ANSI/CTA Standard

Inclusive, Audio-based, Network Navigation Systems for All Persons including those Who are Blind/Low vision

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(Formulated under the cognizance of the CTA **R6 Intelligent Mobility Committee**.)

FOREWORD

This standard was developed by the Consumer Technology Association's Intelligent Mobility Committee.

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Inclusive, Audio-based, Network Navigation Systems for All Persons including those Who are Blind/Low Vision

1   SCOPE

This standard specifies requirements for the design of inclusive audio-based network navigation systems (IABNNS), which are technologies used to augment the physical environment by delivering sufficient audio, haptic, visual instructions or instructions in other formats as may be required. This standard helps design professionals achieve an inclusive environment through IABNNSs that augment the physical environment by the provision of aural information about environments for users.

This standard applies to IABNNS that provide real-time wayfinding and location support. The wayfinding technologies include but are not limited to beacon-based location, software-based location, Wi-Fi, Bluetooth, electromagnetic signals, Ultra-Wide Band, location-based algorithms, and a variety of smart device components. IABNNS features may include but are not limited to indoor positioning, points of interest (POI), mapping and localization, low vision maps, virtual tours, pre-journey learning, audio navigation, route directions, step-by-step navigation, distance calculation and location-based announcements.

2   REFERENCES

2.1   Normative References

The following standards contain provisions that, through reference in this text, constitute informative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

2.1.1   Normative Reference List

1. The Americans with Disabilities Act of 1990, 42 U.S.C. § 12101.
2. W3C Web Content Accessibility Guidelines (WCAG) 2.1 (2018).
3. Rehabilitation Act of 1973. Pub. L. 93-112. 87 Stat. 355. 26 September 1973. 29 U.S.C. § 701.
4. ISO 23599:2012, *Assistive products for blind and vision-impaired persons – Tactile walking surface indicators*.
5. Allen, G.L. (2000). Principles and practices for communicating route knowledge. *Applied Cognitive Psychology*, **14**, 333–359.
6. Gaunet, F., Briffault, X. (2005). "Exploring the functional specifications of a localized wayfinding verbal aid for blind pedestrians: Simple and structured urban areas." *Human-Computer Interaction*, **20**(3), 267–314.

7. Kulyukin, V., Nicholson, J., Ross, D., Marston, J., Gaunet, F. (2008). "The blind leading the blind: Toward collaborative online route information management by individuals with visual impairments." *AAAI Spring Symposium: Social Information Processing*, pp. 54–59.

2.1.2 Normative Reference Acquisition

1. Available from the Government Publishing Office. https://www.govinfo.gov/
2. Available from the World Wide Web Consortium (W3C). https://www.w3.org/TR/WCAG21/
3. Available from the Government Publishing Office. https://www.govinfo.gov/
4. Available from the International Organization for Standardization (ISO). https://www.iso.org/obp/ui/#iso:std:iso:23599:ed-1:v1:en
5. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.456.5686&rep=rep1&type=pdf.
6. Available at: https://dl.acm.org/citation.cfm?id=1466580.
7. Available at: https://www.aaai.org/Papers/Symposia/Spring/2008/SS-08-06/SS08-06-011.pdf.

2.2 Informative References

The following standards contain provisions that, through reference in this text, constitute informative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

2.2.1 Informative Reference List

1. Wiener, William R., Welsh, Richard L., & Blasch, Bruce B. (Eds) (2010). *Foundations of Orientation and Mobility*, 3rd Edition: Volume 2, *Instructional Strategies and Practical Applications*. Arlington, VA: AFB Press.
2. 21st Century Communications and Video Accessibility Act (CVAA).

2.2.2 Informative Reference Acquisition

1. Available at: https://shop.aph.org/webapp/wcs/stores/servlet/Product_Foundations%20of%20Orientation%20and%20Mobility,%20Volume%20II,%20Instructional%20Strategies%20and%20Practical%20Applications_31127P_10001_11051.
2. Available at: https://www.fcc.gov/consumers/guides/21st-century-communications-and-video-accessibility-act-cvaa.

3 DEFINITIONS, ACRONYMS AND ABBREVIATIONS

3.1 Definitions

3.3.1 Absolute frame of reference (cardinal coordinates): Absolute Frame of Reference (Cardinal Coordinates) refers to systems that orient users based upon the fixed points of a compass as North, South, East, West, and related variants. It is widely used in outdoor applications and helps with cognitive mapping and off-site or pre-trip planning.

3.3.2 Accessible: Describing a route, path or facility for a visually impaired traveler using a mobility device, such as a wheelchair, scooter, walker, support cane, or similar mobility device in the best professional judgment of a certified Orientation and Mobility (O&M) specialist. This does not necessarily represent full compliance with the Americans with Disabilities Act, *42 U.S. 12101*, and any applicable ADA Guidelines (ADAG) 36 C.F.R. Sections 1191 *et seq.* or the FTA's regulations for transportation facilities, 49 C.F.R. Part 37, although those principles should provide general guidance to the O&M specialist.

3.3.3 Accessible gate: A gate that is specifically designed for persons with disabilities and is usually wider and more easily navigated than other turnstiles or gates.

3.3.4 Accessibility: The degree to which a product, device, service or environment (virtual or real) is most usable by persons with disabilities.

3.3.5 Allocentric frame of reference: A system that specifies an object's position within a framework external to the observer and independent of its position and orientation. It refers to objects or landmarks that are fixed within a given space and not subject to movement, such as walls, elevators, stairwells, etc. It helps in creating long term memory of the space and is therefore widely used for cognitive mapping and off-site or pre-trip planning.

3.3.6 Audio alert: Aural signal designed to precede audio instructions.

3.3.7 Audio instruction: Aural message that provide wayfinding instructions and directions for users of audio-based network navigation systems (IABNNSs).

3.3.8 Barrier: An obstacle controlled to permit ingress and egress.

3.3.9 Cardinal coordinates: A means of communicating general directions to a user based on fixed points of a compass.

3.3.10 Clock face directions: A means of communicating general directions to a user by reference to the positions of the hours on an analogue clock, with 12 o'clock being straight ahead.

3.3.11 Countable delimiter: Word or phrase that uses numbers to communicate directions – e.g., the first (corridor).

3.3.12 Decision point/Waypoint: An intermediate point during a step-by-step navigation where the user needs to take an action – e.g., crossing or intersection of a pathway, a fork in a corridor.

3.3.13 Degree directions: Means of communicating general directions to a user by reference to the degrees of a circle, with 0° being straight ahead.

3.3.14 Descriptive delimiter: Word or phrase that describes an object or point of interest to communicate directions – e.g., "the lower (concourse)".

3.3.15 Directional delimiter: Word or phrase that usually follows a verb and communicates direction – e.g., left.

3.3.16 Disability: The ADA defines a person with a disability as a person who has a physical or mental impairment that substantially limits one or more major life activity.

3.3.17 Egocentric frame of reference: A reference frame in which the spatial layout and orientation are communicated based on the individual's current location and viewpoint.

3.3.18 Frame of reference: A coordinate system, or the set of physical and spatial reference points, that uniquely locates and orients a person in space. Spatial information such as direction or distance can then be coded egocentrically (relative to an observer) or allocentrically (in a reference frame independent of the observer). Technologies may utilize different types of frames of reference, including allocentric, egocentric, or absolute (Cardinal Coordinate).

3.3.19 Inclusive Audio-Based Network Navigation System (IABNNS): Technologies used to augment the physical environment by the provision of an audio version of that environment for users.

3.3.20 Journey completed notification alert: A notification of the completion of the route. This is different from mobile device operating system alerts.

3.3.21 Landmark: Feature in the physical environment that is unlikely to change but which can provide useful location information – e.g., an isolated column.

3.3.22 Notification alert: A short sound or haptic vibration provided just before audio alerts and audio instructions to notify the user of an impending audio alert or audio instruction. This is different from a mobile device operating system alert.

3.3.23 O&M specialist: A vision professional trained to teach travel skills to individuals who are blind or who have low vision and holds the COMS certification from the Academy for Certification of Vision Rehabilitation & Education Professionals (ACVREP) or the National Orientation and Mobility Certification (NOMC).

3.3.24 Orthogonal: Means of communicating general directions to a user that is different to the "degree" approach and uses directions based on 90° angles from a direction straight ahead.

3.3.25 Pathways: Corridors, ramps, tunnels, subways, escalators, stairs or elevators, footways and road crossings.

3.3.26 Platform: A boarding facility to provide access to rail-mounted vehicles or other transit vehicles.

3.3.27 Point of Interest (POI): A specific point location that may be defined with the use of an O&M specialist, which someone may find useful or interesting.

3.3.28 Proportional directions: Means of communicating general directions to a user that is different to the "clock face" or "degree" approach and uses terms like "straight", "ahead", "left" and "right".

3.3.29 Segment: Distinctive area in an environment – e.g., a railway station forecourt.

3.3.30 Sequential delimiter: Word or phrase that limits the relationship of one object to communicate directions – e.g., after (the gates).

3.3.31 Vision impairment: A vision loss that cannot be corrected by the use of glasses, refractive correction, medication or surgery. The vision loss may affect visual acuity, central or peripheral visual field defects, or reduced contrast sensitivity.

3.2   Abbreviations and Acronyms

This standard uses the following abbreviations and acronyms:

ACVREP   Academy for Certification of Vision Rehabilitation & Education Professionals
ADA   Americans with Disabilities Act
IABNNS   Inclusive Audio-Based Network Navigation System
O&M   Orientation & Mobility
POI   Point of Interest
WCAG   Web Content Accessibility Guidelines

3.3   Compliance Notation

As used in this document, "shall" and "must" denote mandatory provisions of the standard. "Should" denotes a provision that is recommended but not mandatory. "May" denotes a feature whose presence does not preclude compliance, and implementation of which is optional.

4   DESIGN PRINCIPLES

Audio based network navigation systems are designed to be fully accessible to the blind, low vision and deaf/blind users. Therefore, designers shall use the professional principles of O&M Specialists in designing these systems. For reasons of safety and limitation of legal liability, certified O&M specialists should be used in the process.

The principles for the design and interoperability of an IABNNS should strongly consider involving users in the design, development and validation process in a real environment. In particular, users or certified O&M specialists can help to identify the location of the main points of interest, key features and optimal routes. The route shall have defined segments and landmarks and be the most accessible. The content, terminology and classification used in the audio instructions is shown in clause 3 and shall be fully accessible to all persons with

disabilities in compliance with WCAG 2.1 [2] and, as applicable, Section 508 of the Rehabilitation Act of 1973 [3].

4.1   Validation Principles

Before launching an IABNNS system, it should be validated. The validation should include the testing of the installation for its usability and accessibility by O&M specialists and persons with disabilities, including the visually impaired.

4.2   Directions

Directions shall be provided through the use of a frame of reference that communicates general directions and alerts. The most accessible route shall be used.

> NOTE – Any frame of reference defined in 3.3.18 may be used.

4.3   Routes

All routes shall be usable. An O&M or accessibility specialist should be consulted in the creation of usable routes. A more usable route may, for example, take the user on a ramp instead of stairs or direct the user to an accessible gate, avoiding obstacles and potential safety hazards within the environment.

5   AUDIO INSTRUCTIONS

Navigation systems should offer different levels of detail to end users to allow them to use the audio instructions to navigate to their destination or explore an area. Systems should allow users to choose their preferences.

In order to support wayfinding, navigation systems shall provide turn-by-turn instructions as outlined below. Navigation systems shall also provide point of interest information and users shall have the option to enable or disable these alerts.

Audio instructions and audio alerts shall be clear, unambiguous, effective and safe ([Allen, 2000]; [Kulyukin, 2008]). The piloting or chaining of routes shall allow instructions to be related to particular segments of the route.

5.1   Components of an audio instruction

An audio instruction shall contain the elements specified in 5.1.1 to 5.3.

5.1.1   Verbs

Verbs are used to communicate the action required – e.g., "walk".

5.1.2 Orientation information

Orientation information is used to communicate users' current location in relationship to their surroundings – e.g., "you are approaching". Orientation information shall make reference to features of the physical environment and the route. These include segments (3.3.29), pathways (3.3.25), decision points (3.3.12), landmarks (3.3.21) and objects.

5.1.3 Direction information

Direction information is used to communicate directions to the user. Direction information shall use directional delimiters (3.3.15), countable delimiters (3.3.11), sequential delimiters (3.3.30) and descriptive delimiters (3.3.14).

5.2 Audio Instructions – Classification

Audio instructions are classified [Gaunet, 2005] as in 5.2.1 to 5.2.8.

5.2.1 Route starting instructions

Define the starting point of the route, the type of environment and identify the orientation of the user – e.g., "Welcome to Central Station. You are now on the main concourse. For your train, walk forward to the ticket barriers."

5.2.2 Route ending instructions

Define the ending point of the route, inform users they have reached their destination and that audio instructions are ending – e.g., "You have exited Central station. You are now on the east side of Alpha High Street facing the Town Hall."

5.2.3 Progression direction instructions

Define the direction to the next segment, pathway, decision point, landmark or object – e.g., "At the bottom of the stairs, turn left and walk forward to the ticket gates." An approximate distance to an object may also be included (e.g., "a short distance", "a few steps").

5.2.4 Reassurance progression direction instructions

Reassure users that they are following a route that is communicated by audio instructions – e.g., "Keep walking forward" – and should be provided every 10m (or a distance chosen by user in preferences) on routes where there are no changes of direction or decision points and where

the user of a IABNNS has not configured their system to receive such notifications less frequently.

5.2.5 Orientation progression direction instructions

The audio instructions shall communicate a change in direction prior to reaching a decision point – e.g., "At the next tactile paving intersection, follow the tactile paving route to the left."

5.2.6 Alerts of the location of the next decision point

The audio instructions shall communicate information about the location of the next decision point – e.g., "The down escalator is the one on the left."

5.2.7 Alert to a POI

The audio instructions shall communicate information about a POI that is close to the user – e.g., "You are approaching the escalators"; "You are approaching the stairs."

5.2.8 Alert to current location

The audio instructions shall communicate information about the spatial layout of a location and the position of the user.

5.3 Audio Instruction – Updates

Audio instructions shall be updated as to changes in route, construction, detours, etc. by the venue as soon as feasible and at the same time the information is available to the public. The developer shall update the messages as soon as it is notified by the venue. If the venue has the ability to make changes to the audio instructions themselves, they shall do so as soon as feasible.

The user shall have the ability to access information on when the venue information was last updated.

5.4 Emergency Notifications

The IANNBS shall provide directions to the nearest emergency exit in a manner that can be activated in the event of an emergency. The IANNBS should allow users to contact 911 or other assistance with a dedicated function.

6   SPECIFIC FEATURES, LANDMARKS AND OBJECTS

This clause includes a range of decision points, landmarks and objects where particular instructions and alerts are be provided. Audio instruction directions shall utilize the most accessible routes.

6.1   Points of Interest

The audio instruction communications from an IABNNS should describe points of interest as a user passes them.

6.2   Destination

The audio instruction communications from an IABNNS shall enable the user to know they have arrived at their destination.

The proximity of the destination should be given in an audio instruction as close to 1 m as technology allows.

6.3   Entrances and Exits

The audio instruction communications from an IABNNS shall:

- utilize the most accessible entrance and exit;
- allow users to choose their entrance and exit.

The audio instruction communications from an IABNNS should:

- provide information about the type, size and opening configuration of doors – for example, "There is a set of double doors with a vertical post between them. The doors open inwards";
- provide information about the position and type of door opening furniture and operating controls – for example, "The door has a horizontal handle on the left side of the door."

6.4   Pathways

The audio instruction communications from an IABNNS shall:

- utilize the most accessible pathway;
- allow users to choose their pathway if there are several equally accessible pathways available;
- provide information about the type and size of the pathway;
- inform users of any curve in the pathway.

The audio instruction communications from an IABNNS should:

- where appropriate, advise users to keep on the side of the pathway that is best for the direction in which they are traveling when on a route where people are moving in both directions.

6.5   Decision Points

The audio instruction communications from the IABNNS shall:

- be provided at all decision points;
- utilize the most accessible decision points;
- provide information about the type, size and configuration of decision points.

6.6   Tactile Walking Surface Indicators

There are two different types of tactile walking surface indicators [ISO 23599:2012], namely warning and directional indicators.

Warning walking surface indicators are used to warn of pedestrian hazards.

Directional walking surface indicators are used to provide direction information.

The audio instruction communications from an IABNNS shall:

- be provided for all walking surface indicators;
- utilize the most accessible route of walking surface indicators;
- provide information about the type, size and configuration of the walking surface indicators.

NOTE – Some tactile walking surface indicators indicate the proximity of platforms.

6.7   Escalators

The audio instruction communications from an IABNNS shall:

- enable the user to locate the escalator;
- describe the proximity of the escalator;
- describe the numbers of escalators in any group;
- where appropriate, state the side of the escalator where travelers stand;
- describe the next direction of the route when leaving the escalator.

The audio instruction communications from an IABNNS may:

- describe the relative width/length of the escalator;
- describe the moving direction of each escalator in a group.

The proximity of an escalator generally shall be given in an audio instruction 6 ± 1 m from the escalator except in cases where precluded by the design or layout of the environment, in which case the instruction will be given as soon as practicable using professional O&M principles.

6.8   Stairs

The audio instruction communications from an IABNNS shall:

- enable the user to locate the stairs;
- describe the proximity of the stairs;
- describe the direction of the stairs;
- describe the numbers of steps;
- describe the location of a landing within a flight of stairs;
- where appropriate, state the side of the stairs travelers use to move up and down;
- describe the relative width/length of the stairs;
- describe the next direction of the route when leaving the stairs;
- where appropriate, announce the presence of an open riser staircase.

The audio instruction communications from an IABNNS may:

- describe the location of handrails.

NOTE: Only describe the number of steps when less than 12.

The proximity of a staircase shall be given in an audio instruction 6 ± 1 m from the first step, except in cases where precluded by the design or layout of the environment, in which case the instruction will be given as soon as practical using professional O&M principles.

6.9   Elevator

The audio instruction communications from an IABNNS shall:

- enable the user to locate the elevator;
- describe the proximity of the elevator;
- describe the numbers of elevator;
- describe the location of call buttons outside the elevator;
- describe the size of the elevator;
- describe the location of call buttons inside the elevator;

- indicate whether there is a possibility the elevator doors will open at the rear;
- describe the next direction of the route when leaving the elevator.

The audio instruction communications from an IABNNS may:

- indicate which button to operate to get to different levels.

The proximity of an elevator shall be given in an audio instruction 6 ± 1 m from the elevator, except in cases where precluded by the design or layout of the environment, in which case the instruction will be given as soon as practical using professional O&M principles.

The audible announcements generated by the elevator – e.g., the next elevator to arrive, the travel direction of the elevator, the entry and exit floor, and the position of the opening doors – should supplement the audio instruction communications from the IABNNS.

6.10 Ticket control gates and barriers

The audio instruction communications from an IABNNS shall:

- enable the user to locate the gates and barriers appropriate to the direction of travel, specifically the location of the accessible gate;
- describe the proximity of the gates and barriers;
- describe the numbers of gates and barriers;
- describe the size of the gates and barriers;
- describe the next direction of the route when leaving the gates and barriers.

The proximity of gates and barriers shall be given in an audio instruction 6 ± 1 m (or a distance chosen by user in preferences) from the gate or barrier, except in cases where precluded by the design or layout of the environment, in which case the instruction will be given as soon as practical using professional O&M principles.

All users, including those with guide dogs, should be directed to the widest accessible gate.

The use of gates and barriers for arriving or departing travelers should be clearly described.

> NOTE – The terminology around ticket control gates and barriers can vary between countries. See 3.3.3 and 3.3.8.

6.11 Platforms

The audio instruction communications from an IABNNS shall:

- enable the user to locate the platform appropriate to the direction of travel;
- enable the user to orientate themselves in relation to the direction of travel of trains;

- enable the user to orientate themselves in relation to their position on the platform;
- describe the proximity of the platform, and other platforms if necessary;
- describe the platform;
- describe the next direction of the route before leaving the platform.

The proximity of a platform shall be given in an audio instruction 6 ± 1 m (or a distance chosen by user in preferences) from the platform, except in cases where precluded by the design or layout of the environment, in which case the instruction will be given as soon as practicable using professional O&M principles.

6.12 Railway Stations

The audio instruction communications from an IABNNS that relates to a rail station shall make available to the user:

- the location and orientation of the station.
- the location of entrances and exits, including elevator and other accessible entrances.
- information on that levels and connections within station.
- information on trains serving the station.
- information on other transportation available at the station – e.g., buses, taxis.
- the location of fare gates or ticket machines or booths.
- the location of elevators within the station.
- the availability and location of any relevant accessibility features of stations, such as tactile flooring.
- if available, location of restrooms within the station.
- if available, location of information or station attendant kiosks.
- if available, where to find information on arrivals and departures (e.g., hyperlinks to real-time arrival information).

7   MOBILE APP FEATURES

The mobile app features specific to the IABNNS for the built environment shall provide instructions and alerts that are accessible, simple, clear, concise, consistent, understandable and safe.

Additionally, the IABNNS software shall:

- use a notification alert before an alert or instruction;
- provide user preview of the objective;
- enable user replay;
- enable user search by dictation;
- use a journey completed notification alert;
- allow for pre-trip planning;

- comply with WCAG 2.1 [2].

A single action should be utilized for user replay.

Consumer Technology Association Document Improvement Proposal

If in the review or use of this document a potential change is made evident for safety, health or technical reasons, please email your reason/rationale for the recommended change to standards@CTA.tech.

Consumer Technology Association
Technology & Standards Department
1919 S Eads Street, Arlington, VA 22202
FAX: (703) 907-7693 standards@CTA.tech