TRANSIT COOPERATIVE RESEARCH PROGRAM

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TCRP Report 45

Passenger Information Services: A Guidebook for Transit Systems

Transportation Research Board
National Research Council

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Report 45

Passenger Information Services: A Guidebook for Transit Systems

TEXAS TRANSPORTATION INSTITUTE
College Station, TX

NUSTATS INTERNATIONAL
Austin, TX

Subject Area

Planning and Administration
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The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, the Transit Development Corporation, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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FOREWORD

By Staff
Transportation Research Board

This guidebook will be of interest to marketing and graphics professionals, customer service personnel, schedulers, transit planners, operating staff, and others who need to be conversant with the design, distribution, and placement of passenger information materials for public transit systems. This guidebook provides instructions for designing passenger information aids.

Transit systems in the United States and Canada have produced and developed a wide variety of information services. However, passenger information materials are often not easily available, user-friendly, or up to date. In addition, the materials often assume that passengers already know about the transit system and the geographic area. As a result of this assumption, connections with other routes, lines, and systems are frequently omitted. Given that transit riders come from various demographic and socioeconomic backgrounds, it is important to design and prepare information materials that will meet the needs of all transit customers.

Under TCRP Project A-12, *Passenger-Information Services*, the Texas Transportation Institute and NuStats International, undertook research to produce a guidebook that includes a compilation of principles for designing passenger information services. This research was not intended to be used to develop a high-technology, paperless approach to passenger information. Rather, it focused on traditional media (e.g., schedules, maps, and signage) for presentation of information. The guidebook primarily consists of three sections. The first section addresses the basic information needs of transit passengers, including wayfinding behavior and decision making during a trip. The second section describes route guidance information and, where appropriate, provides examples to illustrate this information. The third section discusses the design and format details for information aids (e.g., print sizes, visual contrast, use of color and symbols, and map legends).

To achieve the project objective of producing a guidebook, the researchers conducted a review of literature and existing practices to identify the following:

- Methods used in wayfinding behavior,
- Transit riders' perceptions of printed and graphic information,
- Transit riders' memory and learning issues, and
- Transit riders' preferences regarding transit information.

Transit systems from the United States, Canada, and Europe sent samples of passenger information materials (including maps, timetables, signage, and special materials such as videotapes). The materials were compared, and characteristics of the content and format were documented. Elements of several map and timetable examples were used to design the prototypes and to provide examples of different formats, which were evaluated in a representative group.

Preliminary design guidelines for passenger information materials were developed from the literature search and the state-of-the-art survey. These guidelines were used to design a prototype system map and route map timetable, which were then tested, along with other maps and timetables, with a focus group of potential transit riders and with a peer group of transit professionals. The results from both groups were used to modify the design guidelines and the prototypes.

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CONTENTS

PASSENGER INFORMATION SERVICES: A GUIDEBOOK FOR TRANSIT SYSTEMS

HOW TO USE THIS GUIDEBOOK

This guidebook is written for transit planners, customer service departments, marketing and graphics professionals, consultants, and all others responsible for the design of passenger information materials for public transit systems. It is intended to provide basic instructions for designing passenger information aids, as well as theory and background material for those who need or want more of the "why" that is behind the "how."

The guidebook is organized into three main sections:

- **Section 1. Preliminary Considerations.** This section addresses basic information needs of transit passengers, including wayfinding behavior and decision making during a trip.
- **Section 2. Suggestions for Route Guidance Information Aids.** Each type of recommended route guidance information is briefly described, with examples where applicable. An introductory paragraph summarizes each type of information aid and instructs the reader where to find further information, if desired, in Appendix A.
- **Section 3. Design Elements for Information Aids.** Design and format details for information aids (e.g., print sizes, visual contrast, use of color and symbols, and map legends) are discussed.

In addition, there are two appendixes. Appendix A provides background and reference information about some of the topics and recommendations contained in Sections 1 through 3. Appendix B contains material from the Americans with Disabilities Act of 1990 pertaining to elements of bus stop design.

Although the instructions in this guidebook refer to bus service, the same information aids and design elements described also apply to rail transit.

SECTION **1**

GENERAL PRINCIPLES OF TRANSIT INFORMATION DESIGN

1.1 HOW PEOPLE NAVIGATE: WAYFINDING METHODS

Whether walking through a building, driving in a city, or selecting routes on public transit, a traveler must develop a mental image of the surrounding environment, of his or her own location within the environment, and of his or her progression through the environment to the desired destination. Such knowledge is acquired in three basic stages:

- In the first stage of wayfinding, a person identifies landmarks and begins to orient himself or herself using these landmarks as references.
- As landmark knowledge develops into route or procedural knowledge, a person starts to build travel directions and decisions around the framework of landmarks and can visualize travel plans as a series of actions that will take him or her from an origin to a destination.
- Finally, with enough navigational experience in a particular environment, a person will develop a mental picture, or "cognitive map," of that environment, including knowledge of the landmarks, the routes from any one place to another, and approximate or relative distances between them. This survey knowledge allows the person to describe routes he or she may never have traveled, by defining them in terms of this cognitive map.

Although survey knowledge can be developed eventually from route knowledge and real-world navigation through the environment, it can often be acquired more quickly from map study. A printed map of landmarks and the spatial relationships between them helps to form the cognitive map in a reader's mind. (*1*)

1.2 WHAT PEOPLE NEED IN ORDER TO NAVIGATE UNFAMILIAR JOURNEYS BY TRANSIT

Like any wayfinding experience, navigation through a transit system involves the preceding three stages: orientation via landmarks, development of route knowledge to travel between those landmarks, and, finally, survey knowledge of the transit system.

Transit information aids must translate the many elements of a transit system—its geography, connections, operations, and rules—into a base of knowledge that will allow a rider to identify and make decisions about the routes, transfers, and boarding and disembarking locations that will deliver him or her to the correct destination. User-friendly transit information aids provide this information in a way that allows the rider to travel confidently and easily through the various segments of a trip. (*2*)

Ideally, passenger information should be available at every stage of the rider's transit trip. Pre-trip information helps the rider to plan routes and connections. In-transit information assists the rider at each decision point during the trip. Supportive/confirming information repeats and reinforces data and decisions and helps the rider to feel more confident that he or she is progressing toward the desired destination.

Pre-trip information needs consist of the following:

- Location of the nearest bus stop,
- Routes that travel to the desired destination and transfer locations,
- Fare, and
- Time of departure and approximate duration of the trip.

In-transit information needs consist of the following:

- At the departure point—identification of the correct bus to board;
- On the bus—identification of bus stops for transfers or disembarking;
- At transfer points—how to transfer to another route; cost, time limits, and restrictions; and identification of the correct bus to board; and
- At the destination—area geography (i.e., location of the final destination in relation to the bus stop) and return trip information (e.g., departure times and changes in route numbers).

Supportive/confirming information should be provided at any point during the trip when the rider may want to be reassured that he or she is progressing correctly and not getting lost. Repeated information at points throughout the trip provides this reassurance or confirmation.

1.3 DESIGNING A USER-FRIENDLY TRANSIT SYSTEM

Riders learn to use transit information in the same way they learn many other skills. The following factors increase the likelihood of their learning the information:

- Rehearsal, in the form of viewing transit maps and other information, or by simply hearing about transit in the news and other media, removes some of the mystery of how a transit system works.
- Simplicity in transit information requires the use of common names and terms and references to known locations or directions to aid in orientation.
- Consistency must be maintained in information aids—names, codes, and formats must be consistent from sign to sign and from one type of information aid to another so that the rider encounters no surprises.
- Continuity allows the rider to build on initial information with data that confirm decisions and reiterate "next steps" in the trip. This can be provided by bus stop signs, on-board route maps, and other information aids that help the rider progress from one step of the journey to the next.
- Repetition or redundancy (e.g., repeated formats, coding by shape and/or color, and consistent number/name) will help to reinforce trip and transit information in the mind of the rider. (*3*)

1.4 TYPES OF TRANSIT INFORMATION AIDS

Transit information can be presented in various ways (e.g., oral instruction, printed maps, signage at bus stops or on buses, and other oral or written instructions). Each type of aid has benefits and drawbacks (see Table 1). Although no single information aid can meet all of the information needs of transit passengers, a combination of information types will accommodate different learning styles, different levels of transit experience, and different stages of a rider's transit trip.

TABLE 1 Types of information aids

Information Aids	What They Provide	What They Don't Provide
Oral Instructions (Telephone information, bus operator, other passengers)	• Straightforward and personalized information • Simplicity for new riders and for those who have difficulty reading maps. • Instant accessibility	• An overall picture of the transit system • Reference material for future or continued travel • Flexibility or easy error correction; if a rider misses a step in the process, his or her frame of reference is lost unless he or she can converse further with the information source.
Maps	• "Bird's-eye" view of the transit system; spatial relationships of landmarks, routes, and connections • Flexibility for changing trip plans • Supportive information during a trip • "Portable" information, useful for pre-trip and in transit	• Instant accessibility. Not only is the map a physical object that a potential rider must obtain before trip planning can begin, but map reading presents difficulties for many people.
Signs	• Information at "decision points": bus stops, transfer points, terminals • Supportive information	• Detailed information and explanations • Portable information; no help during pre-trip planning or on-board
Timetables	• Portable information • Detailed route information	• Instant accessibility. Many riders have trouble reading and using timetables.

Note: For additional information on principles of information design, see Appendix A, sections 1 through 3.4.

Both transit riders and non-riders often mention timetables as a potentially useful information aid, and some riders use them readily and regularly. However, many people find timetables difficult to read and understand. This guidebook recommends that, rather than print and distribute timetables, systems provide departure times or bus headways on bus stop signs, packaging the schedule information into smaller, manageable pieces. If timetables are used, Section 3.2, Type Size and Visual Angle, has suggestions on format and content that may increase their readability. (Note: For additional information concerning the use and usability of timetables, see Appendix A, sections 3.3 and 3.4.)

SECTION **2**

SUGGESTIONS FOR PASSENGER INFORMATION AIDS

This chapter begins with recommendations for selecting information aids according to their usefulness to transit riders. Four tiers of information aids are presented, from the most basic to the most elaborate, which should fit various budgets. The chapter continues with recommendations for each type of information aid, including information content and basic format.

2.1 PRIORITIES FOR INFORMATION AID SELECTION

The recommendations given in this guidebook for the design of information aids and their use within a transit system are designed to model an "ideal" system of passenger information. Differences in transit system size, complexity, and service may alter the need for or practicality of some of these recommendations, and budgets may limit what can be provided. Table 2 outlines recommendations for levels or "tiers" of information aids. The first tier is suggested as the minimum for transit passenger information. Successive tiers can be added as desired and as budgets permit.

These priorities are not absolutes and may be affected by particular agency regulations or practices. Local circumstances may prevent bus drivers from performing "customer service" duties; some cities may find that their passengers demand and use printed timetables more than telephone information services. In addition, the increasing availability and decreasing cost of higher technology information services present many more options for fast and personalized passenger information, which may supplement or replace some of the information aids discussed in this guidebook.

Table 2 and the following descriptions of passenger information aids are offered as a general guide to providing passengers with information before and during travel, and in written and pictorial formats to accommodate different wayfinding styles.

2.2 PASSENGER INFORMATION AIDS: FIRST TIER

2.2.1 Bus Stop Sign #1—Basic Sign

A bus stop sign (see Figure 1) can provide useful information to a rider arriving at the bus stop on foot or approaching on a bus. Including the route numbers served and location information on this sign will provide decision-making help and "confirmation" during a trip. (Note: For further information on bus stop sign design, see Appendix A, sections 4.6 through 4.7.)

APPLICATION: Bus stops

FEATURES:

- Transit system logo/name
- Transit information telephone number
- Names of streets and landmarks where bus stop is located
- Route number(s) serving the bus stop

DESIGN CHARACTERISTICS:

Background Size: Consistent with area required for character sizes to meet requirement below

Character Sizes:

- Transit identifier and route number(s) must be legible to persons with low vision (20/200), in daylight conditions, at 30 ft (i.e., 6-in.-high characters and/or symbols).
- Names of streets or landmarks must subtend at least ¼ deg of arc (0.00436 radian) at the design closest viewing distance (one-half a block or across the intersection, whichever is further away). (See Section 3.2, Type Size and Visual Angle, for how to calculate viewing distance from visual angle.)

Typefaces:

- Transit Identifier: Consistent with maps and other system information.
- Other Information: See Section 3.1, Typeface Recommendations.

Remarks:

- Signs should be mounted to be conspicuous against other signs, advertising, and other visual clutter. Consideration must also be given to local ordinances and protection against vandalism.

TABLE 2 Tiers of information aids

	Information Aids	Remarks
First Tier	• Bus Stop Sign #1—Basic Sign • Bus Header/Identification Signs (on bus) • Telephone Information System/Operator	• If bus stops on request (flag-down) or at location other than marked bus stops (e.g., at every corner), bus stop signs should be placed at least every few blocks and where several routes connect.
Second Tier	• System Map (printed for distribution) • Bus Stop Sign #2—Single Route Map at bus stops, terminals	• Different cost levels: color or black-and-white
Third Tier	• Bus Stop Sign #3—Departure time/Headway at bus stops, terminals • Wall-Mounted System Map at terminals, bus stop shelters	• Different cost levels: color or black-and-white
Fourth Tier	• On-board System Map and/or Route Map • Trailblazer signs • Route maps with timetables, printed for distribution	• • If there is sufficient public demand for printed timetables

Figure 1. Bus stop sign #1—basic sign.

- Sign must be visible to bus passengers inside bus when bus is at stop.
- Consider use of duplicate sign with 3-in. raised letters/symbols in location suitable for approach to within 3 in., with Grade II Braille under each character.
- Colors and design of the logo/identifier will be determined by the transit system; the logo shown in Figure 1 is merely an example.

2.2.2 Bus Header/Identification Sign

A bus header/identification sign (see Figure 2) is mounted on the bus, in static or electronic form, to identify the route number and name (if any) and, if applicable, the direction in which the bus is traveling. The sign should be visible to passengers waiting at the bus stop.

APPLICATION: Outside of bus—front (at least); rear and sides if possible

FEATURES:

- Route number
- Route name (if applicable)
- Route destination (if applicable)

Bus Header/Identification sign showing route number and route direction

Bus Header/Identification Sign showing route number, route name and route direction

Figure 2. Bus header/identification signs.

DESIGN CHARACTERISTICS:

Background Size: Consistent with area required for character sizes to meet requirements below

Character Sizes: Route number must be legible to persons with low vision (20/200), in daylight conditions, at 30 ft (i.e., 6-in.-high characters and/or symbols, preferably larger).

Typefaces: See Section 3.1, Typeface Recommendations.

Remarks:

- Placement should be high on the bus body, above the window line.
- Display may be by changeable message sign. Back illumination or flood illumination should be provided for nighttime operations. Minimum background luminance should be 25 ft-lamberts (86 nits) for negative contrast signs (dark letters on a white background). This luminance level is similar to a white-painted wall under typical office lighting.
- For other types of sign elements, consult the current edition of the *IES Lighting Handbook* in the section on lighting for advertising. [Reference: Illumination Engineering Society of North America, *IES Lighting Handbook*, New York, current edition]

2.2.3 Telephone Information Services and Bus Operators

2.2.3.1 Telephone Information Systems

The transit information source that most passengers consult first is the transit system telephone information system. For many riders, the telephone will remain their primary choice for obtaining information about new trips.

Like the other transit information aids discussed in this guidebook, information provided by the transit system's information operators or by automated recordings should be consistent in name/number identification of routes, names of bus stop locations, and terminology used for other elements of the transit system.

2.2.3.2 Information Provided by Operators

Even with the best system of signs and rider information, the primary source of information about the transit system for many riders remains the bus operator. People with visual disabilities, cognitive problems, or functional illiteracy rely on the operator for route guidance, transfer information, and times.

This reliance is strong enough that Americans with Disability Act of 1991 (ADA) regulations mandate that operators announce major intersections, transfer points, and "regular intervals" and advise riders, on request, that their stops are approaching.

Transit operations with limited funds for signs, maps, and schedules will find it especially cost-effective to encourage good communication skills in bus operators. The use of training sessions combined with recognition for good reports from riders can help foster this low-cost method of providing rider information.

2.3 PASSENGER INFORMATION AIDS: SECOND TIER

2.3.1 Printed System Map

The system map should show and label all major elements of the transit system, including routes, major transfer points, and transfer centers (see Figure 3). In addition, enough topographical information should be shown to assist the rider in orienting himself or herself within the transit system and the city. A map legend and instructions on using the map should be included. (Note: For further information on system map design, see Appendix A, Section 4.1.)

APPLICATION: Information for distribution to passengers, visitor publications

FEATURES:

- Transit Elements
  - –Identify all routes with a label on the route line, even if other coding (e.g., color or line design) is used. A number or single-letter label is easiest for a user to identify.
  - –Identify transfer points where possible. If it is possible to transfer between two routes at any intersection where they coincide, state this in the legend or "how-to-use" section of the map. At major transfer points or transfer centers, include a box showing the numbers/names of the routes that intersect.
  - –If buses stop at relatively few points along a route, indicate these bus stops with small circles or other symbols and show these symbols in the legend. If the bus stops at every street intersection or at other frequent intervals along routes, state this in the legend or "how-to-use" section of the map.
- Topographical Elements
  - –Label all streets that routes travel on. In addition, show and label other major streets as useful for wayfinding assistance. Streets (other than those on which routes travel) should be printed in gray lines and/or in thinner lines than route lines.
  - –Show landmarks served by routes, where possible. Other major landmarks near bus routes may be included for wayfinding assistance.
  - –Include compass directions at a prominent location.
- Other Elements
  - –Include a legend that identifies all codes and symbols, including any route numbers/names.
  - –Include instructions pertaining to bus transfers, bus stops, and any special features of the routes shown. In addition, include information on hours/days of service. If possible, include basic "how-to-ride" information on the system map, including fares, identification of buses, boarding and disembarking instructions. If this is not feasible because of the size of the map, provide this information in a separate "how-to-ride" leaflet.
  - –Indicate the telephone information number for the transit service on the map.

DESIGN CHARACTERISTICS:

Background Size: Maximum 36 × 36 in.

Character Sizes: 10-point type, minimum.

Typefaces: See Section 3.1, Typeface Recommendations, for route guidance text. System logos and other non-route-guidance-related information may be in other legible typefaces (Note: Section 3 contains design details for system map elements.)

2.3.2 Bus Stop Sign #2—Single-Route Map

A route map sign (see Figure 4) can provide useful information to a rider arriving at the bus stop, at the beginning of a bus trip, or transferring from one bus to another. A sign showing the map of the route that stops at a particular stop helps riders to orient themselves within the transit system. This sign should be posted under the basic bus stop sign (see Section 2.2.1). (Note: For further information on route map and bus stop sign design, see Appendix A, sections 4.4 and 4.7.)

APPLICATION: Bus Stops

FEATURES:

- Route number
- Illustration of the route, including major streets that the route travels on or intersects
- Bus stops and transfer points as practicable
- "You Are Here" label marking position of current bus stop
- Major landmarks the route serves

DESIGN CHARACTERISTICS:

Background Size: Depends on surfaces available at stop, but top edge should be no more than 70 in. from street level and bottom edge no less than 41 in. from street level.

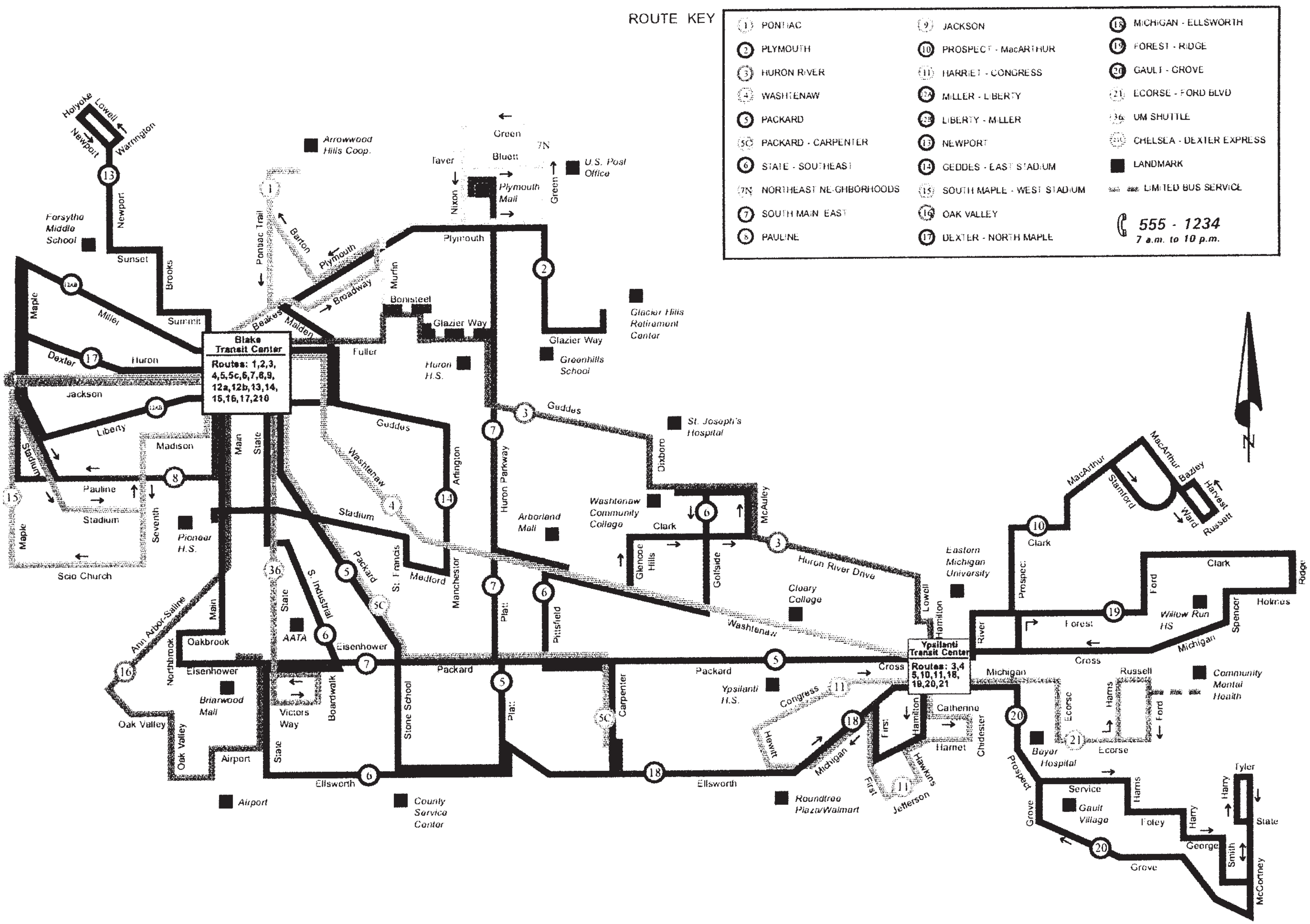
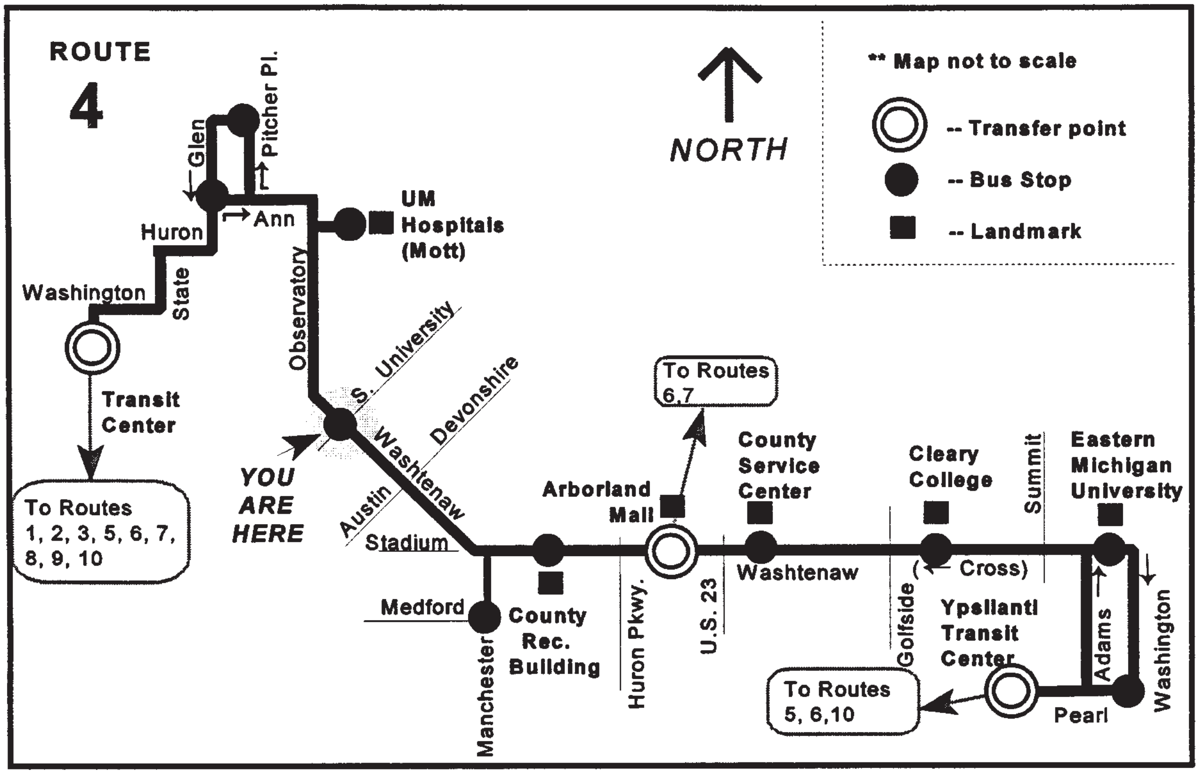


Figure 3. Printed system map (example adapted from Ann Arbor Transit Authority; shown much smaller than actual size).



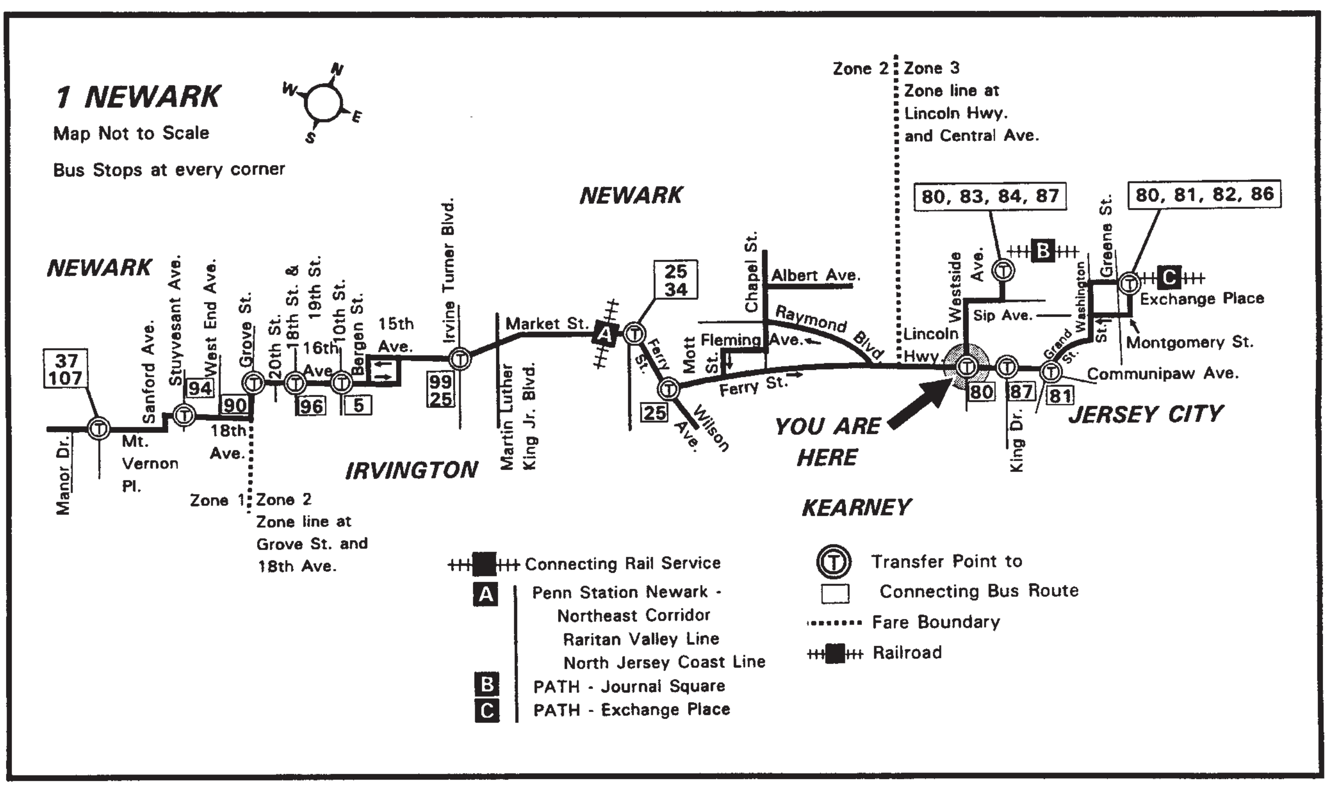


Figure 4. Route maps (examples adapted from Ann Arbor Transit Authority and New Jersey Transit).

Character Sizes: Subtend vertical ¼ deg of arc (0.00436 radian) at design closest viewing distance. (See Section 3.2, Type Size and Visual Angle, for how to calculate viewing distance from visual angle.)

Typefaces: See Section 3.1, Typeface Recommendations, for route guidance. System logos and other non-route-guidance-related information may be in other legible typefaces.

Other Codes, Colors, Distinguishing Features:

- *One Color:* Streets and highways necessary for clarity: medium to light gray or thin black lines; Routes, landmarks, transfer points, and bus stops: black
- *Two or More Colors:* Streets and highways necessary for clarity: medium to light gray or thin black lines; Route: color (keep consistent with route color in system map and other information); Landmarks and transfer points: black; Bus stops: consistent with color and symbol used in system map

Remarks:

- Should show geographic location of route and spatial relationships and intersections along the route as practicable, with route appearing as straight lines, angles, and simple curves.
- Symbols, names, and any colors used should be consistent with system map.
- Mount where riders with visual impairments can approach to within 3 in. to read the sign, but not where the sign protrudes or is an obstacle (see the ADA guidelines in Appendix B).
- "You are Here" symbol may be an adhesive decal affixed to the sign to reduce costs associated with producing individual signs.

2.4 PASSENGER INFORMATION AIDS: THIRD TIER

2.4.1 Wall-Mounted System Map

The wall-mounted system map should look identical to the printed system map, except for size and the addition of a "You are Here" locator symbol (see Figure 5). The map should be mounted in accordance with ADA guidelines (Appendix B, paragraph 4.30.6) for signage. (Note: For further information on system map design, see Appendix A, Section 4.1. Section 3 contains design details for system map elements.)

APPLICATION: Bus terminals, bus stop shelters

FEATURES:

- Transit Elements
  –Identify all routes with a label on the route line, even if other coding (e.g., color and line type) is used.

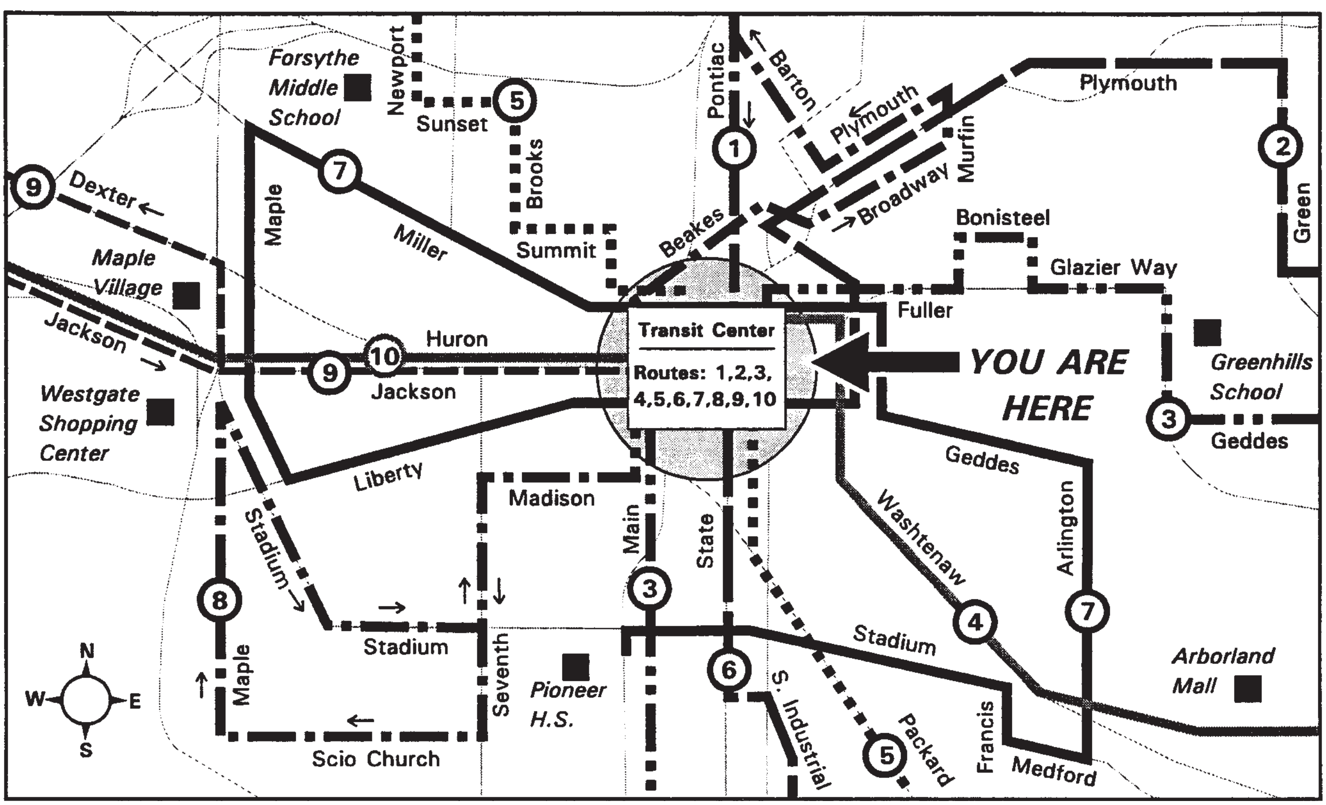


Figure 5. Portion of a wall-mounted system map showing a "You are Here" label.

Number or single-letter label is easiest for a user to identify.
  - –Identify transfer points where possible. If it is possible to transfer between two routes at any point where they coincide, state this in the legend or "how-to-use" section of the map. At major transfer points or transfer centers, include a box showing the numbers/names of the routes that intersect.
  - –If buses stop at relatively few points along a route, indicate these bus stops with small circles or other symbols and show these symbols in the legend. If the bus stops at every street intersection or otherwise frequently along routes, state this in the legend or "how-to-use" section of the map.
- Topographical Elements
  - –Label all streets that routes travel on. In addition, show and label other major streets as useful for wayfinding assistance. Streets (other than those on which routes travel) should be printed in gray lines and/or in thinner lines than route lines.
  - –Show landmarks served by routes, where possible. Other major landmarks near the routes may be included for wayfinding assistance.
  - –Include compass directions at a prominent location.
- Other Elements
  - –Include a legend that identifies all codes and symbols, including any route numbers and names.
  - –Indicate the telephone information number for the transit service on the map.
  - –Include a "You are Here" label on the map to indicate the location where the map is mounted. This label may be a stick-on decal or other changeable label, so that only one printing of the map is necessary.

DESIGN CHARACTERISTICS:

Background Size: Any size consistent with user capability to approach to easy viewing distance, but top edge should be no more than 70 in. from floor, and bottom edge no less than 41 in. from floor.

Character Sizes: Should subtend vertical ¼ deg of arc (0.00435 radian) at design closest viewing distance. (See Section 3.2 , Type Size and Visual Angle, for how to calculate viewing distance from visual angle.)

Typefaces: See Section 3.1, Typeface Recommendations, for route guidance text. System logos and other non-route guidance-related information may be in other legible typefaces.

2.4.2 Bus Stop Sign #3—Bus Headways/Schedule Sign

This sign lists the frequencies or the departure times for the bus routes serving the stop. Where budgets and space permit, this sign should be posted under the Basic Bus Stop Sign (#1) and the Single-Route Map Sign. (Note: For further information on bus stop sign design, see Appendix A, Section 4.7.)

APPLICATION: Bus stops

FEATURES:

- For each route—Route number and bus departure times for each route (or bus frequencies if departure times are closely spaced)
- Telephone information phone number for the transit system

DESIGN CHARACTERISTICS:

Background Size: Depends on mounting area available at stop, but top edge should be no more than 70 in. from street level and bottom edge no less than 41 in. from street level.

Character Sizes: Subtend vertical ¼ deg of arc (0.00436 radian) at design closest viewing distance. (See Section 3.2, Type Size and Visual Angle, for how to calculate viewing distance from visual angle.)

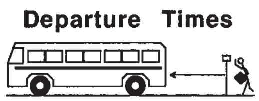
Typefaces: See Section 3.1, Typeface Recommendations, for route guidance. System logos and other non-route-guidance-related information may be in other legible typefaces.

Other Codes, Colors, Distinguishing Features:

- *One Color:* All text in black, on white or light background
- *Two or More Colors:* If color codes are used with routes, the color code can be shown with a circle or other shape/icon with the route number (follow style that is used in the system map)

Remarks:

- Mount where riders with visual impairments can approach to within 3 in. to read the sign, but not where the sign protrudes or is an obstacle (see ADA guidelines in Appendix B).
- Figure 6 shows one way of displaying route departure times. Figure 7 shows a suggestion for routes with short headways. An example of a more complicated departure schedule and multiple routes is shown on Figure 8.
- Figure 8 is a suggestion for displaying departure times for one or more routes at a single stop. The format should eliminate most language barriers.
- The icon at the top of the sign indicates "Bus Arrival Times." If you prefer to specify "Bus Departure Times" for the stop, replace the icon with the one below:



2.5 PASSENGER INFORMATION AIDS: FOURTH TIER

2.5.1 Trailblazer Sign

A trailblazer sign points the way to a bus stop or terminal, helping pedestrians to find the nearest stop (see Figure 9). In a transit system with closely spaced bus stops, trailblazer signs may be unnecessary; for systems with widely spaced bus stops (or for outlying areas of the system), trailblazer signs will provide wayfinding assistance for riders and increased "visibility" for the transit system.

APPLICATION: On street, remote from bus stop or terminal. Use at least every other block on all major streets or arterials within a 6-block radius. Mount in conjunction with street signs at intersections

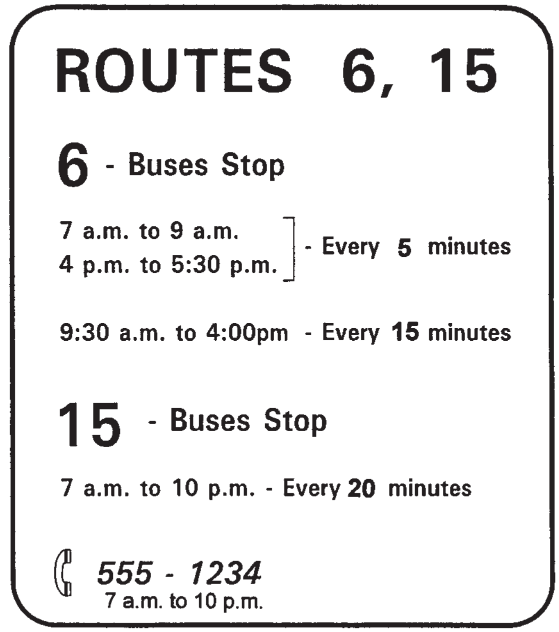


Figure 7. Bus headways/schedule sign for route with short headways.

Figure 6. Simple bus headways/schedule sign.

FEATURES:

- Transit logo or identifier
- Direction of bus stop or terminal
- Distance to bus stop or terminal
- Routes served by bus stop or terminal

DESIGN CHARACTERISTICS:

Background Size: Consistent with area required for character sizes as specified below.

Character Sizes:

- Transit Logo/Identifier 6 in.
- Route numbers 6 in.
- Distance (in blocks) 2 in.

Remarks: Background should be different color than surrounding street signs.

2.5.2 On-Board Maps

An On-Board Single-Route Map or System Map (see Figure 10) provides supportive information to passengers during the trip. The format of the On-Board Single-Route Map should be identical to that of Bus Stop Sign #2—Single-Route Map. The format of the On-Board System Map should be identical to the Wall-Mounted System Map. If the system

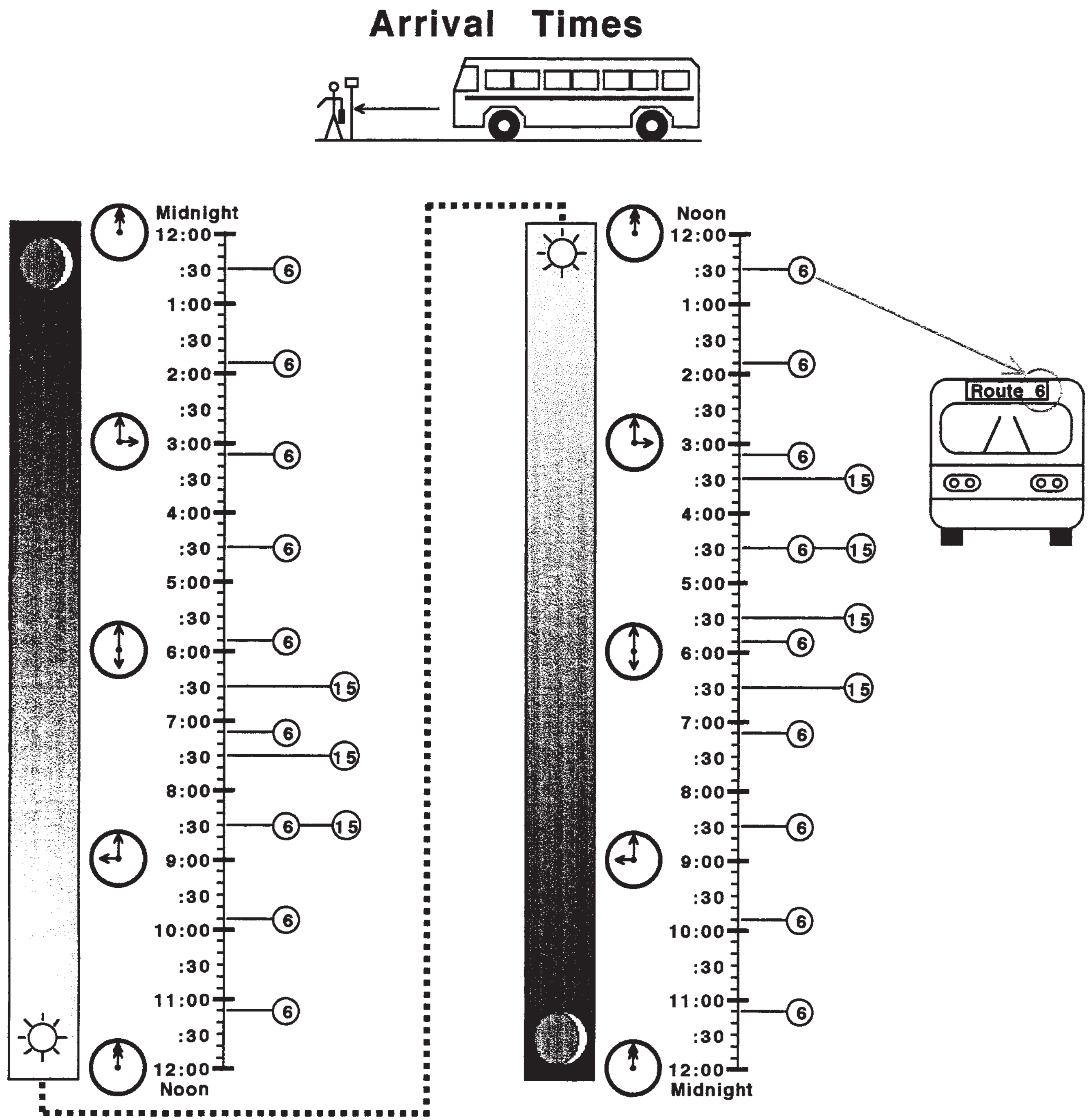


Figure 8. *Bus headways/schedule sign for a more complicated departure schedule and multiple routes.*

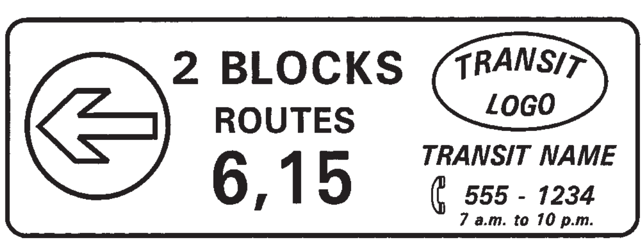


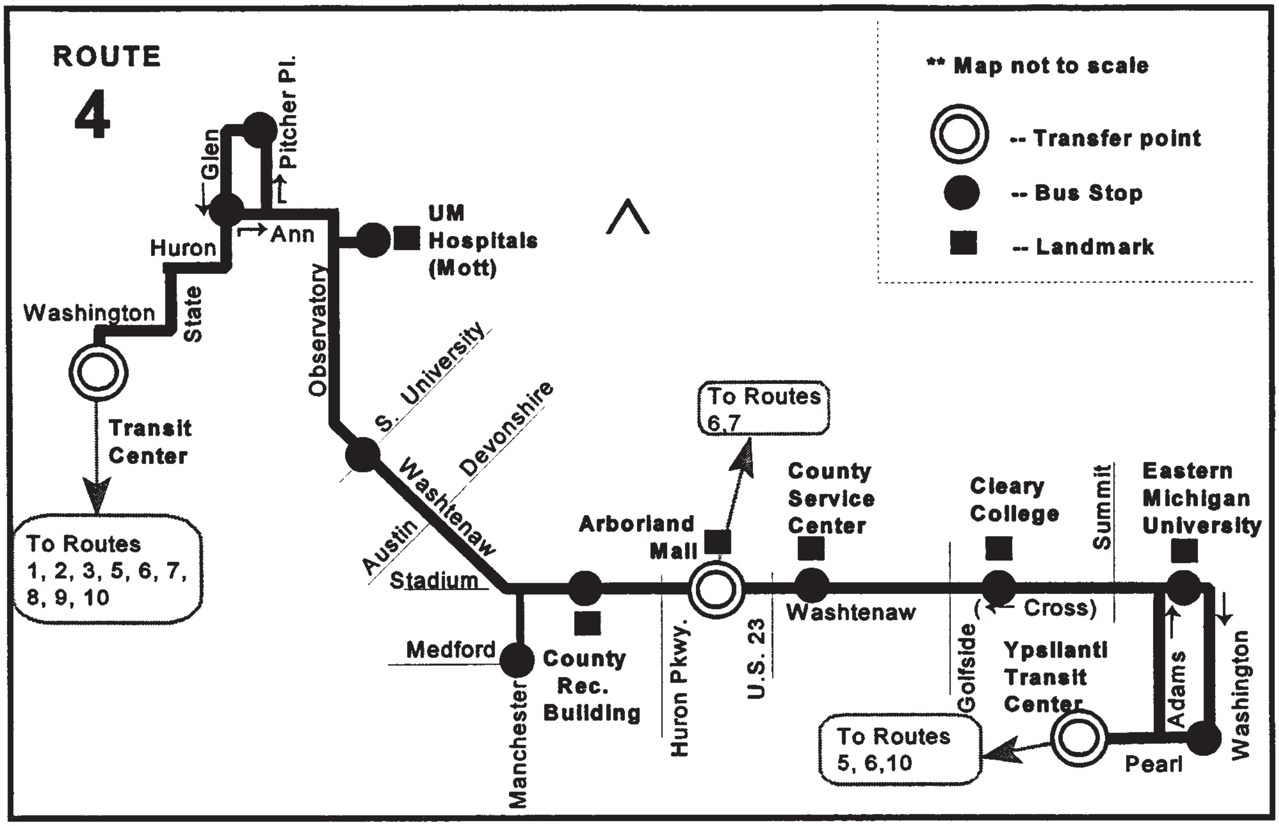
Figure 9. *Trailblazer sign.*

map is used, a sign should be posted inside the bus indicating the current route.

APPLICATION: Inside Bus

FEATURES:

- On-Board Single-Route Map
  –Route number
  –Illustration of the route, including major streets that the route travels on or intersects



On-Board Route Sign

"Current Route" sign -- to be used with On-Board System Map

Figure 10. On-board single-route map or system map.

–Bus stops and transfer points as practicable
–Major landmarks the route serves

- On-Board System Map
  –All routes in the transit system, with transfer points and transit centers shown as applicable
  –Streets and landmarks as needed for orientation within the city and the transit system
  –Legend and compass directions

DESIGN CHARACTERISTICS:

Background Size: Consistent with area required for character sizes to meet requirements below.

Character Sizes: Subtend vertical ¼ deg of arc (0.00436 radian) at design closest viewing distance. (See Section 3.2, Type Size and Visual Angle, for how to calculate viewing distance from visual angle.)

Typefaces: See Section 3.1, Typeface Recommendations, for route guidance. System logos and other non-route-guidance-related information may be in other legible typefaces.

Other Codes, Colors, Distinguishing Features:

- *One Color:* Streets and highways necessary for clarity: medium to light gray or thin black lines; Routes: black
- *Two or More Colors:* Streets and highways necessary for clarity: medium to light gray or thin black lines; Routes: color (keep consistent with route color in system map, other information); Landmarks and transfer points: black

2.5.3 Route Timetable/Route Map

A route map should accompany the timetables for the route and should be identical in format to the route maps used in bus stop or onboard signs (see Figure 11). Indicate time-points on the route map with a label that can be matched to a labeled column in the timetable. (Note: For further information on route map/timetable design, see Appendix A, sections 4.4 through 4.5.)

APPLICATION: Information for distribution to passengers, visitor publications

FEATURES:

- Route Map
  –Route number
  –Illustration of the route, including major streets that the route travels on or intersects
  –Bus stops and transfer points as practicable (if bus stops at every corner or otherwise frequently, state this on the map)
  –Major landmarks the route serves
  –Timepoints, marked with a circle and a letter or number label
- Timetable
  –Times the bus arrives at labeled timepoints in route map, reading left to right
  –Columns labeled with the same circle and letter/number as the timepoints, and with street intersections or landmarks listed for each timepoint
  –Line or space break after every three to five rows of times, or use shading to visually separate rows
  –"A.M./P.M." or "Morning/Afternoon/Evening" designations

DESIGN CHARACTERISTICS:

Character Sizes: 10-point type, minimum; Route number in 30-point type.

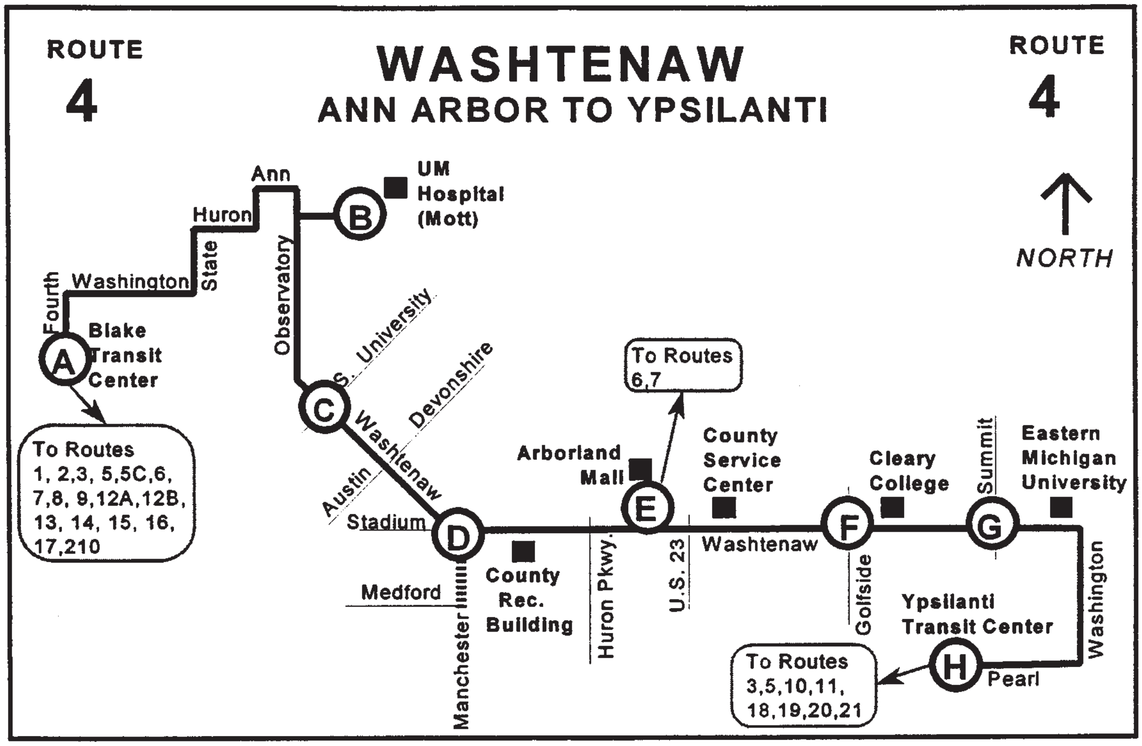
Typefaces: See Section 3.1, Typeface Recommendations, for route guidance.

Other Codes, Colors, Distinguishing Features:

- *One Color:* Streets and highways necessary for clarity: medium to light gray or thin black lines; Routes: black
- *Two or More Colors:* Streets and highways necessary for clarity: medium to light gray or thin black lines; Route: color (keep consistent with route color in the system map, other information); Landmarks and transfer points: black; Bus stops: consistent with color used in the system map

Remarks:

- Should show geographic location of route and spatial relationships and intersections along the route as practicable, with route appearing as straight lines, angles, and simple curves.
- Colors, symbols, names, and so forth should be consistent with the system map except possibly number of colors used.
- If there are occasional branches in the route, such as the branch to Medford Street in the example shown, they may be indicated with a dashed or other line pattern and a notation in the timetable. For routes with extensive variations, it is better to show the variations with separate route maps and separate timetables (e.g., "Route 4A" and "Route 4B").



	(A) BUS STARTS at Blake Transit Center	(B) BUS ARRIVES at University Hospital	(C) BUS ARRIVES at Washtenaw & S.University	(D) BUS ARRIVES at Washtenaw & Manchester	● DOES BUS TRAVEL on Manchester to Medford?	(E) BUS ARRIVES at Arborland Mall	(F) BUS ARRIVES at Wastenaw & Golfside	(G) BUS ARRIVES at Washtenaw & Summit	(H) BUS ARRIVES at Ypsilanti Transit Center
A.M.	6:45	6:57	7:00	7:04	Yes	7:10	7:16	7:21	7:30
	7:00	7:12	7:15	7:19	Yes	7:25	7:31	7:36	7:45
	7:15	7:27	7:30	7:34	No	7:40	7:46	7:51	8:00
	7:30	7:42	7:45	7:49	Yes	7:55	8:01	8:06	8:15
	7:45	7:57	8:00	8:04	No	8:10	8:16	8:21	8:30
	8:00	8:12	8:15	8:19	Yes	8:25	8:31	8:36	8:45
	8:15	8:27	8:30	8:34	No	8:40	8:46	8:51	9:00
	8:30	8:42	8:45	8:49	Yes	8:55	9:17	9:16	9:15
	8:45	8:57	9:00	9:04	No	9:10	9:16	9:21	9:30
	9:00	9:12	9:15	9:19	Yes	9:25	9:31	9:36	9:45
	9:15	9:27	9:30	9:34	Yes	9:40	9:46	9:51	10:00
	9:45	9:57	10:00	10:04	Yes	10:10	10:16	10:21	10:30
	11:45	11:57	**12:00**	**12:04**	**Yes**	**12:10**	**12:16**	**12:21**	**12:30**
P.M	**12:15**	**12:27**	**12:30**	**12:34**	**Yes**	**12:40**	**12:46**	**12:51**	**1:00**
	12:45	**12:57**	**1:00**	**1:04**	**Yes**	**1:10**	**1:16**	**1:21**	**1:30**

Figure 11. Route timetable/route map.

SECTION **3**

DESIGN ELEMENTS OF INFORMATION AIDS

This section offers recommendations for the design principles and format details that are part of all passenger information aids. First, the sections on typefaces, visual angle, and contrast provide guidelines that will make maps, signs, and printed materials easier for riders to see. Second, the sections on route coding and color, coding of transit elements, landmarks, and map legends offer suggestions to help make system maps and route maps easier to read and understand.

3.1 TYPEFACE RECOMMENDATIONS

"Serifs" are fine end strokes on letters, such as those on the Times Roman typeface used in the text of this guidebook and shown below:

Route 6 to Marvin Gardens

Studies have shown that letters without serifs are easier to read in the following situations:

- At a distance
- By people with visual impairments
- By children and those with limited education

See Figure 12.

The Helvetica typeface family is a "sans serif" (without serifs) font. Helvetica is only one of a number of typefaces suitable for a transit system. Other typefaces to consider include Folio Book, News Gothic, Trade Gothic, Futura Medium, Spartan Gothic, and Optima. The letter styles used by traffic engineers for street signing are similar to those listed here. Sans serif fonts are recommended for all signs, and for short labels on maps and other printed material.

This guidebook is printed in Times Roman, a serif font. For long blocks of text, such as instructions printed on a map or other brochure, serif fonts are easier to read. Related fonts include Palatino and Letter Gothic.

Generally, the following suggestions apply:

- Use all capital letters (upper case) for stop designations, terminals, and other short labels.
- Use capital and lower case letters for long legends and instructions.
- Standard typefaces (e.g., those shown in Figure 12) will satisfy requirements for letter stroke width (thickness of the lines that make up each stroke of a letter) and for letter height to width ratios.
- If you use a non-standard typeface, then be sure the characters satisfy the two following requirements:
  - The letter stroke width (of line) to stroke height (of line) ratio should be 1:6 (minimum 1:10) for dark letters on a white background. Given that white or light letters on a dark background tend to "bleed" they are not recommended for route guidance information.
  - Letter height to width ratio should be between 5 : 3 and 3 : 2, and never less than 1 : 1. Letter spacing should be at least 1 stroke width. Line spacing should be at least 3 stroke widths.

(Note: For more information on typefaces and text, see Appendix A, Section 4.3.)

3.2 TYPE SIZE AND VISUAL ANGLE

How large do letters on signs and maps have to be? "Big enough to be seen" is a not-too-helpful answer. "Big enough to be seen by whom?" is one of the primary concerns for designers of transit information aids. Elderly people and people with visual disabilities are a significant segment of the ridership for many transit systems—and they are among the riders who may be the most transit-dependent. Transit information aids must therefore be developed with these riders in mind.

3.2.1 Printed Materials: Type Size

A 10-point minimum type size is recommended for text on maps and other printed materials—larger if and where possible. Examples are as follows:

- This sentence is printed in 12-point Times Roman.
- This sentence is printed in 10-point Times Roman.
- This sentence is printed in 10-point Arial.

3.2.2 Signs: Visual Angle

Given that viewing distances for signs will vary according to where they are placed in relation to the intended reader, MARVIN GARDENS Marvin Gardens Helvetica

MARVIN GARDENS Marvin Gardens Helvetica Narrow

MARVIN GARDENS Marvin Gardens Gothic Book

MARVIN GARDENS Marvin Gardens Symbol

MARVIN GARDENS Marvin Gardens Times Roman

MARVIN GARDENS Marvin Gardens Times Roman Bold

MARVIN GARDENS Marvin Gardens Palatino Italic

Compare the legibility of these various typefaces by placing this page of the book 12 feet distant. At that distance, the letters look the same size as those on an eye chart 20/20 line. Walk toward the page and watch which line becomes clear first. You will see Helvetica and Gothic Book clearly before you see the others. Narrow letters such as Helvetica Narrow and Bold (thick stroke) letters are less legible than the normal typeface, and probably Palatino Italic is the hardest to see of all.

All of these typefaces meet ADA Guidelines, but Helvetica and Gothic Book families will work best for all transit users.

Figure 12. Typefaces that meet ADA guidelines.

this guidebook specifies most sign character sizes in terms of visual angle. This is expressed either in degrees or in radians. The visual angle is the angle that the letter or other object makes up in the visual field of the reader.

A person with "normal" vision (20/20) will just be able to make out letters that are 1/12 deg (0.00145 radian) of arc. ADA requirements call for the major route designators and other essential information to be visible from 30 ft away by individuals with low vision. "Low vision" means those with 20 percent of normal vision under proper lighting and high contrast. This translates into a requirement for approximately 1-deg letters (0.017 radian).

The ADA requirements do not extend to posted timetables or maps. For these information aids, use the largest character sizes that will allow the sign to fit within size guidelines and the printing budget. Our recommendations for wall-mounted system maps and route maps is ¼-deg letters. Some sample 1-deg and ¼-deg character sizes are shown in Table 3. For viewing distances other than those shown, formulas for computing the visual angle are also given (see Figure 13).

3.3 CONTRAST

"Contrast" refers to the brightness difference between letters or symbols and their background. In general, the greater the contrast, the easier it will be to see and to read text on printed materials and on signs.

- Black letters on a white background provide the greatest amount of contrast—this is recommended whenever possible for text that is essential to the reading audience.
- Never use "reverse polarity" (light lines and letters on a dark background) for either printed materials or for route and timetable information. Such presentation results in poorer and slower reading for many people, especially under low lighting conditions.
- To enhance visibility under all conditions, sign characters and backgrounds must be flat, matte, or "eggshell" in finish. No glossy paint or finish should

TABLE 3 1-deg and 15-min character sizes

Viewing Distance	One-Degree Character Height	15-Minute Character Height	Viewing Distance	One-Degree Character Height	15-Minute Character Height
3 feet	0.6 inches	0.2 inches	30 feet	6.1 inches	1.5 inches
6 "	1.2	0.3	40	8.2	2.0
9 "	1.8	0.5	50	10.2	2.6
12 feet	2.4 inches	0.6 inches	60 feet	12.2 inches	3.0 inches
15 "	3.0	0.8	70	14.3	3.6
18 "	3.7	0.9	80	16.3	4.1
21 feet	4.3 inches	1.0 inches	90 feet	18.4 inches	4.6 inches
24 "	4.9	1.2	100	20.4	5.1
27 "	5.5	1.4			

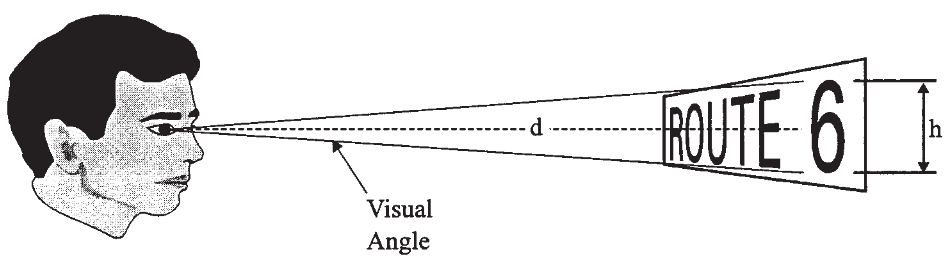
be used. Gloss produces glare points under certain types of lighting and lighting angles that will limit legibility drastically.

For signs and printed materials that are not black-on-white (especially for bus stop signs, which may be a unique color for visibility against other street signs), a contrast formula can help determine how well text or other elements will stand out against a background.

The defining formula is provided in Figure 14, as well as some suggestions on calculating it for design purposes (see Table 4). This formula produces “negative” contrast for signs and publications when the letters are dark against a light background, and “positive” contrast otherwise. Contrast for all signs, schedules, and publications should be at least 70 percent (i.e., always dark letters against a lighter background). Although many highway and street signs are printed in white letters on a dark background, drivers are assumed to have reasonably good vision. When designing for transit riders, some of whom may have very poor vision, it is important to maximize visibility of text on signs, which requires dark letters on a light background.

3.4 BUS ROUTE CODING STRATEGIES AND COLORS

Transit systems can design effective route guidance information without using multiple colors or complicated (and



(for angles less than 5 degrees)

$$VA_{degree} = \arctan \frac{h}{12\,d}$$

or

$$VA_{radians} = \frac{h}{12\,d}$$

Where **VA = Visual Angle**
h = Height of character, inches
d = Viewing distance, feet

Figure 13. Equations for visual angle.

$$Contrast\ (\%) = \left(\frac{L_c - L_b}{L_b}\right)$$

Where L_c **= Luminance (brightness) of characters**
L_b **= Luminance (brightness) of background**

"Luminance" is measured in ft-lamberts or in candela/meter^2

NOTE: If the reflectances (in percent) of the characters and the sign background are known, these values can be substituted for the L_c and L_b in the equation above to find the contrast. Black type has a reflectance of 10%, and white paint has a reflectance of 90%. Substituting in the equation above, the contrast would be

$$\text{Contrast} = ((10\text{-}90)/90) \times 100 = -88.9\%$$

Figure 14. Equation for contrast requirements.

expensive) graphics. Researchers agree that the use of more than one color (black is a color, too) is not necessary, but may be desirable, especially for systems with more than seven or eight routes, and routes that overlap or are close together. Color is a powerful tool for quickly locating information of interest, highlighting items, and separating background "nice to know" information from "need to know" information. Although color reproduction grows less expensive every day, it still is substantially more expensive than single-color reproduction.

3.4.1 Single-Color Route Coding (Including Black and White)

Recommendations for single-color route coding are as follows:

TABLE 4 Examples of reflectances

Color	Reflectance	Color	Reflectance
White:	85	**Medium:**	
		Yellow	65
Light:		Buff	63
Cream	75	Gray	55
Gray	75	Green	52
Yellow	75	Blue	35
Buff	70		
Green	65	**Dark:**	
Blue	55	Gray	30
		Red	13
		Brown	10
		Blue	8
		Green	7

(From *Human Engineering Guide to Equipment Design*, Van Cott, H. and Kinkaid, R., Editors; USGPO, 1972)

- Use the darkest shade lines and letters for system-specific information. All other information (such as secondary streets) should be medium to light saturation.
- Use patterns for different routes if they will otherwise be confused. A particular line pattern can be used for several route lines on a map; as long as adjacent route lines are printed in different line patterns, the patterns will function as a search aid for the reader.

Figure 15 provides an example of a black-and-white system map. Note the following:

- Streets and highways are shown in medium to light gray.
- Routes are in black.
- If several routes overlap or are in proximity, adjacent routes are printed as different line patterns.

3.4.2 Multiple Colors for Route Coding

Color has been shown to be a valuable aid for locating and distinguishing items on a display, particularly as the number of items increases. To maximize accuracy and speed, however, the number of colors should be kept at or below nine. If color is used to distinguish route lines on a map, it is best to minimize the use of color elsewhere on the map—"decorative" color will compete with and distract from the "informative" color.

3.4.2.1 Two-Color Route Coding

Figure 16 provides an example of a two-color system map. Note the following:

- Streets and highways are in medium to light gray.
- Routes are in one color or color with varied line patterns where two or more routes are close together.

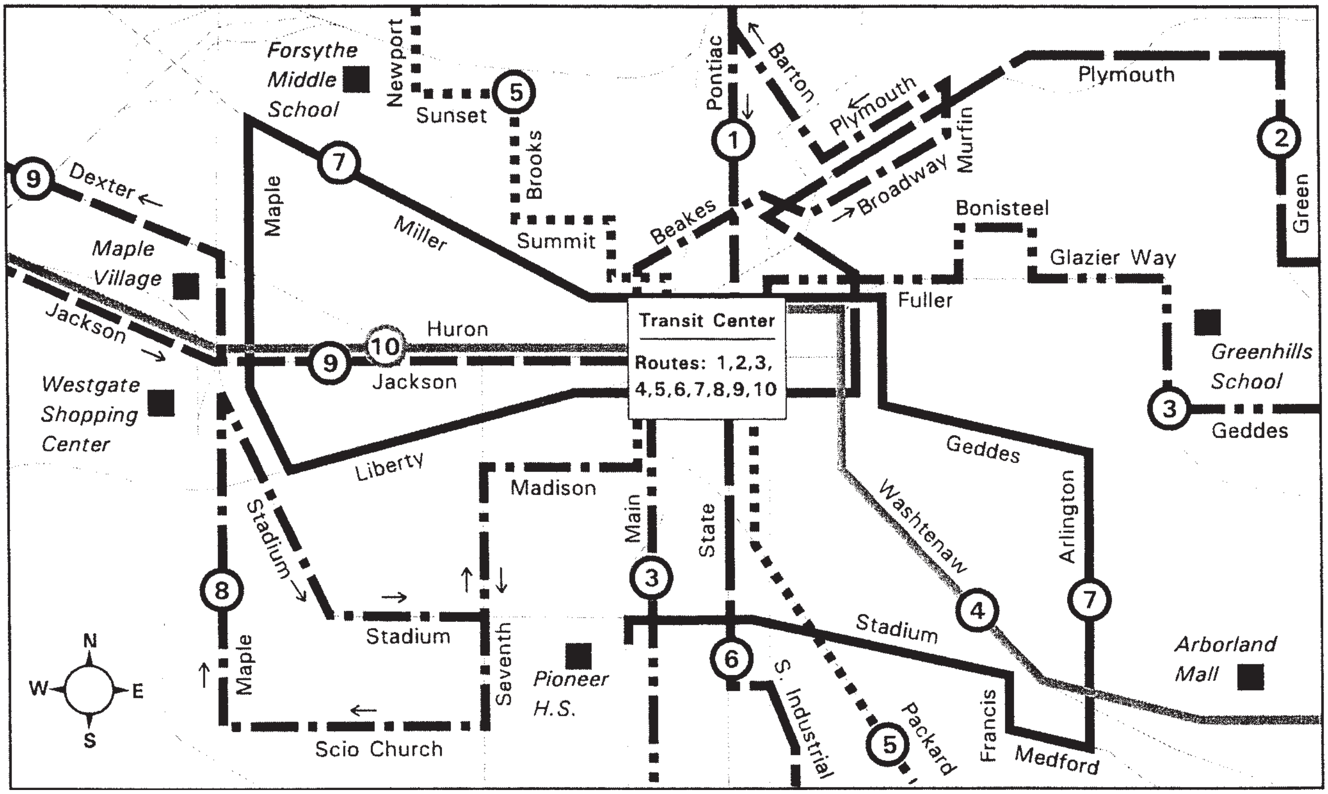


Figure 15. Example of a black-and-white system map.

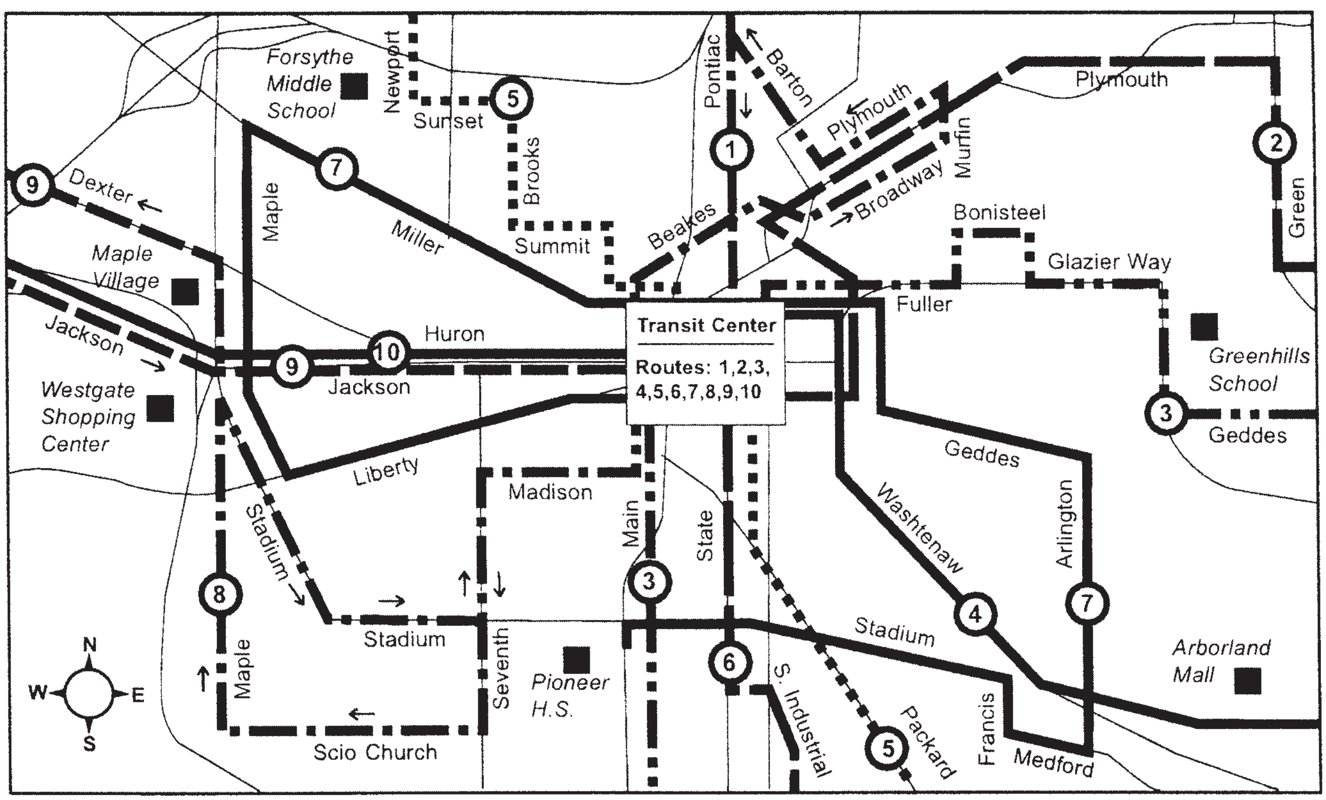


Figure 16. Example of a two-color system map (original color reprinted in black and white).

- Bus stops are in the same color as routes.
- Terminals and transfer points are in black.
- Landmarks are in black.

(Note: For more information on color and coding, see Appendix A, Section 4.2.)

3.4.2.2 Multi-Color Route Coding

Colors used for route coding should be easily distinguishable from one another and should stand out against the background of the map. Use saturated colors, avoiding most pastels. Recommended colors include the following:

- Red
- Green
- Yellow
- Blue
- Orange
- Brown
- Purple
- Light Blue
- Black

These colors are recommended by the Manual of Uniform Traffic Control Devices (MUTCD) for traffic and highway signs (Section 2A-11 of MUTCD).

Figure 17 provides an example of a multi-colored system map. Note the following:

- Streets and highways are in medium to light gray.
- Routes are in different colors; colors are arranged so that adjacent routes are different colors.
- Bus stops are in the same colors as routes.
- Terminals and transfer points are in black.

3.4.2.3 Partial Color Coding

A partial color code, in which each color is used for several items in the display, significantly reduces search time by guiding the user's eye to a smaller number of targets. For example, if a map contains 30 different route lines printed in three different colors, a user looking for Route 10 (red) would scan only those lines that are printed in red, ignoring the other two colors and shortening the search. Note the following:

- Keep the number of routes per color approximately equal.
- Arrange the color coding so that adjacent routes are in different colors, to help the reader distinguish between them (see Figure 3).
- Patterned route lines may also be used in conjunction with color coding.

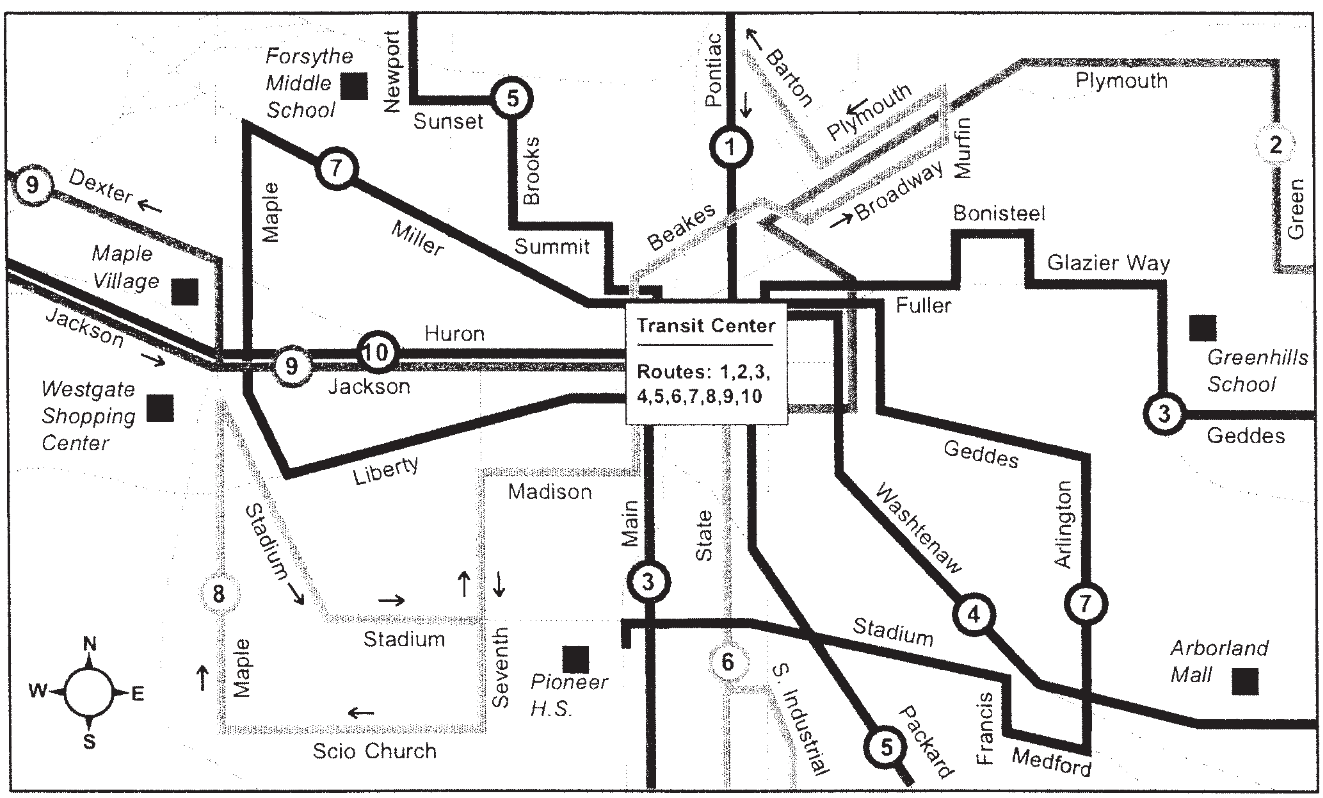


Figure 17. Example of a multi-color system map (original colors reprinted in black and white).

3.4.2.4 Complete Color Coding

A complete color code uses a different color or combination of colors for each item (e.g., route line) in the display. For a transit system with fewer than 10 routes, a complete color code can be effective for route identification as well as a search aid (though routes should still be marked with a number or other label).

For 10 or more routes, using a different color for each route does not generally decrease the usability of the map, if routes are otherwise labeled. Different route colors adjacent to each other will still help in distinguishing between those routes, if the colors are different enough. However, more than nine different colors will not "buy" more help in searching for or identifying routes; as the number of colors on a map increases, the reader becomes less able to absolutely identify any one of them.

3.5 TRANSIT SYSTEM FEATURES

Consistency is the key when designing a system of transit information aids. Route names or numbers, identification of stops or transfer points, and other system features can help to lead the transit passenger through a trip—if these "clues" are as similar as possible from one type of information aid to another.

3.5.1 Route Labels

A number, letter, or number-and-letter designation should be used to identify transit routes. Even if routes are color-coded, do not let the color of the route be the only identifier. All routes on a map should be labeled. If a route has a name in addition to the number/letter identifier (e.g., "Route 3—Washington Avenue") that name should be used in system maps, on signs, and by telephone information operators or recordings **along with** the route number. Figure 18 shows examples of route labels.

3.5.2 Location Names

Names or other verbal designations of terminals, transfer points, stops, and other system-related features must also be consistent from one information aid to another. If a stop is at the intersection of Church Street and Dekker Avenue, near the Public Library, all guidance information must say "CHURCH and DEKKER" as a minimum. If the extra information, PUBLIC LIBRARY, is placed only on certain kinds of information (e.g., a route map), the stop must still be primarily designated by CHURCH and DEKKER—every time. The material would read as follows:

CHURCH and DEKKER—PUBLIC LIBRARY

It is false economy to alternate designations, to have one sign say CHURCH and DEKKER and the next sign say only PUBLIC LIBRARY. Riders may not be able to remember the association of the two.

3.5.3 Transfer Points

Identification of transfer points will be affected by the size and complexity of the transit system. For systems with relatively few, distinct transfer points between routes, transit systems may want to mark all those points on the system map. For a system that contains dozens or hundreds of possible transfer points, it is advisable to limit "marked" transfers to transit centers and possibly show other transfer points on individual route maps.

A transfer point between two or more routes on a system map can be marked with a circle or other symbol at the juncture of the routes. Where several routes meet or wherever there could be a question about connecting routes, it is advisable to identify the route numbers for that transfer point. On a single-route map, any connecting routes should be identified by number where possible.

Large transfer centers or terminals should be shown with a labeled box containing all route numbers that serve the center. Transfers from bus to a rail line can be indicated with a rail icon.

Examples of symbols and labels for transit system elements are shown in Figure 19.

3.6 LANDMARKS

No standard has been universally adopted for landmark icons. Several variations of symbols and drawings are currently in use in the United States and the world (see Figure 20). The examples shown range from the somewhat-universal

Figure 18. Route labels.

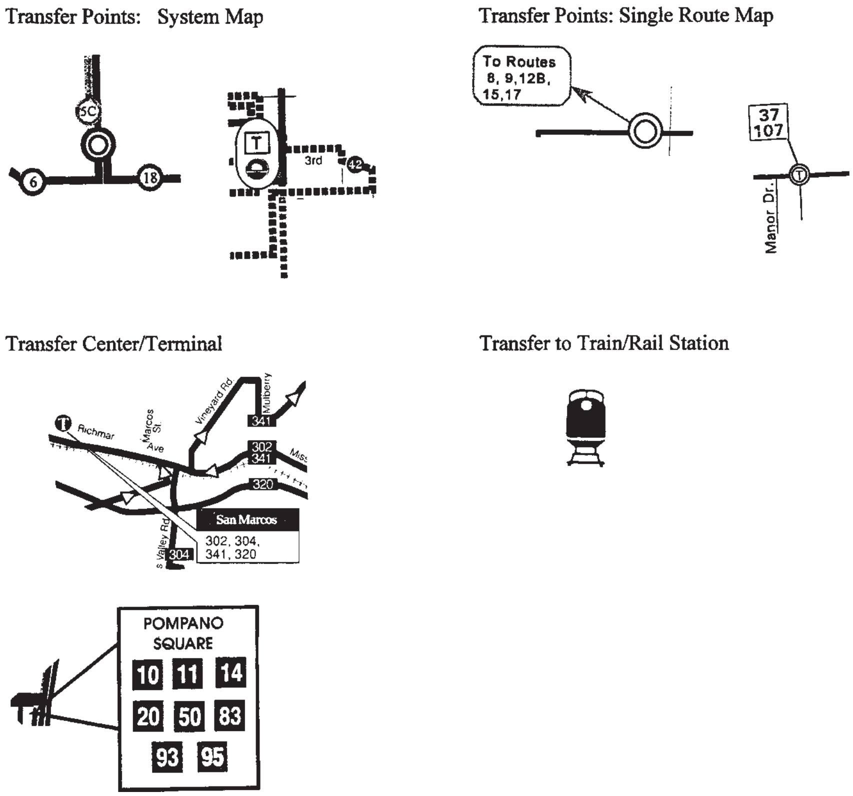


Figure 19. Transfer point symbols.

symbols for “Airport” and “Hospital” to the elaborate and unique drawings depicting Chicago’s tourist attractions. In using landmark icons, note the following:

- Any icon may be misunderstood, so an accompanying label is important.
- Landmarks may also be identified by a simple, labeled dot or square, as in the map examples shown in this guidebook.
- Coding landmarks by number saves a small amount of space in the body of the map, but requires the reader to perform another “task” in matching the number to a landmark name in an index; therefore, coding landmarks by number is not recommended.
- The number of landmarks shown on a map will be affected by the size and complexity of the transit system. For large cities, a system map showing all the landmarks served by the transit system may be so cluttered that it is difficult to read. One solution is to select a few major landmarks to display on the system map for orientation purposes and to show additional landmarks on route maps. For cities with large tourist populations, a special map displaying just the tourist attractions and the routes that serve them will be welcomed. The expense of such a special audience may be defrayed by developing it as a cooperative venture with businesses catering to tourism (e.g., hotels, restaurants, and attractions).

3.7 SYSTEM MAP LEGEND

The system map legend should identify all codes and symbols used in the system map. Figure 21 shows examples of map legends.

APPLICATION: Should appear on printed (distributed) and wall-mounted versions of system map.

FEATURES:

- If routes have names as well as numbers/codes, list those names in the legend with the route numbers
- Coding/line types for streets, highways, and routes
- Symbols for landmarks
- Symbols for stops and transfer points, if any, and terminals/transfer centers

DESIGN CHARACTERISTICS:

Character Sizes: Minimum character size should be at least as large as the minimum character size for the body of the map

Remarks:

- The legend should be placed at an edge of the map where it will not obscure any important map information. If

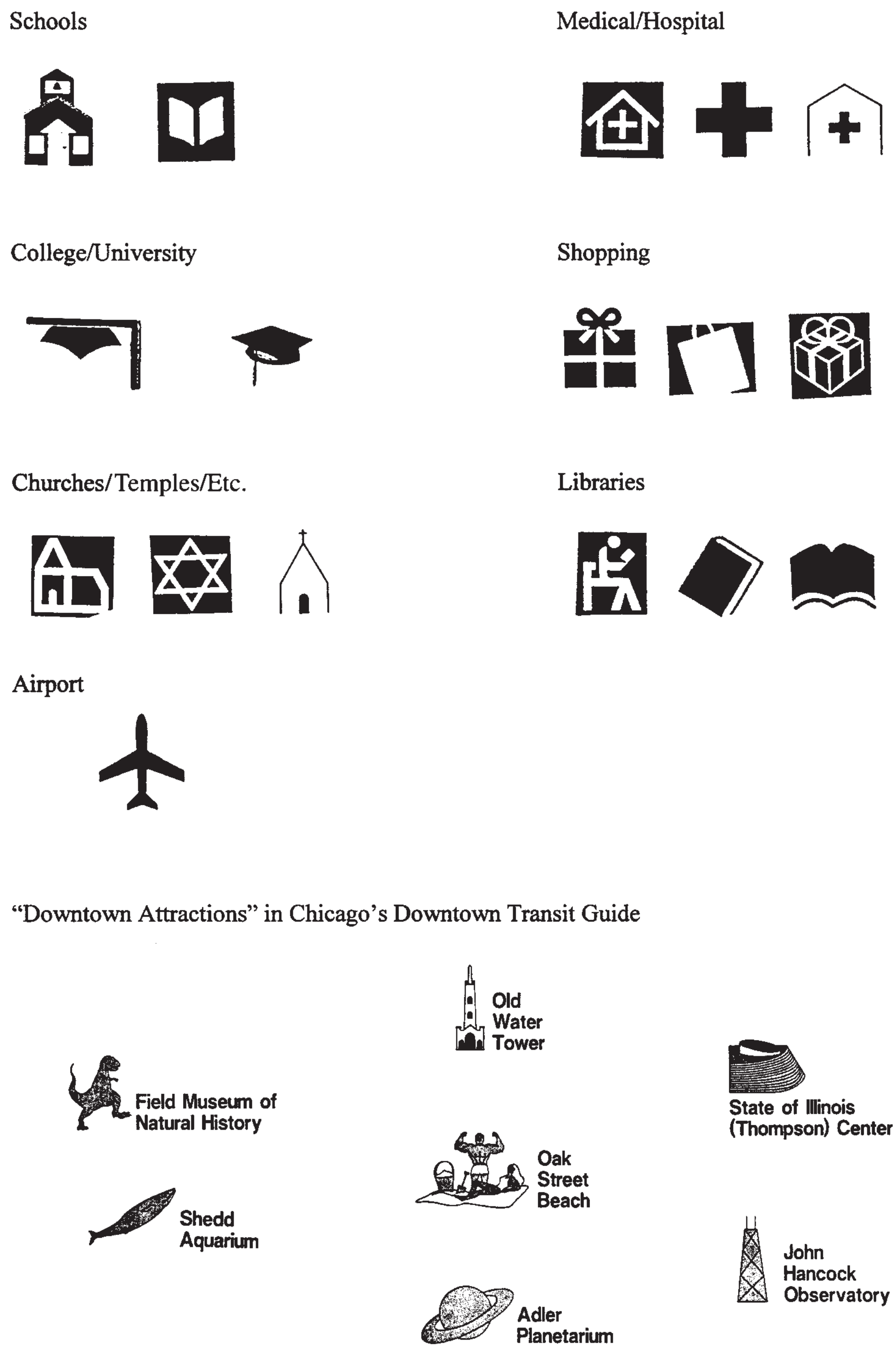


Figure 20. Landmark symbols.

there is an existing "break" in the map with no relevant streets, route lines, etc. the legend may be placed there, space permitting. Otherwise, the legend should be placed outside the body of the map.

- If the map is a schematic, state in the legend that the map is not to scale.
- If only limited transfer points and/or stops are shown on a system map, state that fact in the legend.
- Box the legend and label it "Legend".
- Background color of the legend should be white. Symbols, etc. shown in the legend must follow the color scheme that is used in the body of the map.
- Recognize that many users will **never notice the legend box or use it**, so try to design the map so that the legend is not absolutely necessary to get the basic information. Keep codes simple!

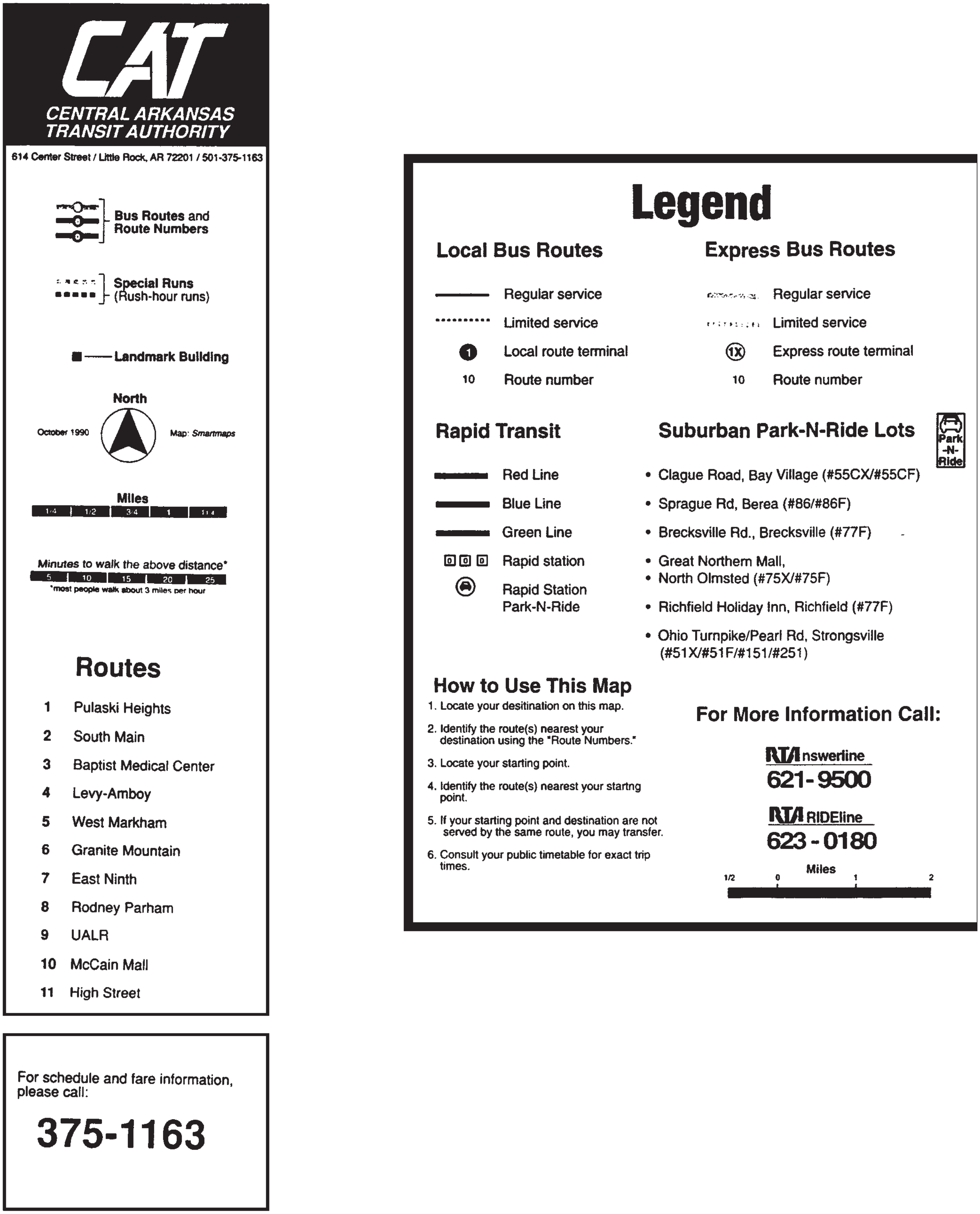


Figure 21. Map legend examples for the Central Arkansas Transit Authority and the Greater Cleveland Regional Transit Authority.

REFERENCES

NOTE: *NCTRP Synthesis of Transit Practice 7: Passenger Information Systems for Transit Transfer Facilities* was used as a resource in developing this guidebook and provides a detailed review of many of the information and design principles associated with transit information aids.

1. Wickens, C. *Engineering Psychology and Human Performance* Harper Collins (1992) p. 140–153.
2. Bartram, D. "The Presentation of Information about Bus Services" Chapter 16 of *Information Design*, R. Easterby and H. Zwaga (Eds.) John Wiley and Sons, New York (1984).
3. Fruin, J. *NCTRP Synthesis of Transit Practice 7: Passenger Information Systems for Transit Transfer Facilities,* Transportation Research Board, National Research Council, Washington DC (October 1985).

APPENDIX A

FURTHER CONSIDERATIONS FOR THE DESIGN OF PASSENGER INFORMATION

1 INTRODUCTION

This appendix contains additional information concerning the principles of information design, specifically of the design of transit passenger information.

This section loosely follows the order of topics found in sections 1 and 2 of this guidebook. Each topic heading under sections 1 and 2 references, where applicable, a section number in this appendix. The information here is intended to provide some background and context for the design guidelines given for passenger information aids in this guidebook and may be helpful when adapting the guidelines to transit systems.

2 WAYFINDING

2.1 Spatial Knowledge

Passenger information is really a special application of the more general cognitive concept of orientation and wayfinding, in other words, spatial knowledge. From maps, actual experience, or both, people acquire various types of spatial knowledge (*1*). People use different procedures to make spatial judgments depending on the types of spatial knowledge that they may have; the accuracy of such judgment depends on the accuracy of both underlying knowledge and procedures. The process of transforming such knowledge into procedural descriptions has been called "mental simulation of navigation" (*1*). Such simulation leads to spatial judgments.

There are two major classifications of spatial knowledge—survey knowledge and procedural descriptions. Survey knowledge is of topographical properties, locations with respect to some coordinate system, and straight line distances between destinations. This is knowledge gained from map study. Navigational experience and/or maps (if they are effective and if the user can extract the information) leads to procedural descriptions. These descriptions tell about routes between destinations, landmarks, features, distances, and directions. Travellers need this information in some form at departure points (home or at a stop) as well as in transit, with confirmation whenever needed.

Seigel and White (*2*) describe the development of orientation and wayfinding, in other words, spatial knowledge, in this way:

- **Level 1** The young child notices and remembers landmarks.
- **Level 2** As the child grows older, it learns routes and uses landmarks to go from point to point.
- **Level 3** The next stage is the development of "clusters" or "minimaps" not well related to the large-scale environment.
- **Level 4** Later still, differentiation of the self from the environment occurs—the conceptualization of outside features and boundaries independent of body position. This occurs in early adolescence.
- **Level 5** Formation of mental "survey maps" occurs in the adult.

Children tend to pick salient but not necessarily relevant landmark cues; adults tend to select reference points at actual nodes or choice points. There is evidence that some older people may regress somewhat to an earlier point in the developmental cycle sketched above (i.e., they may move from Level 5 to Level 4 or 3 as they age). People with developmental or learning disabilities may never attain Level 4 or 5.

Implications from this and similar models for route guidance information are that reference points should be concrete objects such as landmarks rather than arbitrary locations. The memory for objects is superior to the memory of abstractions. Map clutter—extraneous "nice to know" information—is a major factor in making mistakes in distance estimation or route planning; schematic maps that regularize the terrain and make it more grid-like are easier to recall. On the other hand, maps of any kind may limit people to understanding only a single point of view or orientation. Many people are hard pressed to negotiate their way if a new map is presented with a different orientation than the one they learned (*3*). Indeed, 64 percent of the U.S. population are thought to have difficulty reading maps of any sort; those who do have difficulty prefer oral instructions or procedures and rate all landmarks as equally valuable for route finding (*4*). These findings suggest the critical importance of landmarks in any wayfinding information package.

2.2 Locale and Spatial Knowledge

The needs for spatial knowledge and, more importantly, ways to impart that knowledge, differ not only with regard to the particular kind of user, but also can vary greatly from one locale to another. It is much easier, say, to get lost in Baltimore than it is in Washington DC—at least for people who understand the quadrant-grid design of L'Enfant's Washington. Different people bring different knowledge and expectations to their use of information services to help them navigate. Relatively unsophisticated people may not use cardinal directions or conceive of their position with regard to some arbitrary coordinate system, but rather may relate much better to point of origin. "You are here" does not help unless you know where "here" is (*5*). If the cognitive map does not correspond with the presented information, then confusion can and does result. The user is, in some sense, "lost."

2.3 Point of Reference and the Environment

The point of reference must be carefully considered in the design of any information system for riders of a public transit system. The question must be asked and answered, "Where are the common points of reference for all users of this transit system?" Once the common points of reference are established, representation of the physical world and of the transit system in which they are embedded must be considered. At least three aspects of the environment must be simulated (*3*):

- Particular locations;
- Distances between particular locations; and
- Relationships among locations.

2.3.1 Particular Locations

Locations should be labeled with respect to knowledge the rider already has or can be presumed to have. Labels must relate to the mental picture that the rider has formed of the city or district which they are attempting to traverse. One question is whether all possible locations that can be reached from the present location (e.g., a bus stop) should be identified, or whether the location labels should be spaced. Often, place labels are meaningful to operators in the system, but have no such significance to users.

2.3.2 Distances

Distance between locations may be expressed in terms of time between locations or cumulative time or in terms of space to be traversed (e.g., miles, blocks, or some other metric that describes the transit journey for the passenger).

2.3.3 Relationships

The rider or user must convert actual geographic direction into some other represented direction. He or she is moving through three-dimensional space, but must conceptualize the space as a two-dimensional projection.

2.4 Maps Versus Instructions in Wayfinding

Wayfinding information can be presented in two basic forms: (1) oral or written instruction and (2) visually/graphically in maps and signage. There are advantages and disadvantages to each form of information.

Verbal wayfinding information consists of a sequential list of instructions, for example:

1. Go to the bus stop at the corner of Main Street and 4th Avenue.
2. Take Bus Number 324 Northbound to Lilly Transit Station.
3. Transfer to Bus Number 47 Westbound and ride it to the third stop, which is the corner of Southwood and Spring Street.

Telephone information services provide this type of trip planning information, given a specified origin and destination. The primary advantage of this type of information is its straightforward interpretation. A transit rider needs no special geographic or navigational knowledge to understand this sequence of commands and acquire "route knowledge" for this particular trip. For occasional riders or riders who will likely take the same route most of the time, "route knowledge" is sufficient for successful use of the transit system.

The disadvantage of oral wayfinding information is its inflexibility. Each step in the sequence provides the only frame of reference for the next step. An error in the sequence or a change in the rider's trip plans destroys this frame of reference and makes the rest of the information meaningless. The "lost" rider must then seek further instructions to continue the trip.

Maps and related graphical information present the rider with a network of options that the rider must translate into a particular trip plan. Map study provides the rider with "survey knowledge" of the transit system, placing the rider's planned trip into a geographic frame of reference. ("Survey knowledge" can also be obtained through extensive and repeated travel through the transit system, if various routes are taken to different destinations.) This geographic context allows flexibility and the ability to recover from errors; if a rider takes an incorrect bus or disembarks at a different bus stop than intended, a map of the system will help him to "relocate" his or her position and take steps to backtrack to the point of the error or to continue the trip using a revised plan. Maps can present difficulties to beginners and to those who have difficulty comprehending spatial information; although some of these difficulties may be overcome by the graphic design of the map, clarification of the wayfinding information through oral or written instruction may sometimes be necessary (*6, 7*).

Wickens (*6*) describes the relative uses and merits of oral and graphic information as a "tradeoff": the "automaticity and cognitive simplicity" provided by oral instruction versus the "flexibility and generality" of maps, signs, and other graphic information. *NCTRP Synthesis of Transit Practice 7* further specifies the usefulness of each type of information, alone and in tandem: oral assistance in the form of telephone information centers and on-site information desks provide personalized trip plans, answer specific customer questions, and quickly accommodate changes in transit service. Distributed information in the form of maps and route maps/timetables "bridge the knowledge gap" of the many riders who are not familiar with the layout of the city and/or the transit system, provide a permanent reference for the trip, and can help a rider to visualize and clarify the oral instructions received from a telephone information center. Signage identifies the "decision points" of a trip and provides direction and confirmation of the rider's next move at those decision points.

3 TRANSIT PASSENGER INFORMATION NEEDS

3.1 The Legible Transit System

A legible transit system is a system in which a passenger can get from one point to another easily, without anxiety about getting lost, and without outside assistance (*8*). One study defined it as "the ease with which parts of (the transit system) can be reorganized and integrated into a coherent pattern" (*9*). The dilemma faced in designing route information is that of providing the passenger with all the information he or she needs to successfully complete the trip without overloading that rider with irrelevant detail. What constitutes "irrelevant detail" varies with the passenger and with the trip. A frequent public transit user, familiar with the city, needs little more than a list of stops for each route in order to plan his or her trip, and will be frustrated with too much detail. A new or infrequent rider or a rider unfamiliar with the city needs more information: route locations, transfer points, arrival and departure times, and possibly a complete map of the city. In either case, route information that is hard to understand will confuse and frustrate a potential rider and encourage him or her to find some other source of transportation (*10*). Additional challenges face the rider who has visual disabilities, is non-English-speaking, or has low reading ability. It appears that these are the audiences, or customer segments, for which passenger information aids should be designed—the people who may choose not to ride public transit because of their fear of getting lost or stranded.

As Canter (*5*) points out, any information services constitute a prosthesis for the lack of transparency of the transit system, because that system is complex. These information services must somehow build on the following:

1. What people already know about the system (situation awareness),
2. Representation of new information through signs and symbols,
3. Locations and relationships among locations served by the transit system, and
4. The uses of the information services to formulate plans and reach goals.

3.2 What Does the Passenger Need?

Even an unfamiliar locale will give rise to a set of expectations about aspects of the environment (e.g., locations, distances between locations, and relationships among locations). An unfamiliar rider may (a) be new to the city, such as a tourist, or may (b) be familiar with the city in general, perhaps even a commuter on the bus line, but now embarking on a novel journey, going someplace he or she has never been before. The rider who has no familiarity with the city or the bus system is the target for the full gamut of rider information. One may call this rider the beginning rider. For an experienced rider, the information needs will be fewer, but unless the trip is also a familiar one, the rider will still need the bus number and times of departure, as well as any transfers that will be necessary.

During the trip itself, the rider needs "affirming" or reinforcing information at bus stops (e.g., timetable and route information). Inexperienced riders may also want more details on identifying correct stops for disembarking and on the "return" time to get back to their point of origin at the end of the trip.

A detailed listing of passenger information needs appears in *NCTRP Synthesis of Transit Practice 7: Passenger Information Systems for Transit Transfer Facilities* (*11*):

- "Area geography, topographical barriers, major highways, place names, street numbering systems;
- Places served by transit;
- Proximity of transit transfer facility to trip origin and destination (walking distances, transfers);
- Route numbers, transfer points, station names, cross streets at stops, house numbering;
- Hours that service is available;
- Schedules (headways, waiting time);
- Travel distance, total travel time, time between stops;
- Fares, free transfer privileges, riding rules, special rates;
- Special services, facilities for the handicapped, architectural barriers, language barriers;
- Identification of stops, stations, external markers, guide signs to transfer facilities;
- Routes serving the stop or transfer facility;
- Directional signing within transfer facilities for various locations (transfer points, routes, platforms, gates, vehicles, services) and for various types of users (ticket holders, visitors, employees, first class, etc.);

- Vehicle identification signs, route numbers, and names;
- Supplementary information assistance en route (on-board route maps, station assistance telephones, transit personnel, other riders);
- Information center telephone numbers."

3.2.1 What Does the "Beginning" Rider Need to Know?

Transit systems must know the information needs of the beginning rider, together with an idea of who that beginning rider is, in order to develop information design. The beginning riders may be as follows:

- Elderly,
- Children,
- People of any age without a car in a strange town,
- People curious to try a "new" mode of transportation,
- People with disabilities or other disadvantages, and
- People with little or no familiarity with English.

A given beginning rider may be any one of these or a combination of several. These diverse kinds of people have the following needs in common:

1. "The primary need of all prospective riders is to be able to determine if transit provides a reasonable connection between a planned trip origin and destination." (*11*)
2. Beginning riders need to have positive guidance in all aspects of route planning and during the actual trip. The powerful concept of positive guidance, developed under the auspices of the FHWA for highway drivers (*12*), has application to transit as well. Translated into transit terms, positive guidance means giving the rider the maximum amount of visual information that is as follows:
   - Useful;
   - Prioritized in importance;
   - Uniform, consistent, and without surprises; and
   - Easily visible under as many riding conditions as possible.

Information that fulfills these four criteria will not let the rider "get lost." It is crucial that the rider always knows where he or she is going. Specific route guidance information that is needed includes the following (*13*):

1. Area geography, the "lay of the land";
2. Places and areas served by the bus system;
3. How far the closest approach of the bus route is from the actual trip origin or destination;
4. Identification and location of terminals, transfer points, stops, and routes;
5. Hours of service on routes;
6. Schedules and/or headways/waiting times;
7. Trip distances and times;
8. Designation of terminals, transfer points, stops, and which routes are accommodated;
9. Vehicle identification signs and route numbers; and
10. Guidance information en route.

Some of these needs must be met before the rider leaves his or her point of origin (e.g., home, hotel, or a terminal for another mode of travel). Other needs arise at the terminal, transfer point, or bus stop. Information is also needed when the rider is in the bus. When the rider disembarks from the bus, confirmatory information is required that the rider has actually accomplished the trip as planned.

A study in South Yorkshire, England, approached the question of transit passenger needs by taking participants on "escorted bus trips" and asking each participant what he or she needed to know at each stage of the journey. A typical participant needed information in the following order as he or she began the trip:

1. Where is the nearest bus stop?
2. Which bus (or combination of buses) goes from this bus stop to the desired destination?
3. Where can this information be found at the bus stop?
4. What time does the bus run?
5. What is the fare?
6. How can the correct bus be identified?

The study concluded that the greatest information hurdles for transit riders occur during the "planning" phase, before the trip begins (*14*).

3.2.2 What Does the "Experienced" Rider Need to Know?

The experienced rider's needs are not qualitatively different from those of the beginning rider, but are merely a smaller part of that same package. The true "commuter" who takes the same bus each day at the same time and place only needs the bus/route identifier, if the stop is a transfer point; nothing if the bus stop is serviced by only one route. The "commuter" is at one extreme of information needs; the beginning rider is at the other: he or she needs everything he or she can get. Riders familiar with the system, but going different places at various times and occasions, need most of the information the beginner needs, but are much more able to derive the route guidance they seek. In reference to specific route guidance information enumerated above, such riders have little need for the "lay of the land." They usually have a good idea about the places and areas served by the system. They will, however, probably need to know how close the bus stop is to the destination, where are the node points, and when are they served. They may not need much information on waiting times, because they ride the system already, but trip times will be of interest. If they are going to new places on the system, they need to know node point names just as others do. All riders need vehicle identification/route numbers and status on the route (how soon do I get off?) (*13*).

3.3 What Information Aids Do People Prefer?

Several studies over the last several decades have addressed the question of riders' preferences in transit information aids, with varying results. A 1976 Batelle Institute study asked participants, a mixture of transit riders and non-riders, to rank eight different information aids in terms of their usefulness. In descending order, the rankings were as follows:

- Pocket schedule,
- Telephone,
- Bus stop information,
- Fold-out map,
- Bus driver,
- Electronic route finder,
- Sign on front of bus, and
- Other people at bus stop (*15*).

In 1994, a similar survey of passengers in Northhampton County, England, produced a slightly different ranked list, shown in descending order below:

- Timetable leaflet/booklet;
- Timetable display board;
- Asking at enquiry desk,
- Inspector, bus driver, etc.;
- Telephone enquiry;
- Video monitor; and
- Enquiry terminal (*16*).

A focus group study by the Metropolitan Transit Authority of Harris County (METRO) in 1992 also asked participants what information they would need in order to ride METRO buses. Non-riders in the group mentioned bus schedules, connections, and fares as the most needed information, while riders expressed a need only for information on changes to routes they normally ride and on bus token purchase locations. A map of all the routes was also mentioned as a potentially useful item. Nearly all the riders reported carrying pocket schedules or keeping them at home or at work. The non-riders were uncertain of where to obtain schedules or maps, but speculated on some likely sources of these items. A few of the riders and one of the non-riders had a system map. Again, the telephone information number for METRO was mentioned as a useful information source (*17*).

The Texas Transportation Institute and NuStats International conducted a study (*18*) in 1997 with 59 transit riders and non-riders in three U.S. cities: Little Rock, Arkansas; Chicago, Illinois; and Los Angeles, California. The subjects ranged in age from 12 to 65; one-half were English-speaking and one-half were non-English-speaking. Subjects were placed in groups of three to four and asked to verbalize a hypothetical plan for a transit trip. The results indicated that most passengers plan their transit trips before arriving at a bus stop. Therefore, they use a telephone information center or an on-hand schedule (timetable) book to plan their trips. In the course of these hypothetical transit trips, the two key questions that most riders needed to have answered were: "Is this the right bus?" and " At which bus stop do I deboard?" The bus drivers were their preferred information source for answers to these two questions. Frequent riders were less reliant on individuals other than themselves for the answers to these questions. Occasional and non-riders typically would prefer not to use printed schedules and maps to elicit answers to these questions, but would prefer a more individualized information source.

Information about the logistics and policies relating to transferring was important to would-be riders. A transfer could be considered the start of a new bus trip. For this reason, they pre-planned their transfer trips in the same manner as they did their originating trip. Individuals noted that they would likely have the necessary information about a transfer prior to starting out. Bus drivers were the preferred in-route information source for confirmation or reassurance that passengers were transferring correctly.

A consistent finding was the degree to which passengers required confirmation or reassurance that they were navigating the transit system correctly during their trip. Redundancy in information presentation appeared to be a requirement in the development and design of passenger information materials.

Riders and non-riders in all of the above studies mentioned bus route timetables as a useful information aid; however, past research has demonstrated that many people have difficulty using timetables. Appendix A, Section 7.4, provides additional information on the usability of bus timetables and other information aids.

3.4 Usability: TTI/NuStats Study of Passenger Information Aids

In the second part of the TTI/NuStats study on passenger information aids, each subject was given one of two versions of a prototype system map and a set of routemap/timetable leaflets and asked to plan a specific trip using the materials.

The prototype system maps were successfully used by most test subjects to navigate from a particular origin to a particular destination on an unknown transit system. However, the prototype timetable was difficult and frustrating for most test subjects to use in calculating the schedule for a bus trip from a particular origin to a particular destination within a specified period of time. This observation was consistent regardless of the timetable prototype (A or B) used. These data suggest that timetables may be a specialized passenger information aid that are useful to a narrow segment of the ridership market and that bus systems might reconsider the use of an all-inclusive timetable that confuses would-be users with too much information. Deconstructing timetables might be a preferred alternative in which the schedule information is posted in smaller chunks via signage at various points along a bus route (*18*).

If it is decided to print and distribute timetables as a passenger information aid, Section 4.5 in this appendix offers some design considerations to maximize their readability.

4 PASSENGER INFORMATION DESIGN REQUIREMENTS

4.1 Design Considerations for System Maps

Various formats for transit system maps are in use in the United States. The most detailed of these maps superimpose the system of routes on a complete street map of the city. This provides the maximum amount of location information to the user and eliminates the need for a separate city map. It also, however, puts a great deal of visual detail in a limited space and may be hard to read. In order to make the map small enough to conveniently carry and use, some transit system maps are smaller than ordinary city maps, resulting in print sizes that are almost too small to read.

In a study by Houston METRO in 1992 (*17*), METRO riders and potential riders compared system maps from several transit agencies that varied from highly detailed street maps to less-detailed, schematic maps of the routes. Many riders thought that more street detail would help new riders to find stops and destinations, but they preferred the look of the less-detailed maps.

A special case of this type of transit system map is an oblique map, which may show artists' renderings of streets, landmarks, and some topographical information. These maps are used most often in smaller communities or to display one section of a larger city. The added space needed to display buildings and other embellishments makes this type of map infeasible for a large city transit system.

Schematizing a bus route map is a way of reducing "clutter," or irrelevant information, while emphasizing the information that the user needs for route-finding. Schematic maps, which may or may not reflect the spatial layout of the city, have few or no streets shown that are not part of the route lines. Their purpose is to show the relative locations and connections of the routes, and they usually provide no information concerning locations that are not on the routes. These maps are easiest to read because of the limited amount of detail, but the transit companies that use them often have to answer customer requests for information concerning streets or locations that cannot be found with the schematic maps.

Studies measuring route-finding performance generally show faster task completion times and greater user preference for less-detailed schematic maps (*17*, *19*, *20*, *21*, *22*). This is true especially when the user is familiar with the city, when the trip-planning task is isolated within the transit network (i.e., starting points and destinations are given as stops on the route) and in systems such as the London Underground where the routes do not follow city streets. Users faced with an unfamiliar city and an unfamiliar destination feel more confident with a route map that provides street names and spatial information (*8*, *15*).

4.2 Use of Color

Color coding maps has been shown to improve performance on route-finding tasks, particularly on detailed maps. In a study comparing four styles of transit maps in Fort Worth, Texas, a high-detail, color-coded map produced better route-finding performance than either the low-detail or high-detail black-and-white map (*19*). Bartram (*8*) found the beneficial effects of color coding to be secondary to the benefits achieved by simplifying a high-detail map, but also stated that a high-detail map may be necessary to provide sufficient information to a public transit user. Color coding is especially useful for organizing this type of high-density information.

In a Battelle Institute survey of public transit user preferences, approximately one-half of the respondents preferred coding bus routes by color. The survey also found approximately equal preferences for two other uses of color in a route map—designating transit service classes and designating geographical areas of the city. Most people surveyed (74 percent) felt that three to five colors were the maximum that could be used effectively on one map; 44 percent set the ideal number at four (*15*). Christ (*23*) sets the maximum number of colors in a visual display at nine when the colors are being used to identify different values or categories; thus, for a map displaying nine or fewer routes, color coding should aid the reader in selecting a desired route.

Houston METRO's study compared several uses of color coding in system maps. In METRO's own map, adjacent routes were colored differently to aid the reader in discriminating among them on the map; colors were repeated, but "coded" only to maintain different colors on adjacent routes. Participants preferred this use of color to other color-coding schemes such as color coding by service type (i.e., express routes in one color, local routes in another color, and so on) or by region of the city (*17*).

Color is impractical in some situations. Although Ellson and Tebb designed an eight-color leaflet for a rural bus system in Yorkshire (*24*), they rejected color coding in information materials for an urban route in the town of Bingley (*25*). Poor lighting conditions along the urban route would have made the colors in the map hard to distinguish. Color coding of routes loses effectiveness if the number of routes (and colors) is 10 or more. Finally, the expense of printing colored literature limits its use. Some experiments comparing color coding in visual displays with other types of coding have found color to be effective as an aid to identification and search tasks, but not significantly more effective than monochromatic coding techniques (*23*).

4.3 Font Sizes and Styles

4.3.1 Font Size

"The most reliable investigations suggest that the more commonly used sizes between 9 and 12 point are of about equal legibility at a normal reading distance . . . the optimum size is likely to be 10 or 11 point . . . assuming that the reading distance remains constant, the legibility of smaller sizes such as 6 point will be impaired by difficulties in discriminating letters and recognizing words." (*26*)

Individuals with low vision or who are elderly and have advanced cataract and/or macular degeneration have problems reading small type of any kind. The recommendation to use a minimum font size of 10 points is addressed to this transit user group. Essential information on maps and other route guidance material should not require the use of magnifiers to read them.

4.3.2 Sans Serif Versus Serif Fonts

Sans serif fonts appear to be more legible for children, for readers with poor vision, and for signs and labels (*26*, *27*). For long blocks of text, such as rider instructions, it is better to use a serif style (e.g., Times Roman).

4.3.3 All-Capital Text Versus Uppercase and Lowercase Text

Except for the letters with "ascenders" or "descenders" (e.g., g, h, and y), lowercase letters are less legible at a distance than uppercase or capital letters (*26*). Military Standard 1472D (*28*), which specifies human factors design criteria for various systems, recommends that all capital letters be used for labels, legends, and short instructions on signs. For several lines of text, both uppercase and lowercase letters may be used.

4.4 Route Map

The route map is a single route representation in schematic or sometimes geographic format, combined or integrated with a timetable for the route. Such a tool provides information on a route that is similar to that provided by full system maps. Once again, the sign version of the route map performs the same function and should bear a close resemblance to the individual pamphlet or card.

Route names based on streets or landmarks were the most common format encountered in TTI's 1993 passenger information study (*10*). However, when test participants attempted to plan simulated trips using passenger information materials that identified routes in this way, street and landmark names tended to cause confusion rather than alleviate it. Inexperienced transit users who noticed the route names tried, sometimes unsuccessfully, to match those names to their planned destination. These participants would eventually switch to the route numbers and colors to finish the planning exercise.

Another disadvantage of long route names is the difficulty presented to riders who cannot read or for whom English is a second language. Options such as shape coding or single-letter/number route identifiers may provide a solution.

4.5 Design Considerations for Route Maps and Timetables

Bus riders ranked pocket schedules, or timetables, first out of eight suggested transit aids in a study conducted by Battelle (*15*). However, timetables generated poorer performance than maps in a route-finding exercise, even in locating departure times. Other studies have supported the conclusion that people generally perform poorly with timetables; moreover, performance with timetables seems to worsen with the age of the individual (*8*).

Several studies have focused on the effect of timetable formats on user performance. In general, formats that required the least amount of "translation" or interpolation by the user produced faster and more accurate responses. Users had difficulty with the coded timetables in a British bus route leaflet which used designations such as "odd" and "even" hours (*24*). Other formats that hurt performance were timetables containing phrases such as "6:06 every 12 minutes until 7:06" to designate departure times (*20*). Full hour and minute presentation of departure times produced better performance. Twelve-hour clock times (2:15 a.m., 3:05 p.m.) were more usable than 24-hour times (0215, 1505), and designations such as "Morning," "Afternoon," and "Evening," seemed to be more effective than "a.m." and "p.m." (*29*).

Wildbur (*30*) recommends generous spacing between timetable entries and breaks after every five entries to aid in visual searching. He also suggests including an example of timetable use in the display. Minimizing the use of printed lines and grids reduces clutter and allows the eye to focus on the time and location information (*31*); however, lines or shading separating rows of times were noted as helpful aids by participants in Houston METRO's study, with shading preferred (*17*). Arranging the timetable with the route (successive bus stops) represented on the horizontal axis and time on the vertical axis produced better performance than the reverse arrangement (*29*).

Graphics may also play a part in bus schedule comprehension. Participants in Houston METRO's study showed greater preference for individual route maps that included details such as surrounding landmarks and transfer information for each of the stops. Labeled "time points" on the route map that corresponded to the time points given in the timetable were also considered helpful (*17*). These findings were duplicated in a separate study evaluating the usability of Akron Metro's bus timetables. Additionally, Akron Metro's study recommends keeping the timetable and the associated route map on the same page, so that the reader does not need to search for information, and providing a separate route map and timetable for different route directions (e.g., "To Downtown" and "From Downtown") (*31*).

4.6 Transit System Signage

4.6.1 Terminal and Bus Stop Designation

Terminal and bus stop signs are signs denoting the stop, transfer point, or terminal. They must be designed to be compatible with the map and route guidance information that the rider has or has seen. There should be a seamless progression from the most global geographic map representation to this sign on this street corner, so that riders have every confidence that when they step off the bus, they have arrived at the destination planned—with no surprises.

4.6.2 Exterior Bus Route/Direction

Signage on the exterior of the transit vehicle completes the information system by identifying the mobile (and crucial) part of the transit system. The vehicle is meaningful only in the context of the route and the direction that it is going. The direction must be in terms that the beginning rider can understand, and those terms may not be cardinal direction. Terms like "uptown," "downtown," and "cross-town," may only have meaning for long-time residents and system operators.

4.6.3 Interior Bus Route/Direction/Destination

Interior signs or information presentation provide confirmatory information for riders at the time or just after they have committed to the vehicle. Some vehicles provide much or all of the entire system (system map) in an interior poster; the riders should be able to "check off" the stops along the route with respect to their destinations by looking at this sign. Thus, they can anticipate when their stops are approaching and start gathering their belongings, companions, and so forth—an important consideration for both the elderly and for parents with small children.

4.6.4 Trailblazer

Trailblazer signs are located on major streets and other strategic spots to direct riders to the nearest stop or stops. These signs satisfy the need for approach information, and thus should be compatible with route guidance information with regard to location labels, directions, and route designation. A real consideration is where these signs should be placed in a cost-effective way to ensure access without cluttering the city with signs.

4.7 Design Considerations for Bus Stop Signage

More than 10 years ago, *NCTRP Synthesis of Transit Practice 7: Passenger Information Systems for Transit Transfer Facilities* (*11*) gave some general design parameters for consideration. These included the following:

- The user;
- Setting (architectural context);
- Message;
- Sign hardware;
- Specific human factors considerations, including such items as the following:
  - –Target value of the sign (conspicuity),
  - –"Official" appearance,
  - –Legibility,
  - –Placement (interacts with legibility), and
  - –Fonts and letter styles.

A recent study of bus stop design (*33*) refers to the Manual on Uniform Traffic Control Devices (MUTCD) (*34*), which identifies two variants in the context of parking control signage (R7-107 and 107A). Some general suggestions are given with regard to Americans with Disabilities (ADA) compliance, the major one being the installation of two sets of signs—one for general use and the other for those with sensory disabilities.

Koppa and Higgins in a route guidance information manual (*13*) offer specific designs for bus stop, transfer point, and terminal signage which is generally consistent with *TCRP Synthesis of Transit Practice 17: Customer Information at Bus Stops* (*35*) design information. This synthesis essentially gives the state of the art in customer information at bus stops.

TCRP Synthesis of Transit Practice 17: Customer Information at Bus Stops references the still-useful American Public Transit Association handbook (*36*). Surveys of different transit operators reveal that 71 percent provide route designators at stops; over one-half also give telephone numbers to facilitate obtaining route guidance information. Twenty-four percent of the systems provide a "bus stop" sign of some sort with no other information. Only 14 percent of the systems surveyed give service information on bus stop signs (i.e., times, stops, and route information [other than designation]).

TCRP Synthesis of Transit Practice 17: Customer Information at Bus Stops also provides some summary information on complying with ADA requirements, such as using non-glare backgrounds for high-contrast signs, with lettering as large as practicable (3-in. minimum height).

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APPENDIX B

ADA GUIDELINES/IMPLICATIONS OF AMERICANS WITH DISABILITIES ACT OF 1990 FOR BUS STOP DESIGN

The Americans with Disabilities Act (ADA) of 1990 replaces a patchwork of previous accessibility and barrier-free legislation with a comprehensive set of requirements and guidelines for providing reasonable access to and use of buildings, facilities, and transportation. The purposes of ADA are as follows:

- To provide a clear and comprehensive national mandate for the elimination of discrimination against individuals with disabilities;
- To provide clear, strong, consistent, enforceable standards addressing discrimination against individuals with disabilities;
- To ensure that the Federal Government plays a central role in enforcing the standards established in the Act on behalf of individuals with disabilities; and
- To invoke the sweep of congressional authority . . . to address the major areas of discrimination faced day-to-day by people with disabilities (*1*).

The key language that governs access to transportation and transportation facilities is contained in 49 CFR Part 37 (*2*). The Appendix (*3*) to these rules is a set of design guidelines that are invoked by 49CFR37. Most of these design guidelines are nearly identical to those of the established American National Standards Institute (ANSI) A117.1—1980 which has been invoked by all previous legislation governing access for people with disabilities. Several new sections, however, have been added to ANSI A117.1 for the express purposes of ADA. The transportation-specific section of the ADA Appendix (first promulgated in 1994) is Section 10, "Transportation Facilities." However, the first paragraph of Section 10 calls out "applicable provisions" of any of the previous sections of the Appendix, specifically sections 4.1 through 4.35, then all of sections 5 through 9, in addition to the provisions of Section 10 (thus invoking itself, a somewhat circular procedure). The previous editions of the Appendix (*3*) did not contain any language in Section 10, and handbooks such as that referenced (*1*) made do with the general provisions of the first nine sections.

A short guide written expressly for bus stop accessibility (*4*) makes the valuable point that it may not be within the power of a public entity to ensure that ADA guidelines are met in configuring a bus stop or appurtenances. If private organizations take the responsibility for the provision of stops for the convenience of shoppers, homeowners, and so forth, it may be unclear whether or not they must comply with ADA. Most transit agencies do not have legal control over the right-of-way where bus stops are located, according to this source. However, as a rule, some public entity (e.g., local government or state DOT) does, and they are thus tasked with ensuring ADA compliance. As a matter of practicality, almost any transit system will have accessible bus stops.

SPECIFIC REQUIREMENTS FOR BUS STOP DESIGN FROM ACCESSIBILITY GUIDELINES

Although much of the Guidelines (*3*) with regard to transportation seem aimed at fixed rail systems (both light and heavy rail), numerous paragraphs are scattered throughout the document that have import for bus stop design. Each callout will be discussed in the same order it appears in the Guidelines. (Note: The term "building" is defined by the Guidelines as "any structure used and intended for supporting or *supporting* any use or occupancy (italics added)." By this definition, shelters at bus stops would qualify as buildings and will be so treated here.)

The bus stop designer should also be alert to accessibility considerations other than those associated with wheelchairs. Many of the provisions relate to sensory disabilities, especially individuals with visual impairments, and make sense only when the designer considers those types of disabilities.

DISCUSSION OF SECTIONS 10 AND 4

10. TRANSPORTATION FACILITIES

10.1 **General**

This subsection refers to "applicable provisions" of 4.1 through 4.35 of the Appendix and Sections 5 through 9. Sections 5 through 9 have no provisions applicable to bus stop design and will not be discussed in this review. The discussion will branch to the applicable provisions of Section 4 and then take up the specific transportation-related provisions of Section 10.

4.1.2 **Accessible Sites and Exterior Facilities: New Construction**

This subsection calls for at least one accessible route within the boundary of a site from public transportation stops. This means that the bus stop must be designed so that a person with a disability could proceed unimpeded to an accessible building or facility served by that stop (Detail design in 4.3). It also calls for elimination of obstacles protruding into circulation pathways (Detail design in 4.4). Ground surface design is covered in 4.5. Signage requirements are referenced to applicable sections of 4.30. Public pay phone requirements are in 4.31.2 through 4.31.8 if they are provided for by the bus operation. Curb ramps must meet a 1 : 12 slope criterion, unless the stop is an alteration of an existing (non-accessible) facility. In such a case, a steeper slope may be permissible (6-in. rise, 1 : 10 to 1 : 12; 3-in. rise, 1 : 8 to 1 : 10).

Thus this subsection is the top-level set of general requirements applicable to bus stops. Actual design information is contained in the subsections called out in this subsection.

4.2 **Space Allowance and Reach Ranges**

This section gives basic anthropometric data for wheelchair use—all of these data should be used in bus stop layout.

4.3 **Accessible Route**

The accessible route within the boundary of the site should be the same as that for everybody else. In other words, the path to and from the stop to other facilities or from the stop pad to other appurtenances such as a shelter should be designed to be accessible. For a bus stop used as a part of a park-and-ride, an accessible route to the parking lot would be required.

This subsection has callouts for path width, passing space, head room (clearance) (Subsection 4.4.2), surface texture, slope, and level changes. These data can be directly used for bus stop design purposes.

4.4 **Protruding Objects**

Objects projecting from walls (or equivalent vertical surfaces at a bus stop) with their leading edges between 27 and 80 in. must not protrude more than 4 in. into an accessible route. Objects below that range have no restrictions on protrusions. An object mounted on a post or pylon within the critical range of 27 to 80 in. can protrude as much as 12 in. into an accessible path. Any protrusion in these situations, however, cannot reduce the minimum path widths and other dimensions mandated by 4.2 and 4.3.

4.5 **Ground and Floor Surfaces**

Surfaces along accessible routes must be stable, firm, and slip-resistant. This subsection gives some guidance as to how to achieve these characteristics at a bus stop. If level changes are less than ¼ in., no special treatment is necessary. Between ¼ and ½ in., a bevel must be provided with a slope of at least 1 : 2, and angle of 26.5 deg. Any drop greater than that requires a ramp (4.7 or 4.8). If gratings are in the accessible route, then they must have openings in the direction of travel no greater than ½ in. wide.

4.7 **Curb Ramps**

If curb ramps are part of a bus stop design, this subsection gives explicit guidelines for their location and detail design.

4.8 **Ramps**

In order to achieve compliance with Section 4.5 above, ramps other than curb ramps may be necessary at a bus stop or leading to a bus stop. This subsection gives the guidelines. Note that an accessible route, because of terrain, may involve a slope greater than 1 : 20. If it does, then these provisions apply.

4.30 **Signage**

This subsection gives design guidelines for signs and information about accessible locations within the bus stop site. These include the familiar wheelchair logo that is the international symbol of accessibility. In addition, signs providing route designators (e.g., names, numbers, symbols, colors, or any combination of these), bus numbers, or stop designators are included in these requirements for character proportions, character heights, raised characters, Braille, pictograms, finish and contrast, mounting location, and height. Special provision is made for those with visual impairment—users must be able to approach to within 3 in. of the sign, assuming that the centerline of the sign is 60 in. off the ground. This would suggest that stop identification signs, route designators, and so forth, placed for maximum visibility for the general public would have to be duplicated to meet ADA guidelines.

4.31 **Telephones**

There is nothing in ADA that requires public pay telephones to be placed at bus stops, but if they are, at least one must comply with these provisions for clear floor and ground space, mounting height, and protrusion into an accessible route or space. In addition, this pay telephone must be equipped to be hearing-aid compatible with a volume control, and be pushbutton operated where the telephone company can accommodate such a telephone. If a directory is provided, it must also be accessible as defined in subsections 4.2.5 and 4.2.6.

10. TRANSPORTATION FACILITIES (Resumed)

10.2 **Bus Stops and Terminals**

10.2.1 New Construction

New bus stop pads built to interface with vehicle ramps or lifts must meet the design guidelines provided in this paragraph. Bus stop shelters must connect to the boarding area or stop pad by an accessible path as described in Section 4. The mobility aid user must enter from the public way to reach an area 30 by 48 in. entirely under the shelter.

This paragraph calls out the signage provisions commented on in Section 4.30, however, sizes and proportions of characters and symbols that meet the maximum local, state, or federal regulations are considered in compliance with Section 10.2.1. An important exception is noted here:

"EXCEPTION: Bus schedules, timetables, or maps that are posted at the bus stop or bus bay are not required to comply with this provision."

10.2.2 Bus Stop Siting and Alterations

This paragraph merely states that bus stop sites must be chosen to comply with the previous paragraph to the maximum extent practicable.

CONCLUSION

ADA provisions important to bus stop design are heavily oriented to accommodation for wheelchair users, with some provisions for persons with other disabilities mixed in. The basic design guidelines take a comparatively small number of pages in the standards, but a fair amount of interpretation is necessary to make the "reasonable" accommodations that ADA calls for in a bus stop layout. One of the more challenging aspects may be defining and designing the "accessible path" identified in many of the paragraphs summarized here, especially if that path is also as much as possible the same as the path for general public.

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EXCERPTS FROM *GUIDELINES* (*3*)

The sections of the ADA Guidelines that pertain to bus stop design are referenced here. Information not pertaining to bus stop design has been deleted for the purpose of brevity; wherever material has been deleted, three dots appear in a vertical line.

10. TRANSPORTATION FACILITIES.

10.1 General. Every station, bus stop, bus stop pad, terminal, building or other transportation facility, shall comply with the applicable provisions of 4.1 through 4.35, sections 5 through 9, and the applicable provisions of this section. The exceptions for elevators in 4.1.3(5), exception 1 and 4.1.6(1)(k) do not apply to terminal, depot, or other station used for specified public transportation, or an airport passenger terminal, or facilities subject to Title II.

4. ACCESSIBLE ELEMENTS AND SPACES: SCOPE AND TECHNICAL REQUIREMENTS.

4.1 Minimum Requirements

4.1.1* Application.

(1) General. All areas of newly designed or newly constructed buildings and facilities required to be accessible by 4.1.2 and 4.1.3 and altered portions of existing buildings and facilities required to be accessible by 4.1.6 shall comply with these guidelines, 4.1 through 4.35, unless otherwise provided in this section or as modified in a special application section.

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(5) General Exceptions.

(a) In new construction, a person or entity is not required to meet fully the requirements of these guidelines where that person or entity can demonstrate that it is structurally impracticable to do so. Full compliance will be considered structurally impracticable only in those rare circumstances when the unique characteristics of terrain prevent the incorporation of accessibility features. If full compliance with the requirements of these guidelines is structurally impracticable, a person or entity shall comply with the requirements to the extent it is not structurally impracticable. Any portion of the building or facility which can be made accessible shall comply to the extent that it is not structurally impracticable.

4.1.2 Accessible Sites and Exterior Facilities: New Construction. An accessible site shall meet the following minimum requirements:

(1) At least one accessible route complying with 4.3 shall be provided within the boundary of the site from public transportation stops, accessible parking spaces, passenger loading zones if provided, and public streets or sidewalks, to an accessible building entrance.

(2) At least one accessible route complying with 4.3 shall connect accessible buildings, accessible facilities, accessible elements, and accessible spaces that are on the same site.

(3) All objects that protrude from surfaces or posts into circulation paths shall comply with 4.4.

(4) Ground surfaces along accessible routes and in accessible spaces shall comply with 4.5.

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(7) Building Signage. Signs which designate permanent rooms and spaces shall comply with 4.30.1, 4.30.4, 4.30.5 and 4.30.6. Other signs which provide direction to, or information about, functional spaces of the building shall comply with 4.30.1, 4.30.2, 4.30.3, and 4.30.5. Elements and spaces of accessible facilities which shall be identified by the International Symbol of Accessibility and which shall comply with 4.30.7 are:

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(b) Accessible passenger loading zones:

(c) Accessible entrances when not all are accessible (inaccessible entrances shall have directional signage to indicate the route to the nearest entrance):

4.1.3 Accessible Buildings: New Construction. Accessible buildings and facilities shall meet the following minimum requirements:

(1) At least one accessible route complying with 4.3 shall connect accessible building or facility entrances with all accessible spaces and elements within the building or facility.

(2) All objects that overhang or protrude into circulation paths shall comply with 4.4.

(3) Ground and floor surfaces along accessible routes and in accessible rooms and spaces shall comply with 4.5.

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4.2 Space Allowance and Reach Ranges.

4.2.1* Wheelchair Passage Width. The minimum clear width for single wheelchair passage shall be 32 in (815 mm) at a point and 36 in (915 mm) continuously (see Fig. 1 and 24(e)).

4.2.2 Width for Wheelchair Passing. The minimum width for two wheelchairs to pass is 60 in (1525 mm) (see Fig. 2).

4.2.3* Wheelchair Turning Space. The space required for a wheelchair to make a 180-degree turn is a clear space of 60 in (1525 mm) diameter (see Fig. 3 (a)) or a T-shaped space (see Fig. 3(b)).

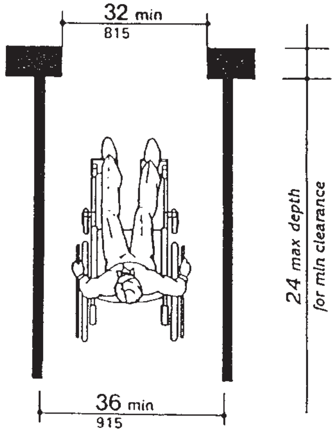


Fig. 1
Minimum Clear Width
for Single Wheelchair

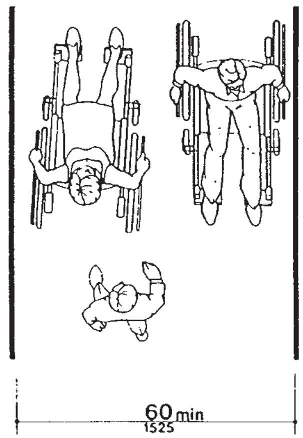


Fig. 2
Minimum Clear Width
for Two Wheelchairs

4.2.4* Clear Floor or Ground Space for Wheelchairs.

4.2.4.1 Size and Approach. The minimum clear floor or ground space required to accommodate a single, stationary wheelchair and occupant is 30 in by 48 in (760 mm by 1220 mm) (see Fig. 4(a)). The minimum clear floor or ground space for wheelchairs may be positioned for forward or parallel approach to an object (see Fig. 4(b) and (c)). Clear floor or ground space for wheelchairs may be part of the knee space required under some objects.

4.2.4.2 Relationship of Maneuvering Clearance to Wheelchair Spaces. One full unobstructed side of the clear floor or ground space for a wheelchair shall adjoin or overlap an accessible route or adjoin another wheelchair clear floor space. If a clear floor space is located in an alcove or otherwise confined on all or part of three sides, additional maneuvering clearances shall be provided as shown in Fig. 4(d) and (e).

4.2.4.3 Surfaces for Wheelchair Spaces. Clear floor or ground spaces for wheelchairs shall comply with 4.5.

4.2.5* Forward Reach. If the clear floor space only allows forward approach to an object, the maximum high forward reach allowed shall be 48 in (1220 mm) (see Fig. 5(a)). *The minimum low forward reach is 15 in (380 mm).* If the high forward reach is over an obstruction, reach and clearances shall be as shown in Fig. 5(b).

4.2.6* Side Reach. If the clear floor space allows parallel approach by a person in a wheelchair, the maximum high side reach allowed shall be 54 in (1370 mm) and the low side reach shall be no less than 9 in (230 mm) above the floor (Fig. 6(a) and (b)). If the side reach is over an obstruction, the reach and clearances shall be as shown in Fig 6(c).

4.3 Accessible Route.

4.3.1* General. All walks, halls, corridors, aisles, skywalks, tunnels, and other spaces that are part of an accessible route shall comply with 4.3.

4.3.2. Location.

(1) At least one accessible route *within the boundary of the site* shall be provided from public transportation stops, accessible parking, and accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance they serve. *The accessible route shall, to the maximum extent feasible, coincide with the route for the general public.*

(2) At least one accessible route shall connect accessible buildings, facilities, elements, and spaces that are on the same site.

(3) At least one accessible route shall connect accessible building or facility entrances with all accessible spaces and elements and with all accessible dwelling units within the building or facility.

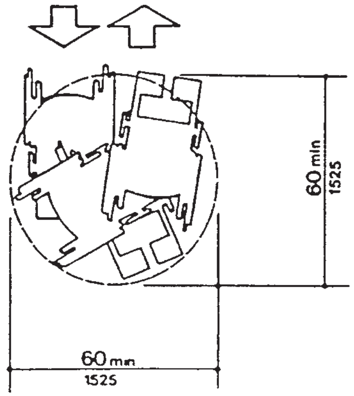
(4) An accessible route shall connect at least one accessible entrance of each accessible dwelling unit with those exterior and interior spaces and facilities that serve the accessible dwelling unit.

4.3.3 Width. The minimum clear width of an accessible route shall be 36 in (915 mm) except at doors (see 4.13.5 and 4.13.6). If a person in a wheelchair must make a turn around an obstruction, the minimum clear width of the accessible route shall be as shown in Fig. 7(a) and (b).

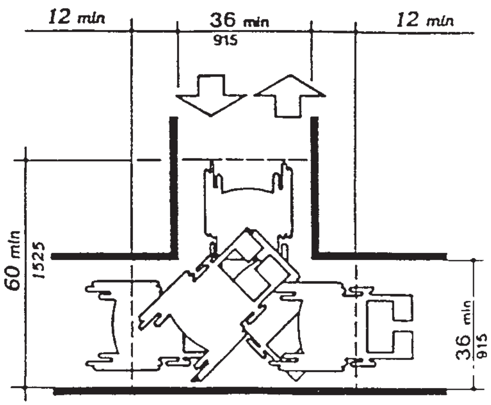
4.3.4 Passing Space. If an accessible route has less than 60 in (1525 mm) clear width, then passing spaces at least 60 in by 60 in (1525 mm by 1525 mm) shall be located at reasonable intervals not to exceed 200 ft (61m). A T-intersection of two corridors or walks is an acceptable passing place.

4.3.5 Head Room. Accessible routes shall comply with 4.4.2.

4.3.6 Surface Textures. The surface of an accessible route shall comply with 4.5.

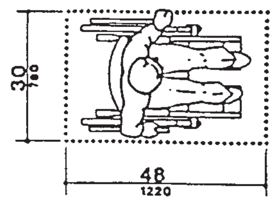


(a)
60-In (1525-mm)-Diameter Space

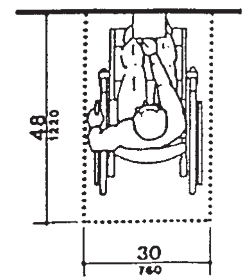


(b)
T-Shaped Space for 180° Turns

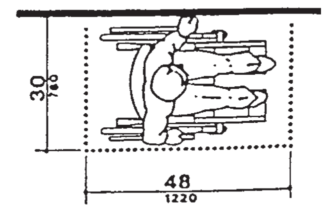
Fig.3
Wheelchair Turning Space



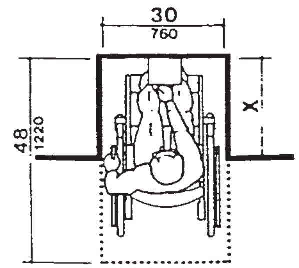
(a)
Clear Floor Space



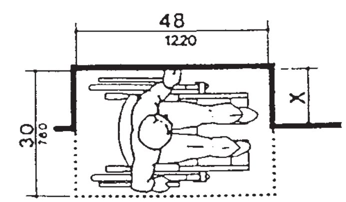
(b)
Forward Approach



(c)
Parallel Approach

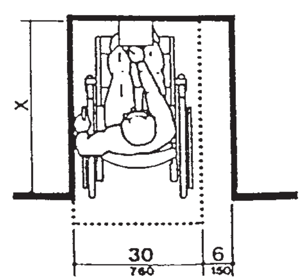


NOTE: x ≤ 24 in (610 mm).

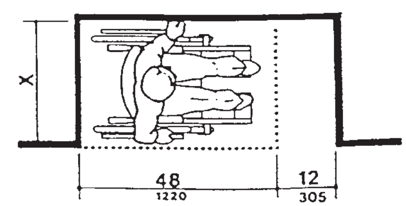


NOTE: x ≤ 15 in (380 mm).

(d)
Clear Floor Space in Alcoves



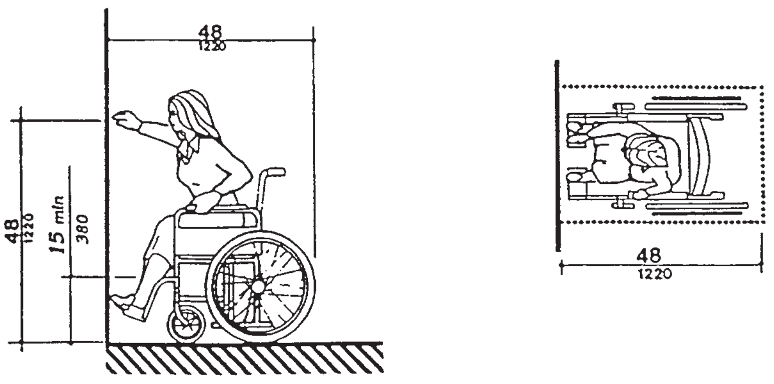
NOTE: If x > 24 in (610 mm), then an additional maneuvering clearance of 6 in (150 mm) shall be provided as shown.



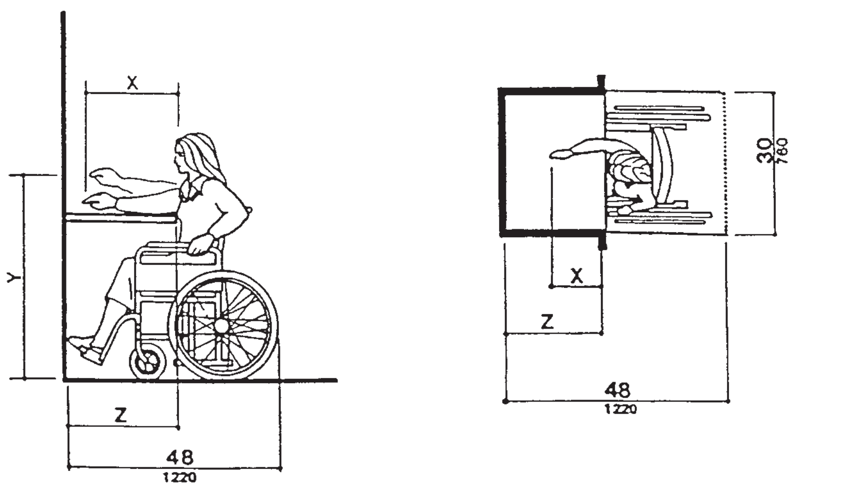
NOTE: If x > 15 in (380 mm), then an additional maneuvering clearance of 12 in (305 mm) shall be provided as shown.

(e)
Additional Maneuvering Clearances for Alcoves

Fig. 4
Minimum Clear Floor Space for Wheelchairs



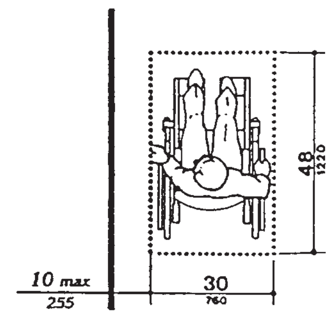
(a)
High Forward Reach Limit



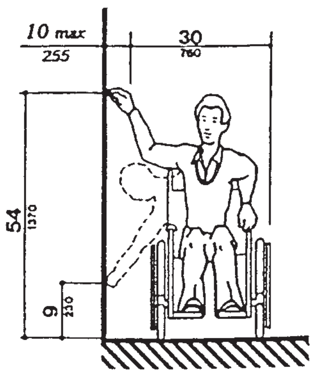
NOTE: x shall be ≤ 25 in (635 mm); z shall be ≥ x. When x < 20 in (510 mm), then y shall be 48 in (1220 mm) maximum. When x is 20 to 25 in (510 to 635 mm), then y shall be 44 in (1120 mm) maximum.

(b)
Maximum Forward Reach over an Obstruction

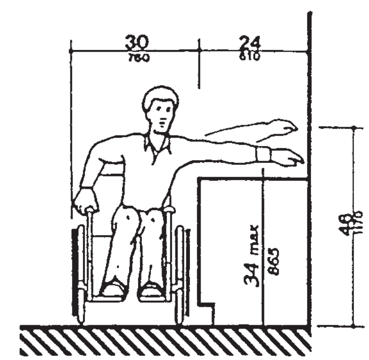
Fig. 5
Forward Reach



(a)
Clear Floor Space Parallel Approach



(b)
High and Low Side Reach Limits



(c)
Maximum Side Reach over Obstruction

Fig. 6
Side Reach

4.3.7 Slope. An accessible route with a running slope greater than 1:20 is a ramp and shall comply with 4.8. Nowhere shall the cross slope of an accessible route exceed 1:50.

4.3.8 Changes in Levels. Changes in levels along an accessible route shall comply with 4.5.2. If an accessible route has changes in level greater than 1/2 in (13 mm), then a curb ramp, ramp, elevator, or platform lift (*as permitted in 4.1.3 and 4.1.6*) shall be provided that complies with 4.7, 4.8, 4.10, or 4.11, respectively. An accessible route does not include stairs, steps, or escalators. See definition of "egress, means of" in 3.5.

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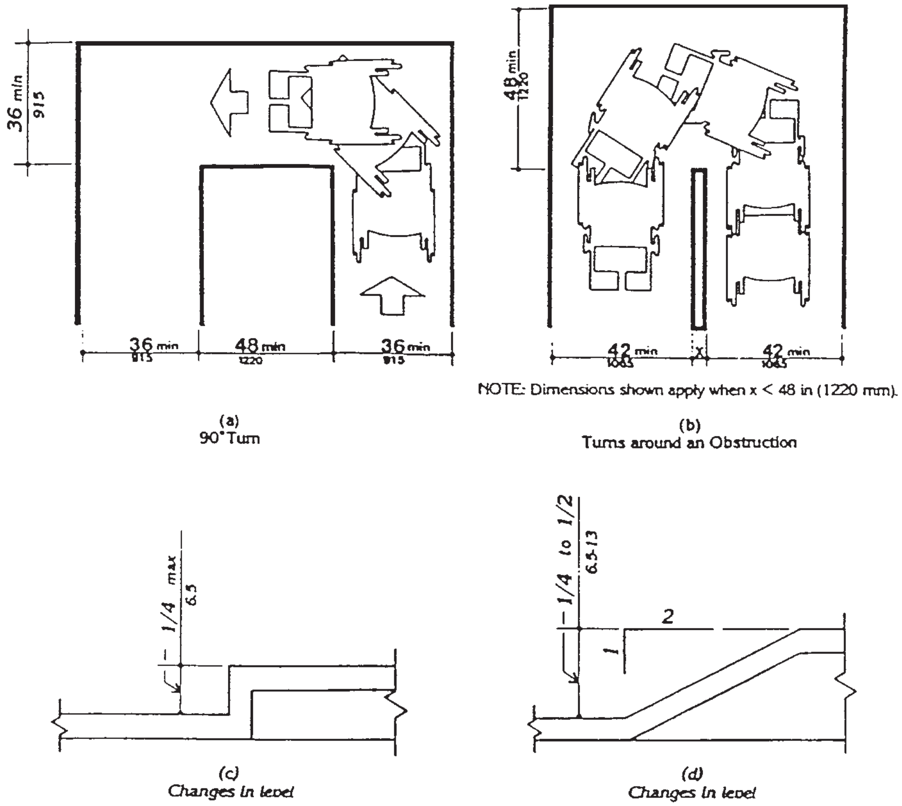

Fig. 7
Accessible Route

4.4 Protruding Objects.

4.4.1* General. Objects projecting from walls (for example, telephones) with their leading edges between 27 in and 80 in (685 mm and 2030 mm) above the finished floor shall protrude no more than 4 in (100 mm) into walks, halls, corridors, passageways, or aisles (see Fig. 8(a)). Objects mounted with their leading edges at or below 27 in (685 mm) above the finished floor may protrude any amount (see Fig. 8 (a) and (b)). Free-standing objects mounted on posts or pylons may overhang 12 in (305 mm) maximum from 27 in to 80 in (685 mm to 2030 mm) above the ground or finished floor (see Fig. 8(c) and (d)). Protruding objects shall not reduce the clear width of an accessible route or maneuvering space (see Fig. 8(e)).

4.4.2. Head Room. Walks, halls, corridors, passageways, aisles, or other circulation spaces shall have 80 in (2030 mm) minimum clear head room (see Fig. 8(a)). *If vertical clearance of an area adjoining an accessible route is reduced to less than 80 in (nominal dimension), a barrier to warn blind or visually-impaired persons shall be provided (see Fig. 8(c-1)).*

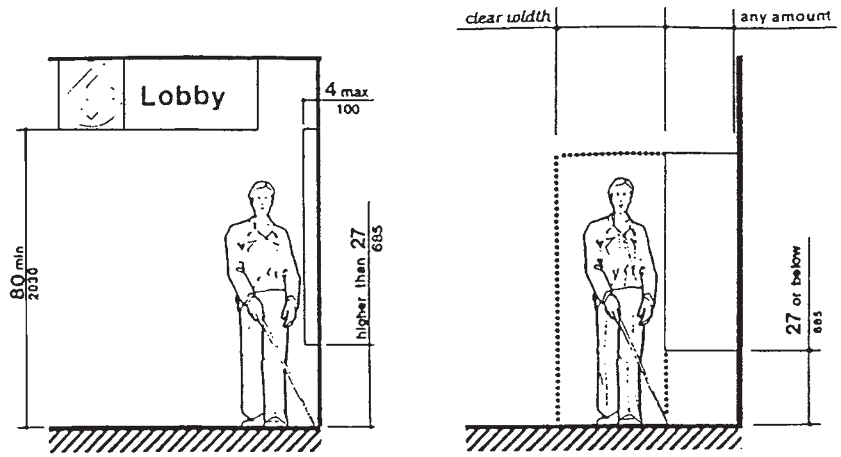

Fig. 8 (a)
Walking Parallel to a Wall

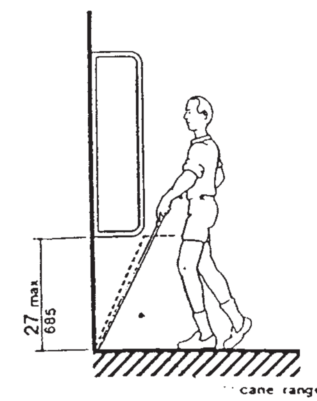

Fig. 8 (b)
Walking Perpendicular to a Wall

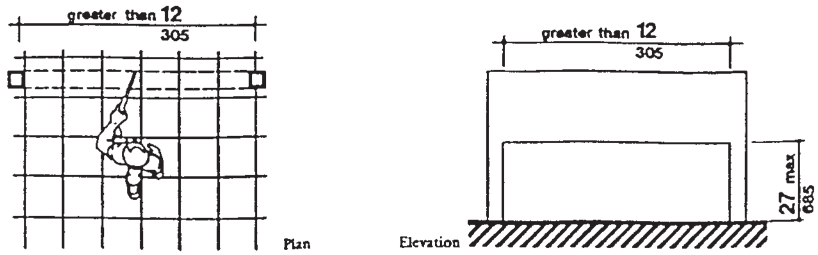

Fig. 8 (c)
Free-Standing Overhanging Objects

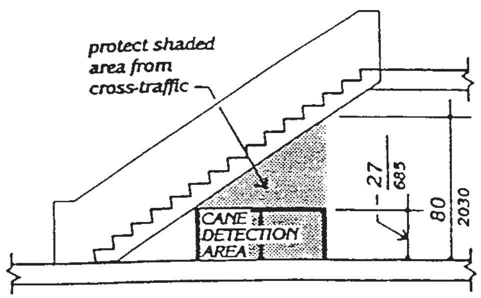

Fig. 8 (c-1)
Overhead Hazards

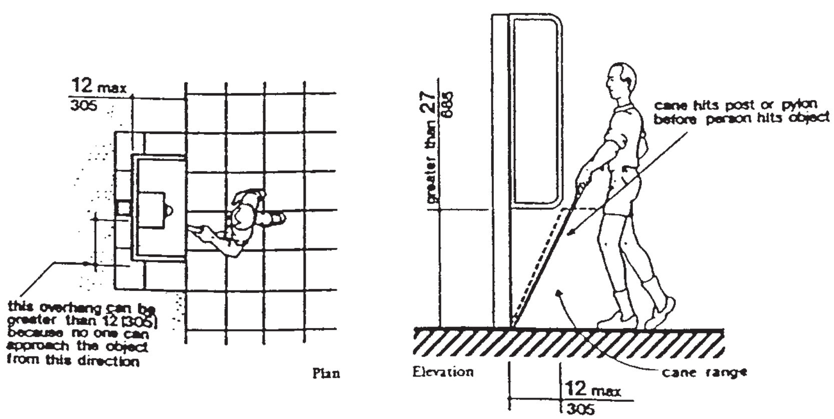

Fig. 8 (d)
Objects Mounted on Posts or Pylons

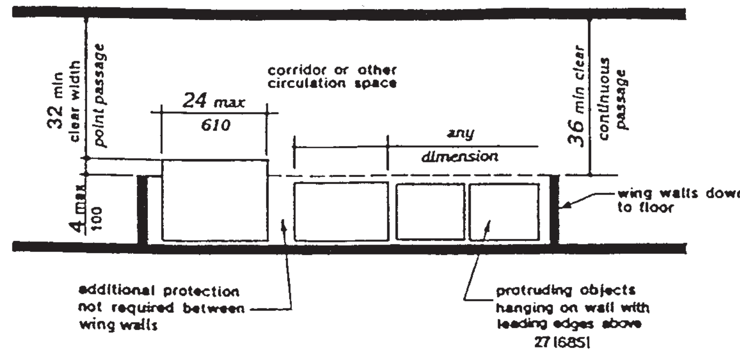

Fig. 8 (e)
Example of Protection around Wall-Mounted Objects and Measurements of Clear Widths

4.5 Ground and Floor Surfaces.

4.5.1* General. Ground and floor surfaces along accessible routes and in accessible rooms and spaces including floors, walks, ramps, stairs, and curb ramps, shall be stable, firm, slip-resistant, and shall comply with 4.5.

4.5.2 Changes in Level. Changes in level up to 1/4 in (6 mm) may be vertical and without edge treatment *(see Fig. 7(c))*. Changes in level between 1/4 in and 1/2 in (6 mm and 13 mm) shall be beveled with slope no greater than 1:2 (see Fig. 7(d)). Changes in level greater than 1/2 in (13 mm) shall be accomplished by means of a ramp that complies with 4.7 or 4.8.

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4.5.4 Gratings. If gratings are located in walking surfaces, then they shall have spaces no greater than 1/2 in (13 mm) wide in one direction *(see Fig. 8(g))*. If gratings have elongated openings, then they shall be placed so that the long dimension is perpendicular to the dominant direction of travel *(see Fig. 8(h))*.

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4.29.2* ***Detectable* Warnings on Walking Surfaces.** *Detectable* warnings shall consists *of raised truncated domes with a diameter of nominal 0.9 in (23 mm), a height of nominal 0.2 in (5 mm) and a center-to-center spacing of nominal 2.35 in (60 mm) and shall contrast visually with adjoining surfaces, either light-on-dark, or dark-on-light.*

The material used to provide contrast shall be an integral part of the walking surface. Detectable warnings used on interior surfaces shall differ from adjoining walking surfaces in resiliency or sound-on-cane contact.

4.7 Curb Ramps.

4.7.1 Location. Curb ramps complying with 4.7 shall be provided wherever an accessible route crosses a curb.

4.7.2 Slope. Slopes of curb ramps shall comply with 4.8.2. The slope shall be measured as shown in Fig. 11. *Transitions from ramps to walks, gutters, or streets shall be flush and free of abrupt changes. Maximum slopes of adjoining gutters, road surface immediately adjacent to the curb ramp, or accessible route shall not exceed 1:20.*

4.7.3 Width. The minimum width of a curb ramp shall be 36 in (915 mm), exclusive of flared sides.

4.7.4 Surface. Surfaces of curb ramps shall comply with 4.5.

4.7.5 Sides of Curb Ramps. If a curb ramp is located where pedestrians must walk across the ramp, or *where it is not protected by handrails or guardrails,* it shall have flared sides; the maximum slope of the flare shall be 1:10 (see Fig. 12(a)). Curb ramps with returned curbs may be used where pedestrians would not normally walk across the ramp (see Fig. 12(b)).

4.7.6 Built-up Curb Ramps. Built-up curb ramps shall be located so that they do not project into vehicular traffic lanes (see Fig. 13).

4.7.7 *Detectable Warnings.* A curb ramp shall have a *detectable* warning complying with 4.29.2. The *detectable warning shall extend* the full width and depth of the curb ramp.

4.7.8 Obstructions. Curb ramps shall be located or protected to prevent their obstruction by parked vehicles.

4.7.9 Location at Marked Crossings. Curb ramps at marked crossings shall be wholly contained within the markings, excluding any flared sides (see Fig. 15).

4.7.10 Diagonal Curb Ramps. If diagonal (or corner type) curb ramps have returned curbs or other well-defined edges, such edges shall be parallel to the direction of pedestrian flow. The bottom of diagonal curb ramps shall have 48 in (1220 mm) minimum clear space as shown in Fig. 15(c) and (d)). If diagonal curb ramps are provided at marked crossings, the 48 in (1220 mm) clear space shall be within the markings (see Fig. 15(c) and (d). If diagonal curb ramps have flared sides, they shall also have at least a 24 in (610 mm) long segment of straight curb located on each side of the curb ramp and within the marked crossing (see Fig. 15(c)).

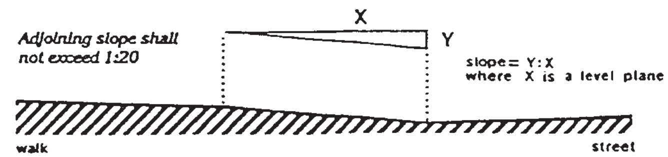
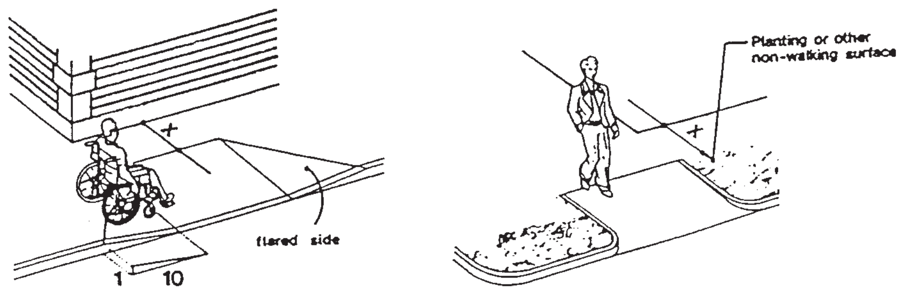


Fig. 11
Measurement of Curb Ramp Slopes



(a)
Flared Sides

(b)
Returned Curb

If X is less than 48 in, then the slope of the flared side shall not exceed 1:12.

Fig. 12
Sides of Curb Ramps

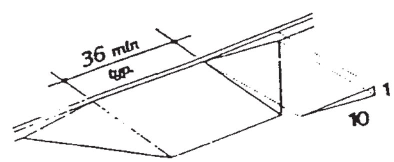


Fig. 13
Built-Up Curb Ramp

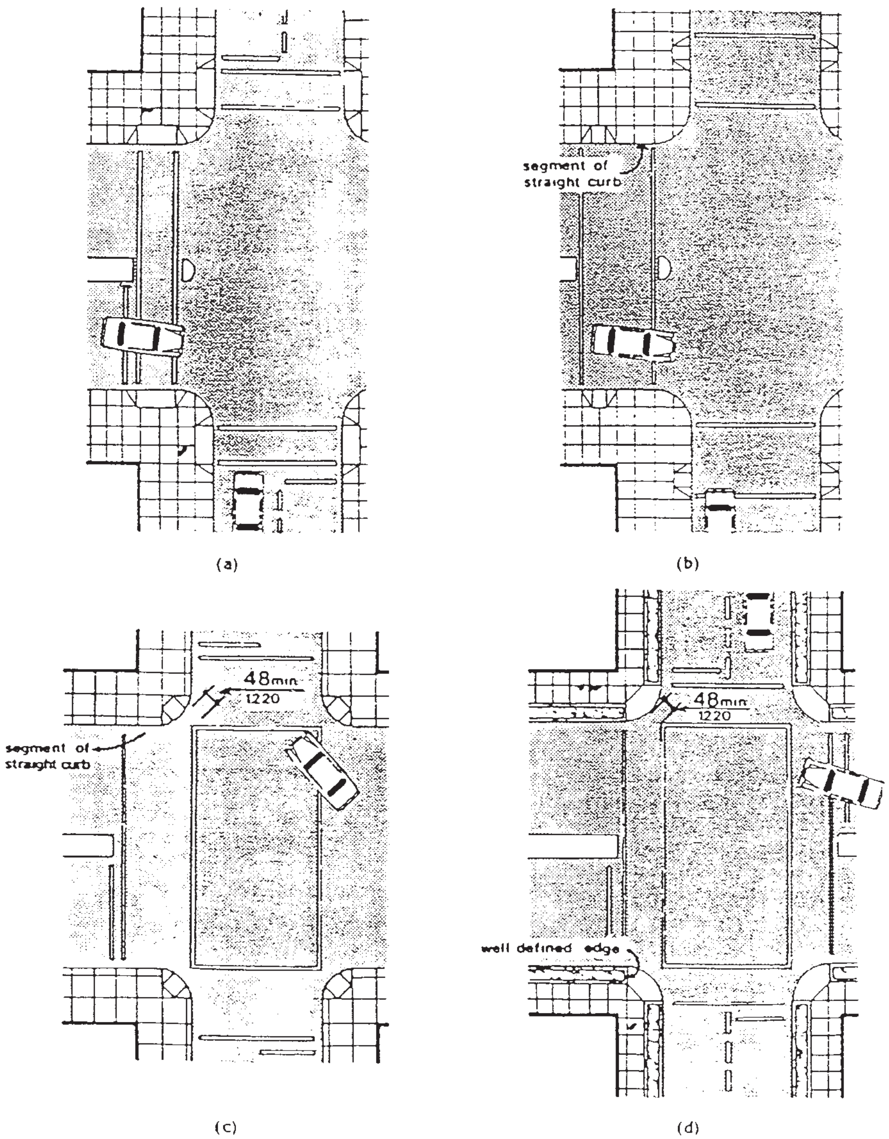


Fig. 15
Curb Ramps at Marked Crossings

4.7.11 Islands. Any raised islands in crossings shall be cut through level with the street or have curb ramps at both sides and a level area at least 48 in (1220 mm) long between the curb ramps in the part of the island intersected by the crossings (see Fig. 15(a) or (b)).

4.8 Ramps.

4.8.1* General. Any part of an accessible route with a slope greater than 1:20 shall be considered a ramp and shall comply with 4.8.

4.8.2* Slope and Rise. The least possible slope shall be used for any ramp. The maximum slope of a ramp in new construction shall be 1:12. The maximum rise for any run shall be 30 in (760 mm) (see Fig. 16). Curb ramps and ramps to be constructed on existing sites or in existing buildings or facilities may have slopes and rises as allowed in 4.1.6(3)(a) if space limitations prohibit the use of a 1:12 slope or less.

4.8.3 Clear Width. The minimum clear width of a ramp shall be 36 in (915 mm).

4.8.4* Landings. Ramps shall have level landings at bottom and top of each ramp and each ramp run. Landings shall have the following features:

(1) The landing shall be at least as wide as the ramp run leading to it.

(2) The landing length shall be a minimum of 60 in (1525 mm) clear.

(3) If ramps change direction at landings, the minimum landing size shall be 60 in by 60 in (1525 mm by 1525 mm).

(4) If a doorway is located at a landing, then the area in front of the doorway shall comply with 4.13.6.

4.8.5* Handrails. If a ramp run has a rise greater than 6 in (150 mm) or a horizontal projection greater than 72 in (1830 mm), then it shall have handrails on both sides. Handrails are not required on curb ramps or adjacent to seating in assembly areas. Handrails shall comply with 4.26 and shall have the following features:

(1) Handrails shall be provided along both sides of ramp segments. The inside handrail on switchback or dogleg ramps shall always be continuous.

(2) If handrails are not continuous, they shall extend at least 12 in (305 mm) beyond the top and bottom of the ramp segment and shall be parallel with the floor or ground surface (see Fig. 17).

(3) The clear space between the handrail and the wall shall be 1 - 1/2 in (38 mm).

(4) Gripping surfaces shall be continuous.

(5) Top of handrail gripping surfaces shall be mounted between 34 in and 38 in (865 mm and 965 mm) above ramp surfaces.

(6) Ends of handrails shall be either rounded or returned smoothly to floor, wall, or post.

(7) Handrails shall not rotate within their fittings.

4.8.6 Cross Slope and Surfaces. The cross slope of ramp surfaces shall be no greater than 1:50. Ramp surfaces shall comply with 4.5.

4.8.7 Edge Protection. Ramps and landings with drop-offs shall have curbs, walls, railings, or projecting surfaces that prevent people from slipping off the ramp. Curbs shall be a minimum of 2 in (50 mm) high (see Fig. 17).

4.8.8 Outdoor Conditions. Outdoor ramps and their approaches shall be designed so that water will not accumulate on walking surfaces.

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4.26 Handrails, Grab Bars, and Tub and Shower Seats.

4.26.1*General. All handrails, grab bars, and tub and shower seats required to be accessible by 4.1, 4.8, 4.9, 4.16, 4.17, 4.20 or 4.21 shall comply with 4.26.

4.26.2*Size and Spacing of Grab Bars and Handrails. The diameter or width of the gripping surfaces of a handrail or grab bar shall be 1-1/4 in to 1-1/2 in (32 mm to 38 mm), or the shape shall provide an equivalent gripping surface. If handrails or grab bars are mounted adjacent to a wall, the space between the wall and the grab bar shall be 1-1/2 in (38 mm) (see Fig. 39(a), (b), (c), and (e)). Handrails may be located in recess if the recess is a maximum of 3 in (75 mm) deep and extends at least 18 in (455 mm) above the top of the rail (see Fig. 39(d)).

4.26.3 Structural Strength. The structural strength of grab bars, tub and shower seats, fasteners, and mounting devices shall meet the following specification:

(1) Bending stress in a grab bar or seat induced by the maximum bending moment from the application of 250 lbf (1112N) shall be less than the allowable stress for the material of the grab bar or seat.

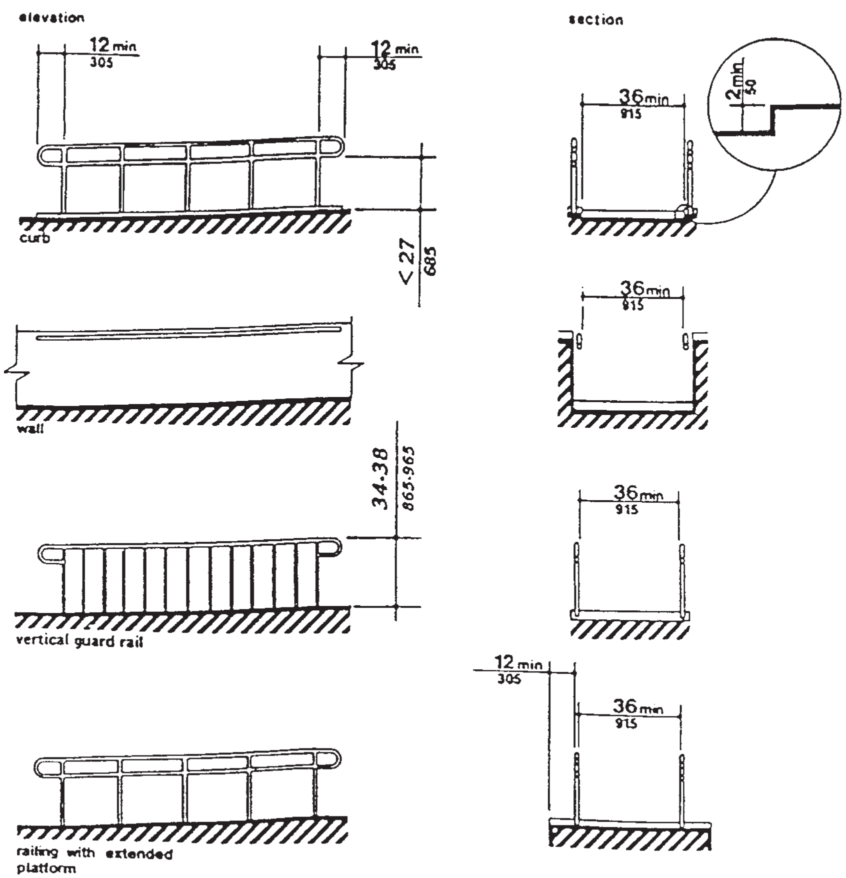

Fig. 17
Examples of Edge Protection and Handrail Extensions

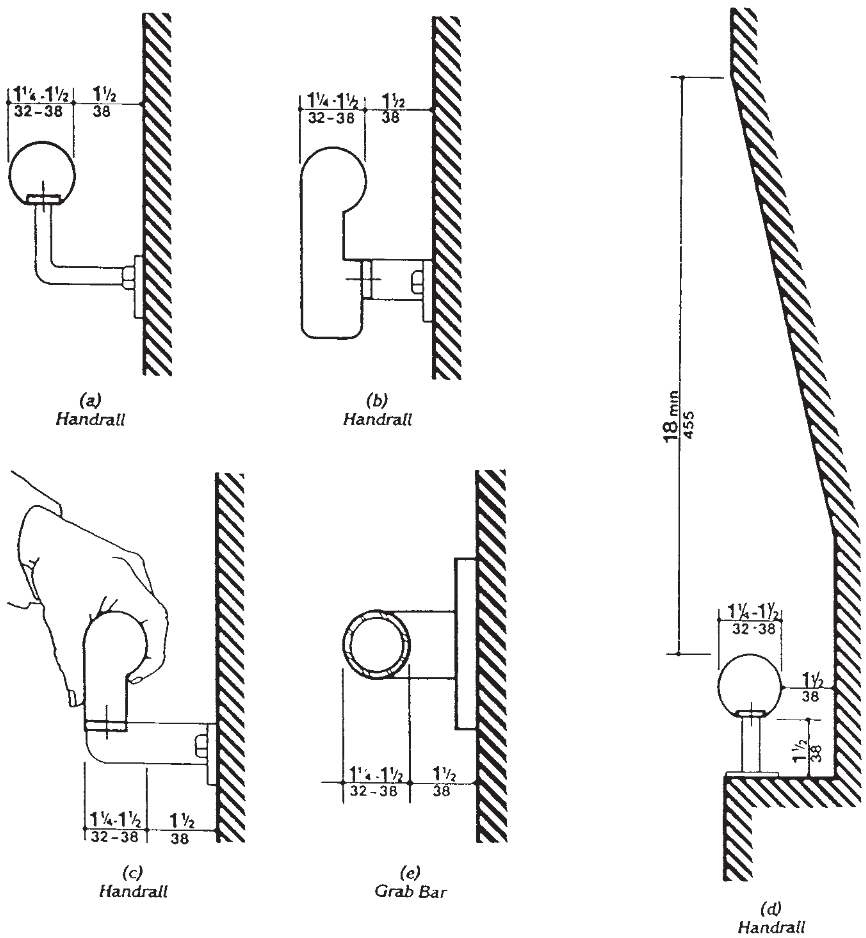

Fig. 39
Size and Spacing of Handrails and Grab Bars

(2) Shear stress induced in a grab bar or seat by the application of 250 Ibf (1112N) shall be less than the allowable shear stress for the material of the grab bar or seat. If the connection between the grab bar or seat and its mounting bracket or other support is considered to be fully restrained, then direct and torsional shear stresses shall be totaled for the combined shear stress, which shall not exceed the allowable shear stress.

(3) Shear force induced in a fastener or mounting device from the application of 250 Ibf (1112N) shall be less than the allowable lateral load of either the fastener or mounting device or the supporting structure, whichever is the smaller allowable load.

(4) Tensile force induced in a fastener by a direct tension force of 250 Ibf (1112N) plus the maximum moment from the application of 250 Ibf (1112N) shall be less than the allowable withdrawal load between the fastener and the supporting structure.

(5) Grab bars shall not rotate within their fittings.

4.26.4 Eliminating Hazards. A handrail or grab bar and any wall or other surface adjacent to it shall be free of any sharp or abrasive elements. Edges shall have a minimum radius of 1/8 in (3.2 mm).

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4.30 Signage.

4.30.1*General. Signage required to be accessible by 4.1 shall comply with the applicable provisions of 4.30.

4.30.2*Character Proportion. Letters and numbers on signs shall have a width-to-height ratio between 3:5 and 1:1 and a stroke-width-to-height ratio between 1:5 and 1:10.

4.30.3 Character Height. Characters and numbers on signs shall be sized according to the viewing distance from which they are to be read. The minimum height is measured using an upper case X. Lower case characters are permitted.

Height Above Finished Floor	Minimum Character Height
Suspended or Projected Overhead in compliance with 4.4.2	3 in. (75 mm) minimum

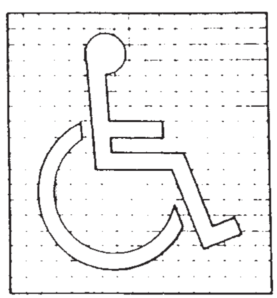
4.30.4*Raised and Brailled Characters and Pictorial Symbol Signs (Pictograms). Letters and numerals shall be raised 1/32 in (0.8 mm) minimum, upper case, sans serif or simple serif type and shall be accompanied with Grade 2 Braille. Raised characters shall be at least 5/8 in (16 mm) high, but no higher than 2 in (50 mm). Pictograms shall be accompanied by the equivalent verbal description placed directly below the pictogram. The border dimension of the pictogram shall be 6 in (152 mm) minimum in height.

4.30.5*Finish and Contrast. The characters and background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast with their background - either light characters on a dark background or dark characters on a light background.

4.30.6 Mounting Location and Height. Where permanent identification is provided for rooms and spaces, signs shall be installed on the wall adjacent to the latch side of the door. Where there is no wall space to the latch side of the door, including at double leaf doors, signs shall be placed on the nearest adjacent wall. Mounting height shall be 60 in (1525 mm) above the finish floor to the centerline of the sign. Mounting location for such signage shall be so that a person may approach within 3 in (76 mm) of signage without encountering protruding objects or standing with in the swing of door.

4.30.7*Symbols of Accessibility.

(1) Facilities and elements required to be identified as accessible by 4.1 shall use the international symbol of accessibility. The symbol shall be displayed as shown in Fig. 43(a) and (b).



(a)
Proportions
International Symbol of Accessibility

(b)
Display Conditions
International Symbol of Accessibility

4.31 Telephones.

4.31.1 General. Public telephones required to be accessible by 4.1 shall comply with 4.31.

4.31.2 Clear Floor or Ground Space. A clear floor or ground space at least 30 in by 48 in (760 mm by 1220 mm) that allows either a forward or parallel approach by a person using a wheelchair shall be provided at telephones (see Fig. 44). The clear floor or ground space shall comply with 4.2.4. Bases, enclosures, and fixed seats shall not impede approaches to telephones by people who use wheelchairs.

4.31.3*Mounting Height. The highest operable part of the telephone shall be within the reach ranges specified in 4.2.5 or 4.26.

4.31.4 Protruding Objects. Telephones shall comply with 4.4.

10.2 Bus Stops and Terminals.

10.2.1 New Construction.

(1) Where new bus stop pads are constructed at bus stops, bays or other areas where a lift or ramp is to be deployed, they shall have a firm, stable surface; a minimum clear length of 96 inches (measured from the curb or vehicle roadway edge) and a minimum clear width of 60 inches (measured parallel to the vehicle roadway) to the maximum extent allowed by legal or site constraints; and shall be connected to streets, sidewalks or pedestrian paths by an accessible route complying with 4.3 and 4.4. The slope of the pad parallel to the roadway shall, to the extent practicable, be the same as the roadway. For water drainage, a maximum slope of 1:50 (2%) perpendicular to the roadway is allowed.

(2) Where provided, new or replaced bus shelters shall be installed or positioned so as to permit a wheelchair or mobility aid user to enter from the public way and to reach a location, having a minimum clear floor area of 30 inches by 48 inches, entirely within the perimeter of the shelter. Such shelters shall be connected by an accessible route to the boarding area provided under paragraph (1) of this section.

(3) Where provide, all new bus route identification signs shall comply with 4.30.5. In addition, to the maximum extent practicable, all new bus route identification signs shall comply with 4.30.2 and 4.30.3. Signs that are sized to the maximum dimensions permitted under legitimate local, state or federal regulations or ordinances shall be considered in compliance with 4.30.2 and 4.30.3 for purposes of this section.

EXCEPTION: Bus schedules, timetables, or maps that are posted at the bus stop or bus bay are not required to comply with this provision.

10.2.2 Bus Stop Siting and Alterations.

(1) Bus stop sites shall be chosen such that, to the maximum extent practicable, the areas where lifts or ramps are to be deployed comply with section 10.2.1(1) and (2).

(2) When new bus route identification signs are installed or old signs are replaced, they shall comply with the requirements of 10.2.1(3).

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation