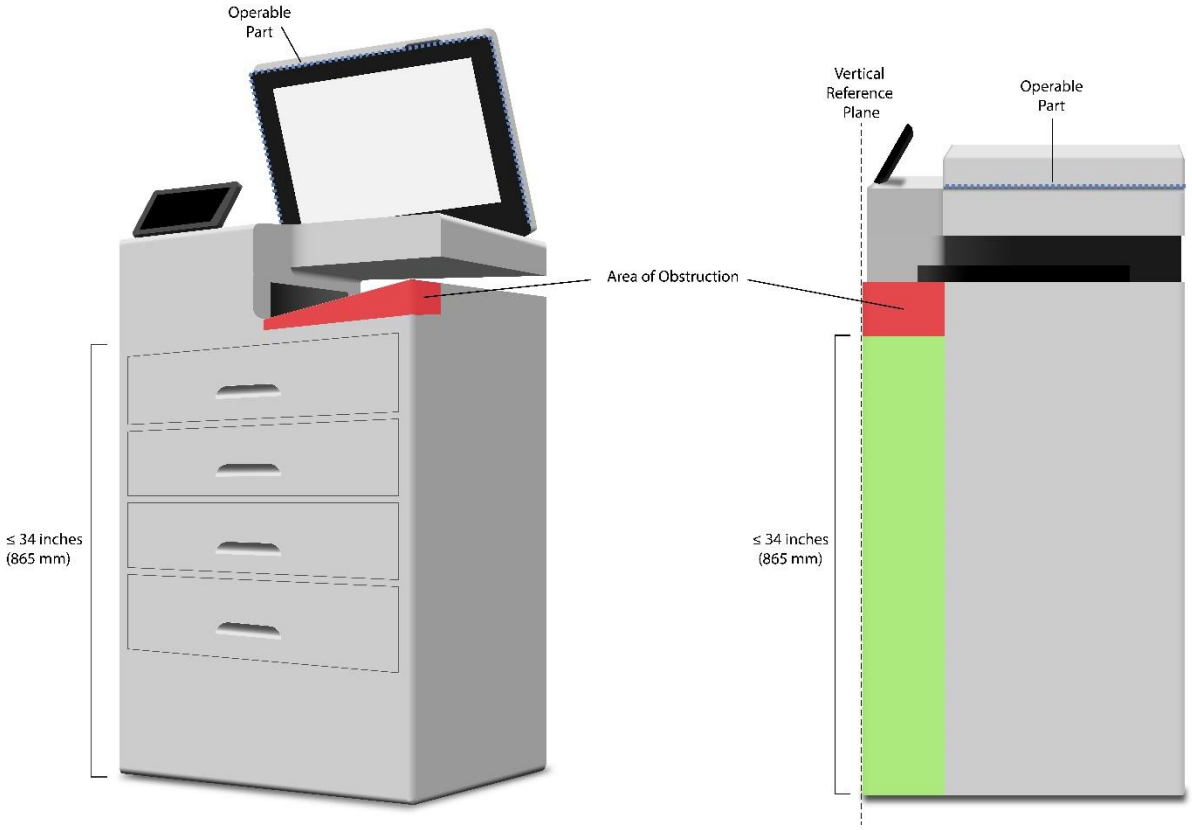

Figure 21 Side reach – failing example

407.8.2.2 Obstructed Side Reach (Stationary ICT Only)

Where the operable part is located more than 10 inches (i.e., 255 mm), but not more than 24 inches (i.e., 610 mm), beyond the vertical reference plane, the height of the operable part shall be 46 inches (i.e., 1170 mm) high maximum and 15 inches (i.e., 380 mm) high minimum above the floor. The operable part shall not be located more than 24 inches (i.e., 610 mm) beyond the vertical reference plane.

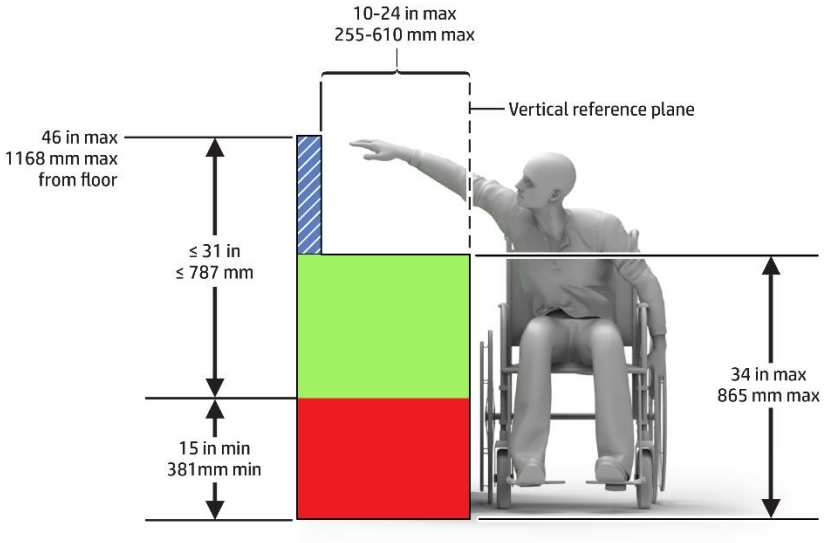

Figure 22 Obstructed side reach diagram

Test procedure:

1. Establish a vertical reference plane for the ICT that complies with 407.8.2.
2. Verify that the control being tested is between 10 and 24 inches beyond the vertical reference plane.
    a. If the control is less than 10 inches beyond the vertical reference plane, test using 407.8.2.2 instead.
    b. If the control is more than 24 inches beyond the vertical reference plane, it fails this criterion.
3. Ensure that the operable part is at least 15 inches above the floor and no more than 46 inches high.

407.8.3 Forward Reach (Stationary ICT Only)

Operable parts of ICT providing a forward reach shall conform to 407.8.3.1 or 407.8.3.2. The vertical reference plane shall intersect with the operable part and be centered. Where a forward reach allows a reach over a portion of the ICT, the height of that portion of the ICT shall be 34 inches (i.e., 865 mm) maximum.

Test procedure:

1. When testing a side reach with 407.8.3.1 or 407.8.3.2, ensure that the vertical reference plane meets the following specifications:
    a. Vertical reference plane should be 30 inches long minimum.
    b. Vertical reference plane should be centered on, and intersect with, the user control being tested.
    c. Vertical reference plane should be placed on the leading edge of the maximum protrusion of the ICT within the length of the reference plane.
    d. If the user is required to reach over part of the ICT, that part should be no more than 34 inches high.

407.8.3.1 Unobstructed Forward Reach (Stationary ICT Only)

Where the operable part is located at the leading edge of the maximum protrusion within the length of the vertical reference plane of the ICT, the operable part shall be 48 inches (i.e., 1220 mm) high maximum and 15 inches (i.e., 380 mm) high minimum above the floor.

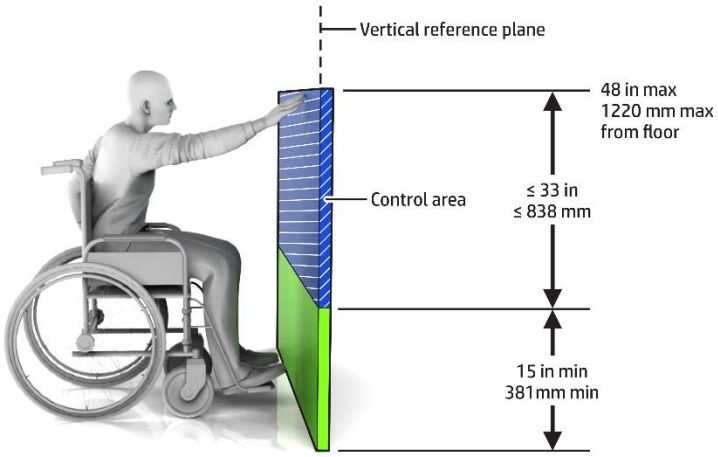

Figure 23 Unobstructed forward reach diagram

Test procedure:

1. Establish a vertical reference plane for the ICT that complies with 407.8.3.
2. Verify that the control being tested is at the leading edge of the maximum protrusion within the length of the vertical reference plane.
    a. If the control is less than 10 inches beyond the vertical reference plane, test using 407.8.3.2 instead.
    b. If the control is more than 24 inches beyond the vertical reference plane, it fails this criterion.
3. Ensure that the operable part is no more than 48 inches high and at least 15 inches above the floor.

407.8.3.2 Obstructed Forward Reach (Stationary ICT Only)

Where the operable part is located beyond the leading edge of the maximum protrusion within the length of the vertical reference plane, the operable part shall conform to 407.8.3.2. The maximum allowable forward reach to an operable part shall be 25 inches (i.e., 635 mm).

Test procedure:

1. Establish a vertical reference plane for the ICT that complies with 407.8.3.
2. Verify that the control being tested is no more than 25 inches beyond the vertical reference plane.

407.8.3.2.1 Operable Part Height for ICT with Obstructed Forward Reach (Stationary ICT Only)

The height of the operable part shall conform to Table 407.8.3.2.1.

Where the operable part is located beyond the leading edge of the maximum protrusion within the length of the vertical reference plane, the operable part shall conform to 407.8.3.2 Obstructed Forward Reach. The maximum allowable forward reach to an operable part shall be 25 inches (i.e., 635 mm).

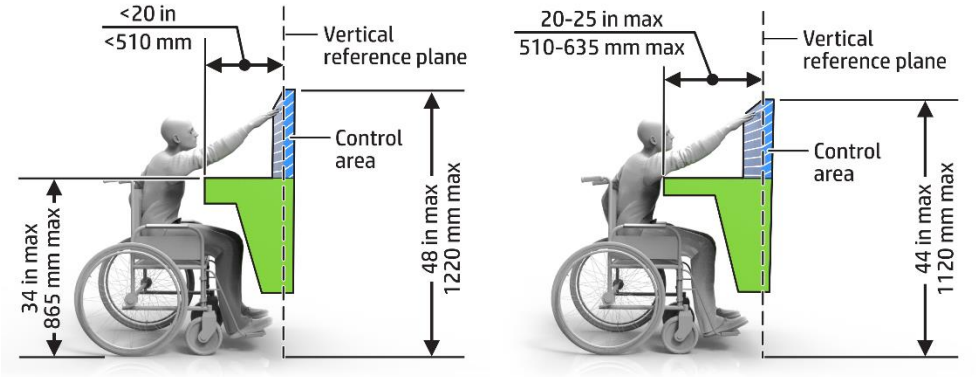

Figure 24 Operable part height for ICT with obstructed forward reach diagram

Test procedure:

1. The height of the operable part should be based its distance beyond the vertical reference plane:
    a. If the operable part is less than 20 inches beyond the vertical reference plane, it should be no more than 48 inches high.
    b. If the operable part is between 20 and 25 inches beyond the vertical reference plane, it should be no more than 44 inches high.

407.8.3.2.2 Knee and Toe Space under ICT with Obstructed Forward Reach (Stationary ICT Only)

Knee and toe space under ICT shall be 27 inches (i.e., 685 mm) high minimum, 25 inches (i.e., 635 mm) deep maximum, and 30 inches (i.e., 760 mm) wide minimum and shall be clear of obstructions.

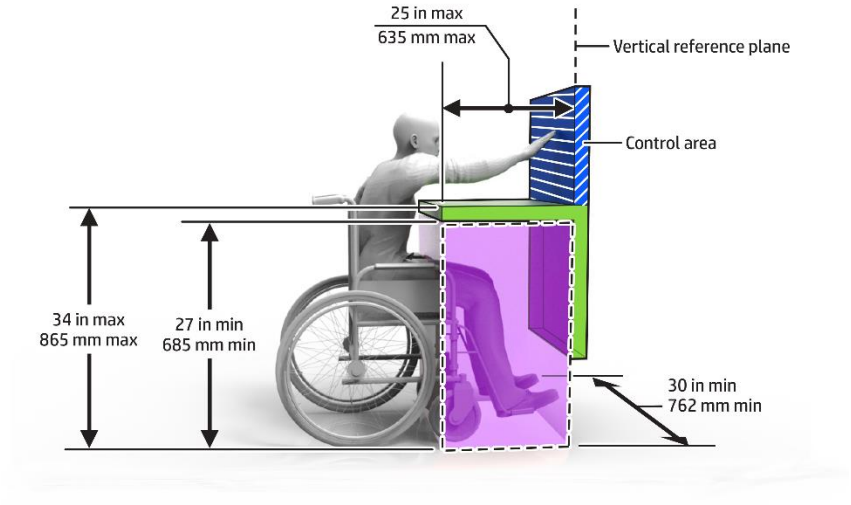

Figure 25 Knee and toe space under ICT with obstructed forward reach diagram

Exceptions to this requirement include:

1. Toe space shall be permitted to provide a clear height of 9 inches (i.e., 230 mm) minimum above the floor and a clear depth of 6 inches (i.e., 150 mm) maximum from the vertical reference plane toward the leading edge of the ICT.

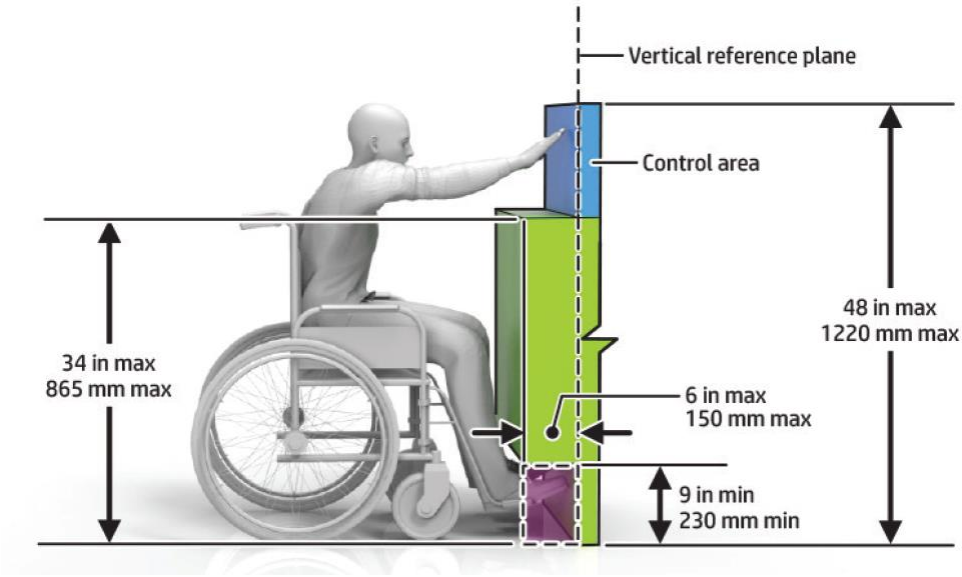

Figure 26 Knee and toe space – toe clearance diagram

2. At a depth of 6 inches (i.e., 150 mm) maximum from the vertical reference plane toward the leading edge of the ICT, space between 9 inches (i.e., 230 mm) and 27 inches (i.e., 685 mm) minimum above the floor shall be permitted to reduce at a rate of 1 inch (i.e., 25 mm) in depth for every 6 inches (i.e., 150 mm) in height.

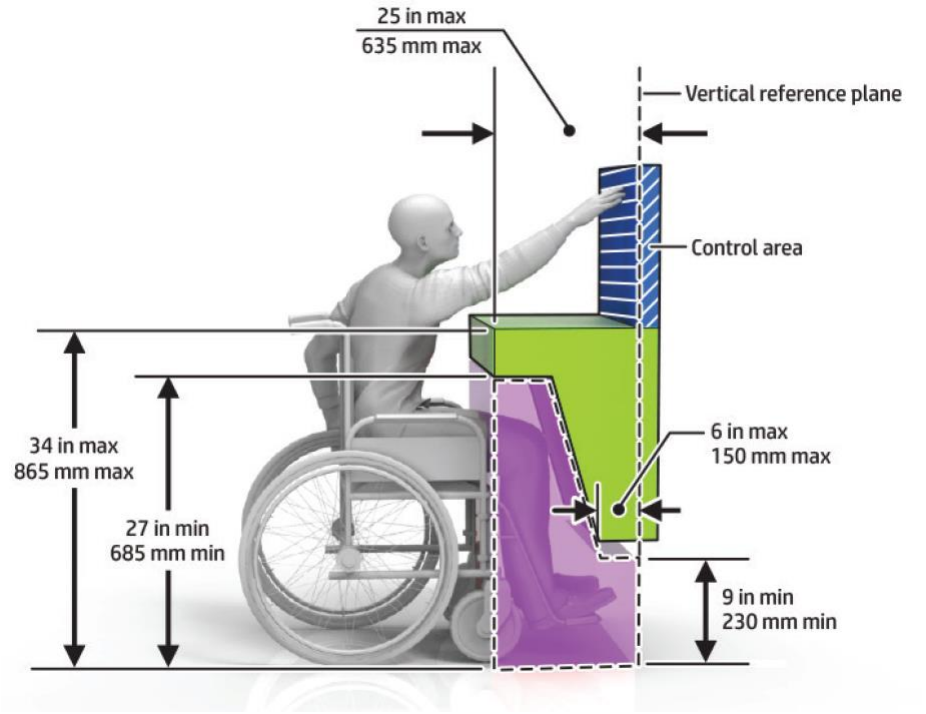

Figure 27 Knee and toe space – knee and toe clearance diagram

Test procedure:

1. Knee and Toe Space under the ICT should be:
    a. At least 27 inches high
    b. 25 inches deep maximum
    c. At least 30 inches wide
    d. Clear from obstructions

408 Display Screens

Where provided, display screens shall conform to 408. This section only applies to display screens.

408.1 General (Display screens only)

Where provided, display screens shall conform to 408.

408.2 Visibility (Display screens only)

Where stationary ICT provides one or more display screens, at least one of each type of display screen shall be visible from a point located 40 inches (i.e., 1015 mm) above the floor space where the display screen is viewed.

Where the operating area is integral to the ICT, and a display screen is provided, information on the screen should be legible from a point located 1015 mm (i.e., 40 inches) above the center of the floor of the operating area.

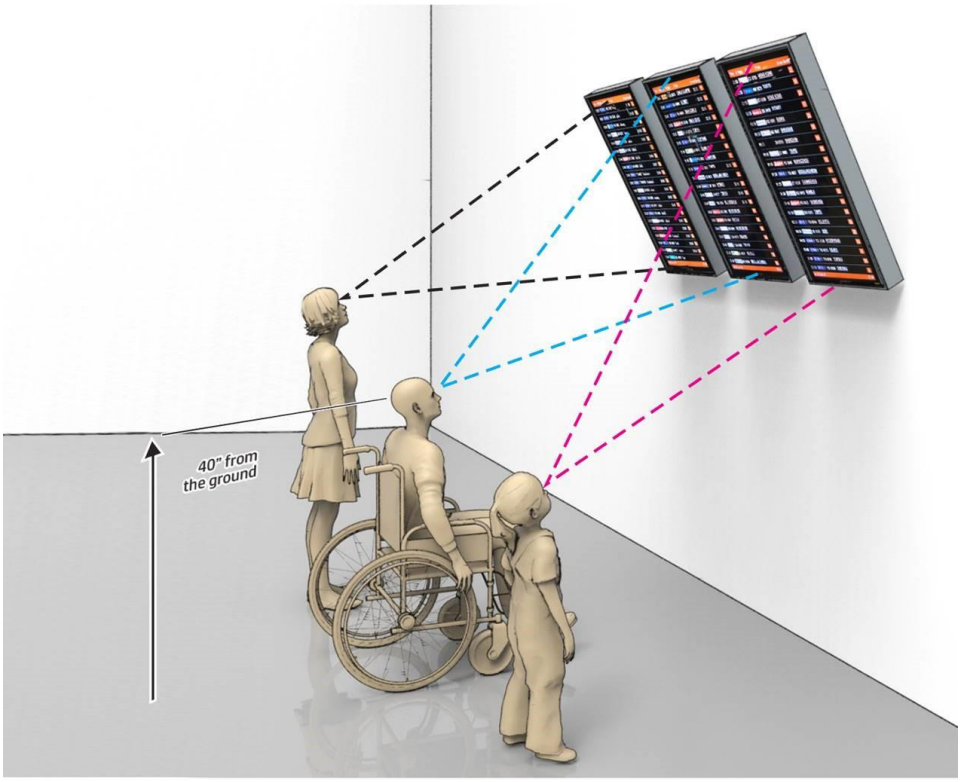

Figure 28 Visibility diagram

Test procedure:

1. Identify operating areas integral to the ICT where a display screen is provided.
2. Ensure the screen is legible from a point 1015 mm (i.e., 40 inches) above the center of the floor of the operating area.

408.3 Flashing (Display screens only)

Where ICT emits lights in flashes, there shall be no more than three flashes in any one-second period. This applies to display screens only.

An exception to this requirement occurs when flashes do not exceed the general flash and red flash thresholds defined in WCAG 2.0 (incorporated by reference). [8]

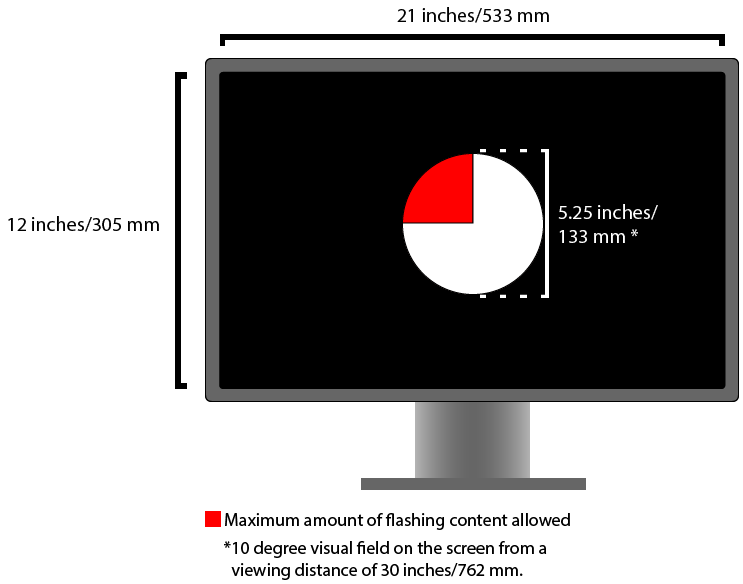

Figure 29 Flashing – maximum allowable flashing content

Test procedure:

1. Identify any flashing elements on the ICT.
2. Check the flash frequency. Make sure the frequency is set below 3Hz. If not determined programmatically, note this in the test. The result will be “Not Supported” if not measurable.

409 Status Indicators

Where provided, status indicators shall conform to 409.

[8] WCAG 2.0 – General flash and red flash threshold. Available at: https://www.w3.org/TR/WCAG21/#dfn-general-flash-and-red-flash-thresholds/

Element Type	Tactile indication is required	Either tactile or auditory indication is required	Example Image
Element is an input control	Yes	No	
Element shows the status of an operation	No	Yes	
Element is an input control that also shows the status of an operation	Yes	Yes	

409.1 General

Where provided, status indicators shall be discernible visually and by touch or sound.

Where ICT has a locking or toggle control and that control is visually presented to the user, the ICT shall provide at least one mode of operation where the status of the control can be determined either through touch or sound without operating the control.

Test procedure:

1. The status of the control should be discernible by a visual status indicator, as well as through either touch or sound.

410 Color Coding

Where provided, color coding shall conform to 410.

410.1 General

Where provided, color coding shall not be used as the only means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.

On a print device, buttons may include color. Ensure that the color used for the button has a secondary way to be represented. An example would be a red “X” button to cancel a print job. Since the button contains color as well as a symbol to identify the purpose of the button, the requirement would be met. Color isn’t the sole identification method for the button.

Figure 30 Color coding

When hardware uses only color to convey information, indicate an action, prompt a response, or distinguish a visual element, the information may be misinterpreted by a user who is unable to differentiate colors. A barrier of use is created when a user is unable to identify the purpose of conveyed information, indicated actions, prompted responses, or visual elements. If a print device contains a status bar that relays error notifications by displaying a specific color on the status bar and the only change between displayed errors is the color of the bar, then it fails this requirement.

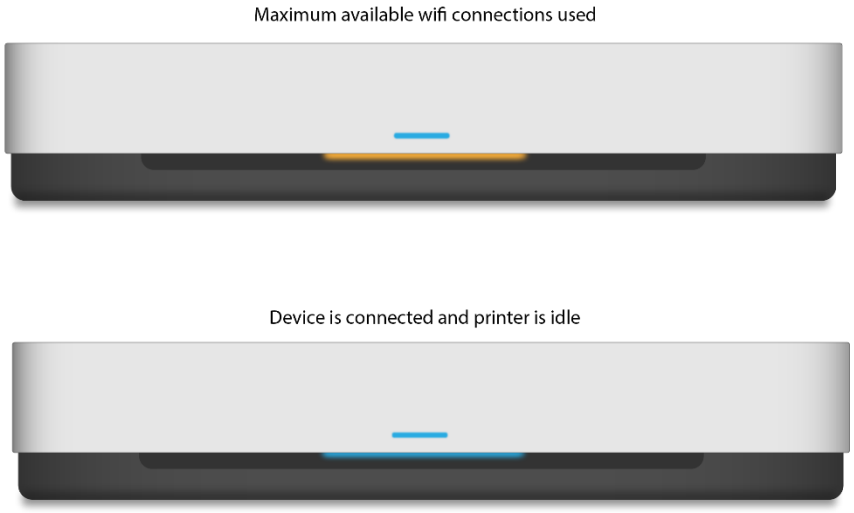

Figure 31 Color coding – failing example

Test procedure:

1. Identify all user-operable parts and user interfaces.
2. Ensure that color is not the sole indication of status or sole means to distinguish the control or hardware from other controls and hardware.

411 Audible Signals

Where provided, audible signals shall conform to 411.

411.1 General

Where provided, audible signals or cues shall not be used as the only means of conveying information, indicating an action, or prompting a response.

Audio signaling shall not be used as the only means of conveying information, indicating an action, or prompting a response. For example, when a print device provides a warning tone, a visual message will also appear on the print device to identify the user of the warning.

Figure 32 Audible signals

Test procedure:

1. Disable the audio for the device under test, or otherwise create a soundproof environment (e.g., with noise cancelling headphones).
2. Attempt to perform the same basic user scenarios as outlined in the main test specification(s) for the product.
    a. Prioritize any testing which focuses on error conditions (e.g., incorrect identification information provided, paper jammed in a printer, invalid key pressed on a phone keypad).
    b. Also prioritize any testing which expects a confirmation from the user before completing an action (e.g., subtotaling purchases before requesting payment).
        i. For example, for self-contained single-purpose retail point of sale kiosk (i.e., a cash register which is not simply a tablet or desktop computer with point-of-sale software), ignore any audio prompts and perform all the basic functionality testing for identifying items, applying discounts, totaling final cost, accepting payment, etc.
3. Verify that audible signals or cues are not used as the only means of conveying information, indicating an action, or prompting a response.

412 ICT with Two-Way Voice Communication

Where provided, two-way voice communications shall conform to 412.

412.2 Volume Gain

Volume gain conforming to 47 CFR 68.317 shall be provided on analog and digital wireline telephones. [9]

Analog and digital wireline telephones shall have a volume gain that is adjustable on the handset from 12 dB minimum to 18 dB maximum measured in term of Receive Objective Loudness Rating

[9] 47 CFR 68.317 – Volume Gain. Available at: https://www.govinfo.gov/content/pkg/CFR-2011-title47-vol3/pdf/CFR-2011-title47-vol3-sec68-317.pdf

(i.e., ROLR) with the minimum gain being achieved without clipping. The ROLR shall be determined over a frequency range of 300 to 3300 Hertz (Hz) for short, average, and long loop conditions represented by 0, 2.7, and 4.6 km of 26 American Wire Gauge (AWG) non-loaded cable, respectively and tested at the minimum volume setting. The input level to the cable simulator shall be -10 dB with respect to 1 V open circuit from a 900-ohm source.

412.2.1 Volume Gain for Wireline Telephones

Volume gain conforming to 47 CFR 68.317 shall be provided on analog and digital wireline telephones.

Analog and digital wireline telephones shall have a volume gain that is adjustable on the handset from 12 dB minimum to 18 dB maximum measured in term of Receive Objective Loudness Rating (ROLR) with the minimum gain being achieved without clipping. The ROLR shall be determined over a frequency range of 300 to 3300 Hertz (Hz) for short, average, and long loop conditions represented by 0, 2.7, and 4.6 km of 26 American Wire Gauge (AWG) non-loaded cable, respectively and tested at the minimum volume setting. The input level to the cable simulator shall be -10 dB with respect to 1 V open circuit from a 900-ohm source.

Test procedure:

1. Verify that the volume gain of the telephone receiver has a volume control and ranges from 12dB of gain minimum to 18 dB of gain maximum. Refer to 47 CFR 68.317 for additional technical information.

412.2.2 Volume Gain for Non-Wireline ICT

A method for increasing volume shall be provided for non-wireline ICT.

Examples that would meet this requirement include:

1. Buttons on the side of a device.
2. Volume controls located in a keyboard.

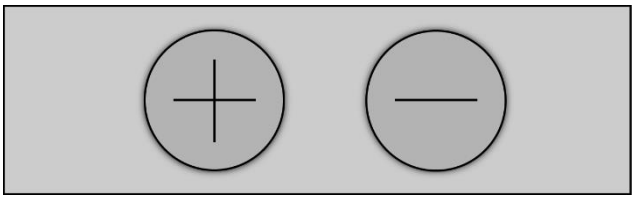

Figure 33 Volume gain for non-wireline ICT – volume adjustment

Test procedure:

1. Verify that a method for increasing volume is provided.

412.3 Interference Reduction and Magnetic Coupling

Where ICT hardware is a wireless communication device with speech output that is normally held to the ear, it shall provide a means of magnetic coupling to hearing technologies which meets the

requirements of ES 200 381-2.[10] ICT fulfilling the requirements of ANSI/IEEE C63.19 [i.1] is deemed to comply with the requirements of this clause.

Exception: The U.S. Revised Section 508 does not specify the standard that must be met.

Since the ICT held to the ear can be wired, wireless or fixed, there are standards with which the ICT needs to comply. Depending on the product, the ICT needs to be measured against the standard. This requirement is met if the ICT passes the appropriate standard compliance. Standards include:

1. ANSI/TIA/EIA-504 Magnetic Field Intensity Criteria for Telephone Compatibility with Hearing Aids (latest amendment), TIA-1083[11]
2. Telephone Terminal Equipment Handset Magnetic Measurement Procedures and Performance Requirements (latest amendment), ETSI ES 200 381-1 Telephony for hearing impaired people
3. Inductive coupling of telephone earphones to hearing aids Part 1: Fixed-line speech terminals (latest amendment)
4. ANSI C63.19 2011 American National Standard for Methods of Measurement of Compatibility Between Wireless Communication Devices and Hearing Aids (latest amendment)

Test procedure:

1. Review the design specifications for the ICT device and ensure that either:
    a. a transducer with a moving coil is used, or
    b. if a custom design is used, that the transducer has been characterized to produce a magnetic field.

412.3.1 Wireless Handsets

ICT in the form of wireless handsets shall conform to ANSI/IEEE C63.19–2011 (incorporated by reference, see 702.5.1).

Where ICT hardware is a wireless communication device with speech output which is normally held to the ear, it shall provide a means of magnetic coupling to hearing technologies which meets the requirements of ES 200 381-2 [3]. ICT fulfilling the requirements of ANSI/IEEE C63.19 [i.1] is deemed to comply with the requirements of this clause.[12]

Refer to ANSI C 63.19-2011 for a testing procedure.

Interreference needs to be measured for the microphone and telecoil. A minimum rating of T3 and M3 is required to comply with this requirement. If the ICT achieves a rating greater than T3 and greater than M3, the product will be relatively better than a product which is T3 and M3. If practical

[10] ES 200 381-2 – Interference reduction and magnetic coupling. Available at: https://www.etsi.org/deliver/etsi_es/200300_200399/20038102/01.01.01_60/es_20038102v010101p.pdf

[11] TIA-1083 available at: https://hp.sharepoint.com/teams/AccessTeamSite/reporting/_layouts/15/download.aspx?SourceUrl=%2Fteams%2FAccessTeamSite%2Freporting%2FShared%20Documents%2FStandards%2FLibrary%2FNon%2DPublic%20Documents%28Controlled%29%2FTIA%2D1083%2Epdf

[12] ANSI/IEEE C63.19-2011 – American National Standard Methods of Measurement of Compatibility between Wireless Communications Devices and Hearing Aids. Available at: https://hp.sharepoint.com/teams/AccessTeamSite/reporting/Shared%20Documents/Standards/Library/Non-Public%20Documents(Controlled)/IEEEANSI.pdf

to do so, this requirement recommends a better rating than T3 and M3 which reflects on less interference and more clarity of the audio heard by the user of the assistive hearing device.

The U.S. Revised Section 508 does not specify the standard that must be met.

412.3.2 Wireline Handsets

ICT in the form of wireline handsets, including cordless handsets, shall conform to TIA–1083–B (incorporated by reference, see 702.9.1).

Where ICT hardware is a fixed-line communication device with speech output that is normally held to the ear and carries the "T" symbol specified in ETS 300 381, it shall provide a means of magnetic coupling which meets the requirements of ES 200 381-2.[13]

ICT fulfilling the requirements of TIA-1083-A [i.24] is deemed to comply with the requirements of this clause.

Test procedure:

1. Confirm ICT hardware carries the “T” symbol. The ICT device must be characterized against the TIA 1083-A (2010) standard and is compliant if all aspects of the TIA 1083-A (2010) are satisfied.

412.4 Digital Encoding of Speech

ICT in IP-based networks shall transmit and receive speech that is digitally encoded in the manner specified by ITU–T Recommendation G.722.2 (incorporated by reference, see 702.7.2) or IETF RFC 6716 (incorporated by reference, see 702.8.1). [14, 15]

Where ICT provides two-way voice communication (to provide good audio quality), ICT should be able to encode and decode two-way voice communication with a frequency range with an upper limit of at least 7,000 Hz (as specified by ITU-T Recommendation G.722.2). This requirement applies not only to the ICT device itself but also to any accessory that may be used in conjunction with the ICT in order to effectively encode and decode speech information. Scope includes any product which decodes or encodes voice communication for use by the end user.

Test procedure for decoding “receive” ICT:

1. Using a source ICT or other device, send a voice communication message to a receiving ICT consisting of a series of tones ranging from 20 Hz to 20000 Hz that have a consistent amplitude and clean audio signal parametric in the entire frequency range. Typically, a professional audio sweep generator made by HP can be used as the source for this purpose.
2. At the receiver ICT, connect a professional audio analyzer to the audio output circuit at a point after the decoding has taken place, and after any amplification, and before any transducer.

[13] ETS 300 381 – Wireline Handsets. Available at: https://www.etsi.org/deliver/etsi_i_ets/300300_300399/300381/01_60/ets_300381e01p.pdf

[14] IETF RFC 6716 – Digital Encoding of Speech. Available at: https://tools.ietf.org/pdf/rfc6716.pdf

[15] ITU-T Recommendation G.722.2 – Digital Encoding of Speech. Available at: https://www.itu.int/rec/T-REC-G.722.2-200307-I/en

3. Using an audio sweep generator, sweep the source ICT over the frequency range keeping the amplitude constant.
4. Using the audio analyzer, develop a frequency vs. amplitude plot for the receive ICT. Make three separate plots using the volume control on the receive ICT: low volume, mid. volume, and maximum volume.
5. Examine all the plots. The curve should be a relatively flat +/- 1.0 dB over the frequency range with no more than 3 dB of degradation at any point up to the 7000 Hz limit. If any plot is non-compliant, this requirement has not been met.

Test procedure for encoding “source” ICT:

1. Modify the source ICT accordingly to inject audio tones from 20 Hz to 20000 Hz that have a consistent amplitude and clean audio signal parametric in the entire frequency range. Typically, a professional audio sweep generator made by HP can be used for this purpose. The modifications should be made before the encoder circuity and as close to the ICT end user audio source as possible (i.e., a jack or plug input on the ICT).
2. Broadcast or directly connect the source ICT to a receive ICT. Connect a professional audio analyzer to the receive ICT at a point where the received audio from the source ICT can be monitored. Note: the receive ICT device should meet all specifications, ensuring no false readings. It is recommended the receive ICT be characterized for its audio performance.
3. Using the audio tone generator, sweep the source ICT over the frequency range 20 Hz - 20000 Hz keeping the amplitude constant.
4. At the receiver ICT connect an audio analyzer to the audio output circuit at a point after the decoding has taken place and before any amplification. a. It may be possible to directly connect some form of system analyzer to the source ICT in place of the above step.
5. Using the audio analyzer, develop a frequency vs. amplitude plot on the receive ICT. If there is an adjustable gain control on the source ICT, take three separate plot measurements: low volume, mid. volume, maximum volume on the receive ICT.
6. Examine all the plots on the receive ICT. The curves should be a relatively flat +/- 1.0 dB over the frequency range with no more than 3 dB of degradation at any point up to the 7000 Hz limit. If any plot is non-compliant, this requirement has not been met.

   Note: The above steps can be simplified if an audio analyzer can capture and decode the output of the encoder in the source ICT. Follow the same basic steps in sweeping the audio signals, etc.

412.5 Real-Time Text Functionality

Where ICT supports two-way voice communication in a specified context of use, the ICT shall allow a user to communicate with another user by RTT. The RTT capability can be provided as a factory default or added later. Provision of RTT may require additional service provision, additional hardware, and/or software which may be provided separately or together.

Test procedure:

1. Connect two separate ICT devices either directly or wireless that are designed for RTT functionality.
   a. ICT 1: Initiator
   b. ICT 2: Receiver
2. Enable the RTT option on each ICT.
3. Enter a text message on ICT 1 starting with simple characters alone and gradually increasing to words or phrases.

4. As ICT 1 is transmitting the RTT information, examine the ICT 2 text display. The characters transmitted by ICT 1 should immediately appear in the ICT 2 display with minimal to no delay and no errors or emissions.
5. Repeat the above steps using ICT 2 as the initiator and ICT 1 as the receiver.

412.6 Caller ID

Where provided, caller identification and similar telecommunications functions shall be visible and audible.

Caller identification and similar telecommunications functions shall be available in text form and in at least one other modality. The Caller ID information presented to the user must be available not only in a text form (visual) but also in at least one other modality. A modality is the way or mode in which something exists or is presented. Examples of Caller ID functions addressed by this requirement include: messages waiting, duration of call in progress, call waiting, dialing directory, wireless signal strength, and battery power.

Test procedure:

1. Identify all audio and visual Caller ID functions that are included in the ICT device by design.
2. Match the items identified in step 1 above to the user manual requirements. All Caller IDs should match.
3. Initiate each Caller ID and validate that the following is true:
    a. The Caller ID is seen in a text form.
    b. The Caller ID is seen in its original form.
    c. The Caller ID appears in an alternative form.
        i. Example: if the Caller ID is an audio alert, ensure there is both a text (visual) form and the original audio form.
        ii. Example: if the Caller ID is a visual alert, ensure there is both a text (visual) form and the original visual form. There should also be an audio form.

412.7 Video Communication

Where ICT provides real-time video functionality, the quality of the video shall be sufficient to support communication using sign language.

Sign language can become unreadable or blurry if the video characteristics of the ICT are inadequate.

Test procedure:

1. Measure latency and frame rate. The IEEE method uses the concept of embedding a timestamp in the caller's video.
    a. The timestamp (i.e., the current system time at the machine running the caller user agent) is displayed at the monitor (ICT) of the machine running the caller user agent every "t" time units.
    b. A webcam is attached to the ICT running the caller user agent and faces the ICT monitor and captures the current image on the monitor, including the timestamp.
    c. The caller user agent then encodes this captured frame with the timestamp and sends it over the network to the callee user agent, which decodes the frame and displays it on its ICT monitor.

d. An application running on the same ICT as the callee user agent grabs the timestamp from the received frame and calculates the time difference between the timestamp grabbed from the received frame and local system time.
e. The timestamps are processed to calculate latency and frame rate.

2. Determine bit rate by using a video measurement test instrument capable of detecting and measuring bit rates using captured video frames. Software applications can also be used to measure the bit rate of the video signal.
3. Measure the delta time between a video signal that has an audio component until the audio component is heard by the user.
   Example: Assume the letter "A" is spoken by the caller. The callee will see the caller's video and should also hear the audio for the letter "A". The sound synchronism is the time delay between the visual and the audio for the letter "A". Compensation for any system embedded delays would need to be subtracted. A simple microphone can be substituted for the webcam. In conjunction with the video monitor test instrument the time can be determined.

412.8 Legacy TTY Support

Guidance for legacy TTY support can be found in the Legacy Section 508 1194.23 paragraphs (a) through (e). [16]

412.8.1 TTY Connectability

ICT shall include a standard non-acoustic connection point for TTYs.

Test procedure:

1. Confirm that at least one industry-standard connector is provided.

412.8.2 Voice and Hearing Carry Over

ICT shall provide a microphone capable of being turned on and off to allow the user to intermix speech with TTY use.

Test procedure:

1. Confirm that there is an on/off switch for microphones.

412.8.3 Signal Compatibility

ICT shall support all commonly used cross-manufacturer non-proprietary standard TTY signal protocols where the system interoperates with the Public Switched Telephone Network (PSTN).

Test procedure:

1. If the hardware supports voice communications functionality (not in the software), confirm it supports all commonly used cross-manufacturer non-proprietary standard TTY signal protocols.

[16] Legacy Section 508. Available at: https://www.govinfo.gov/content/pkg/FR-2000-12-21/pdf/00-32017.pdf

412.8.4 Voice Mail and Other Messaging Systems

Where provided, voice mail, auto-attendant, interactive voice response, and caller identification systems shall be usable with a TTY.

Test procedure:

1. Connect a TTY device to the device.
2. Verify that voice mail, caller ID, and other similar features can be used with the TTY.

413 Closed Caption Processing Technologies

Where used, closed caption processing technologies shall conform to 413.

413.1 General

Where ICT displays or processes video with synchronized audio, ICT shall provide closed caption processing technology that conforms to 413.1.1 or 413.1.2.

413.1.1 Decoding and Display of Closed Captions

Players and displays shall decode closed caption data and support display of captions.

Where ICT displays video with synchronized audio, it shall have a mode of operation to display the available captions. Where closed captions are provided as part of the content, the ICT shall allow the user to choose to display the captions.

Test procedure:

1. Check options to ensure that the ICT supports display of captions.

413.1.2 Pass Through of Closed Caption Data

Cabling and ancillary equipment shall pass through caption data.

Test procedure:

1. Confirm that the cabling and ancillary equipment pass through caption data.

414 Audio Description Processing Technologies

Where used, audio description processing technologies shall conform to 414.

414.1 General

Where ICT displays or processes video with synchronized audio, ICT shall provide audio description processing technology conforming to 414.1.1 or 414.1.2.

414.1.1 Digital Television Tuners

Digital television tuners shall provide audio description processing that conforms to ATSC A/53 Digital Television Standard, Part 5 (2014) (incorporated by reference, see 702.2.1).[17] Digital television tuners shall provide processing of audio description when encoded as a Visually Impaired (VI) associated audio service that is provided as a complete program mix containing audio description, according to the ATSC A/53 standard.

Test procedure:

1. Verify that audio description processing is provided as a service.

414.1.2 Other ICT

With the exception of digital television tuners, ICT shall provide audio description processing.

Where ICT displays video with synchronized audio, it shall provide a mechanism to select and play available audio description to the default audio channel. Where video technologies do not have explicit and separate mechanisms for audio description, an ICT is deemed to satisfy this requirement if the ICT enables the user to select and play several audio tracks.

Test procedure:

1. Enable the product setting that allows audio descriptions to be played automatically.
2. Go to the test content that supports multiple versions.
3. Verify that the audio described version of content plays automatically for the user.

415 User Controls for Captions and Audio Descriptions

Where ICT displays video with synchronized audio, ICT shall provide user controls for closed captions and audio descriptions conforming to 415. Devices for personal use shall not be required to conform to 415.1, provided that captions and audio descriptions can be enabled through system-wide platform settings.

415. 1 General

Where ICT displays video with synchronized audio, ICT shall provide user controls for closed captions and audio descriptions conforming to 415.1.

415.1.1 Caption Controls

Where ICT provides operable parts for volume control, ICT shall also provide operable parts for caption selection.

ICT shall provide user controls for the selection of captions in at least one location that is comparable in prominence to the location of the user controls for volume.

[17] ATSC A/53 Part 5; 2014 Available at: https://muygs2x2vhb2pjk6g160f1s8-wpengine.netdna-ssl.com/wp-content/uploads/2021/04/A53-Part-5-2014.pdf

Test procedure:

1. Verify that the controls to select captions are within three tab stops (or similar logical navigational unit) preceding or following the controls for volume in the player.

415.1.2 Audio Description Controls

Where ICT provides operable parts for program selection, ICT shall also provide operable parts for the selection of audio description.

ICT shall provide user controls for the selection of audio description in at least one location that is comparable in prominence to the location of the user controls for program selection.

Test procedure:

1. For any content where an audio description exists, verify that there is a clearly available method for accessing the audio description of the content. If verifying a system that has a dedicated method for exposing an audio description, verify that it can be accessed successfully when one is supplied.

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[15] Internet Engineering Task Force. 2012. IETF RFC 6716. https://tools.ietf.org/pdf/rfc6716.pdf

[16] Federal Register. 2000. Volume 65, Number 246. Rules and Regulations. Legacy Section 508. Pages 80515-80517. https://www.govinfo.gov/content/pkg/FR-2000-12-21/pdf/00-32017.pdf

[17] Advanced Television Systems Committee. 2014. ATSC Digital Television Standard, Part 5 – AC-3 Audio System Characteristics. Doc. A/53 Part 5. https://muygs2x2vhb2pjk6g160f1s8-wpengine.netdna-ssl.com/wp-content/uploads/2021/04/A53-Part-5-2014.pdf

Glossary

Application: Software designed to perform, or to help the user perform, a specific task or tasks.

Assistive Technology (AT): Any item, piece of equipment, or product system—whether acquired commercially, modified, or customized—used to increase, maintain, or improve functional capabilities of individuals with disabilities. AT helps people who have difficulty speaking, typing, writing, remembering, pointing, seeing, hearing, learning, walking, and more. Different disabilities require different assistive technologies. AT examples include: braille labels, dictation software, high-contrast keyboards, screen readers, and screen magnification.

Audio Description: Narration added to the soundtrack to describe important visual details that cannot be understood from the main soundtrack alone. Audio description is a means to inform individuals who are blind or who have low vision about visual content essential for comprehension. Audio description of video provides information about actions, characters, scene changes, on-screen text, and other visual content. Audio description supplements the regular audio track of a program. Audio description is usually added during existing pauses in dialogue. Audio description is also called “video description” and “descriptive narration”.

Biometric: Metrics related to human characteristics used in computer science as a form of identification and access control. Biometric identifiers are distinctive and measurable. They include fingerprints, DNA, face, hand, retina, or ear features. Note: An alternative to a biometric means of identification or access must be offered where a biometric means is offered.

Closed Functionality: Characteristics that limit functionality or prevent a user from attaching or installing assistive technology. Examples of ICT with closed functionality include self-service machines, information kiosks, set-top boxes, fax machines, calculators, and computers that are locked down so that users may not adjust settings due to a policy such as Desktop Core Configuration.

Content: Electronic information and data, as well as the encoding that defines its structure, presentation, and interactions.

Document: Logically distinct assembly of content (such as a file, set of files, or streamed media) that: functions as a single entity rather than a collection; is not part of software; and does not include its own software to retrieve and present content for users. Examples of documents: email messages, images, letters, movies, podcasts, presentations, and spreadsheets.

Existing Information and Communications Technology (ICT): ICT that has been procured, maintained, or used on or before January 18, 2018.

Hardware: A tangible device, equipment, or physical component of ICT, such as telephones, computers, multifunction copy machines, and keyboards.

Information Technology: Shall have the same meaning as the term “information technology” set forth in 40 U.S.C. 11101(6).

A. “with respect to an executive agency” means any equipment or interconnected system or subsystem of equipment, used in the automatic acquisition, storage, analysis, evaluation, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information by the executive

agency, if the equipment is used by the executive agency directly or is used by a contractor under a contract with the executive agency that requires the use—

i. of that equipment; or

ii. of that equipment to a significant extent in the performance of a service or the furnishing of a product;

B. includes computers, ancillary equipment (including imaging peripherals, input, output, and storage devices necessary for security and surveillance), peripheral equipment designed to be controlled by the central processing unit of a computer, software, firmware and similar procedures, services (including support services), and related resources; however,

C. it does not include any equipment acquired by a federal contractor incidental to a federal contract.

Information and Communication Technology (ICT): Information technology and other equipment, systems, technologies, or processes, for which the principal function is the creation, manipulation, storage, display, receipt, or transmission of electronic data and information, as well as any associated content. Examples of ICT include but are not limited to: computers and peripheral equipment, information kiosks and transaction machines, telecommunications equipment, customer premises equipment, multifunction office machines, software, mobile applications, web sites, videos, and electronic documents.

Label: Text, or a component with a text alternative, that is presented to a user to identify content. A label is presented to all users, whereas a name may be hidden and only exposed by assistive technology. In many cases, the name and the label are the same.

Operable Part: Hardware-based user controls for activating, deactivating, or adjusting ICT. Note: Example of operable parts: power button, automatic document feeder paper guides, touch screen control panel, manual paper draw, paper draws, and scanner glass door handle.

Programmatically Determinable: Ability to be determined by software from author-supplied data that is provided in a way that different user agents, including assistive technologies, can extract and present the information to users in different modalities.

QWERTY: Denoting the standard layout on English-language typewriters and keyboards, having “q, w, e, r, t, y” as the first keys from the left on the top row of letters.

Real-Time Text (RTT): Communications using the transmission of text by which characters are transmitted by a terminal as they are typed. Real-time text is used for conversational purposes. Real-time text also may be used in voicemail, interactive voice response systems, and other similar application. Note: Real-time text is text transmitted instantly while it is being typed or created. The recipient can immediately read the sender's text as it is written, without waiting.

Revised 508 Standards: The standards for ICT developed, procured, maintained, or used by agencies subject to Section 508 of the Rehabilitation Act as set forth in 508 Chapters 1 and 2 (36 CFR part 1194, Appendix A), and Chapters 3 through 7 (36 CFR part 1194, Appendix C).

Software: Programs, procedures, rules, and related data and documentation that direct the use and operation of ICT and instruct it to perform a given task or function. Software includes, but is not limited to mobile applications, non-web software, and platform software.

Tactilely Discernible: Describes an object that can be perceived using the sense of touch.

Telecommunications: The signal transmission, between or among points specified by the user, of information of the user's choosing, without change in the form or content of the information as sent and received.

Terminal: Device or software with which the end user directly interacts and that provides the user interface. For some systems, the software that provides the user interface may reside on more than one device such as a telephone and a server.

Text: A sequence of characters that can be programmatically determined and that expresses something in human language.

Teletypewriter (TTY): Equipment that enables interactive text-based communications through the transmission of frequency-shift-keying audio tones across the public switched telephone network. TTYs include devices for real-time text communications and voice and text intermixed communications. Examples of intermixed communications are voice carry over and hearing carry over. An example of a TTY is a computer with TTY emulating software and modem.

Variable Message Signs (VMS): Non-interactive electronic signs with scrolling, streaming, or paging-down capability. An example of a VMS is an electronic message board at a transit station that displays the gate and time information associated with the next train arrival.

Web Content Accessibility Guidelines 2.0 (i.e., WCAG 2.0): Part of a series of web accessibility guidelines published by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C), the main international standards organization for the internet. WCAG 2.0 is divided into four principles spelling out the acronym POUR: Perceivable, Operable, Understandable, and Robust. Each principle is divided into further detail with guidelines and testable success criteria. The Success Criteria are organized by Level A, AA, and AAA; with A being the most necessary for use with a broad array of assistive technologies, and AA and AAA increasingly narrowed in focus on a specific disability group.

Revision History

Publication Date	Name of Document	Description of Changes
October 2020	HP Hardware Accessibility Testing Guide 1.0	Initial release
March 2022	HP Hardware Accessibility Testing Guide Version 2.0	Updated language Added software testing technologies Grammatical changes New images added Links updated