TABLE OF CONTENTS

SECTION II - STATIONS AND PARKING

I. INTRODUCTION

Design standards for vehicular and pedestrian circulation and parking facilities at commuter rail stations are addressed in this section. The guidelines contained herein are intended to direct design consultants in the development of plans and details that will conform to the Authority's current goals for commuter rail station design. These guidelines include design criteria for roadways, walkways, stairs, ramps, and parking lots. Current State and Federal rules, regulations and standards for accessibility are applicable to commuter rail station facilities. (Refer also to the MBTA Guide to Access).

It should be emphasized that these standards are not exhaustive and will leave many site specific issues unaddressed. It is the design consultant's responsibility to seek direction from the Authority where situations arise not covered by these guidelines. Further, it is the responsibility of the design consultant to review the latest applicable Federal, State, and local regulations. Where conflict may exist between such regulations, these guidelines, and/or the MBTA Guide to Access, the most stringent shall apply.

II. DESIGN OBJECTIVES

Safety, efficiency, and accessibility are the principal objectives to consider in the design of circulation and parking facilities at commuter stations. The organization and detail of the station design must also address specific issues of security, maintenance, and snow removal.

III. DESIGN GUIDELINES

A. Separation of Circulation Modes

For the maximization of safety station site circulation modes of pedestrian, vehicular, and rail movements should be separately delineated. Locations where circulation modes cross or interface must be well identified and sight lines maximized.

B. Arrival/Departure Modes

Station design must address the variety of arrival/departure modes:

- Pedestrian walk-in and bicycles
- Public transportation, including taxis
- Drop-off/pick-up
- Park and ride

Pedestrian, public transportation, and drop-off/pick-up modes should be encouraged by minimizing walking distances from site entry points, and curbside stops to the platform.

C. Pedestrian Circulation

1. General Principles

a. Pedestrian pathways should be direct, well defined, and provide a clear indication of where they lead.

b. Pedestrian access from the surrounding community should be encouraged by providing a direct, paved walkway to the platforms.

c. An accessible route of travel, free from steps, must link the accessible station entrance with public sidewalks, bus stops, parking and passenger loading zones. The platform may be considered to be a part of this accessible entrance route. With exceptions allowing for specific site conditions, this accessible route of travel should be the primary route for all station users.

2. Walkways

Note:
The following section represents a partial summary of the design constraints for walkways. Consult the MBTA Guide to Access and relevant codes for additional information.

a. Width: 5'-0" preferred minimum
4'-0" absolute minimum

Notes:
1. For widths less than 5'-0", provide 5'-0" by 5'-0" passing spaces at intervals not to exceed 200'-0".
2. Subject to Authority approval and code compliance, the clear width of an accessible route may be a minimum of 36" excluding curb stones and 32" at columns or other obstructions having a depth less than 24".

b. Slope in the direction of travel: 5% (approx. 5/8" per foot) absolute maximum

Note:
If the slope is greater than 5%, it must be treated as a ramp with a maximum slope of 8%.

Cross-slope: 2% maximum

c. No level change greater than 1/2" is permitted unless a ramp is provided. Level changes between 1/4" and 1/2" must be beveled with a maximum slope of 1:2.

d. Walkway surfaces must be slip-resistant (minimum static coefficient of friction of 0.6) with all joints finished flush.

e. Walkways adjacent to roadways should be physically separated by curbing, guardrail, or bollards for safety and to prevent encroachment by vehicles.

Note:
The use of bollards should be minimized as they may interfere with snow removal.

f. Where sidewalks are located immediately adjacent to parking areas, vehicle overhang from 90° or angle parking should be accounted for in the layout of walkways to ensure that required sidewalk width is maintained.

g. Snow removal and storage must be considered in the location and design of sidewalks.

h. Sidewalk shall not be utilized simply as a design element, such as an edge treatment along a roadway. Minimize the amount of sidewalk to that which is truly required.

3. Crosswalks

a. Locate crosswalks to maximize visibility between pedestrians and vehicles.

b. Width: Equal to or wider than walkway width. (6'-0" minimum)
Curb cuts at marked crossings must be wholly within the crossing markings (excluding flared sides).

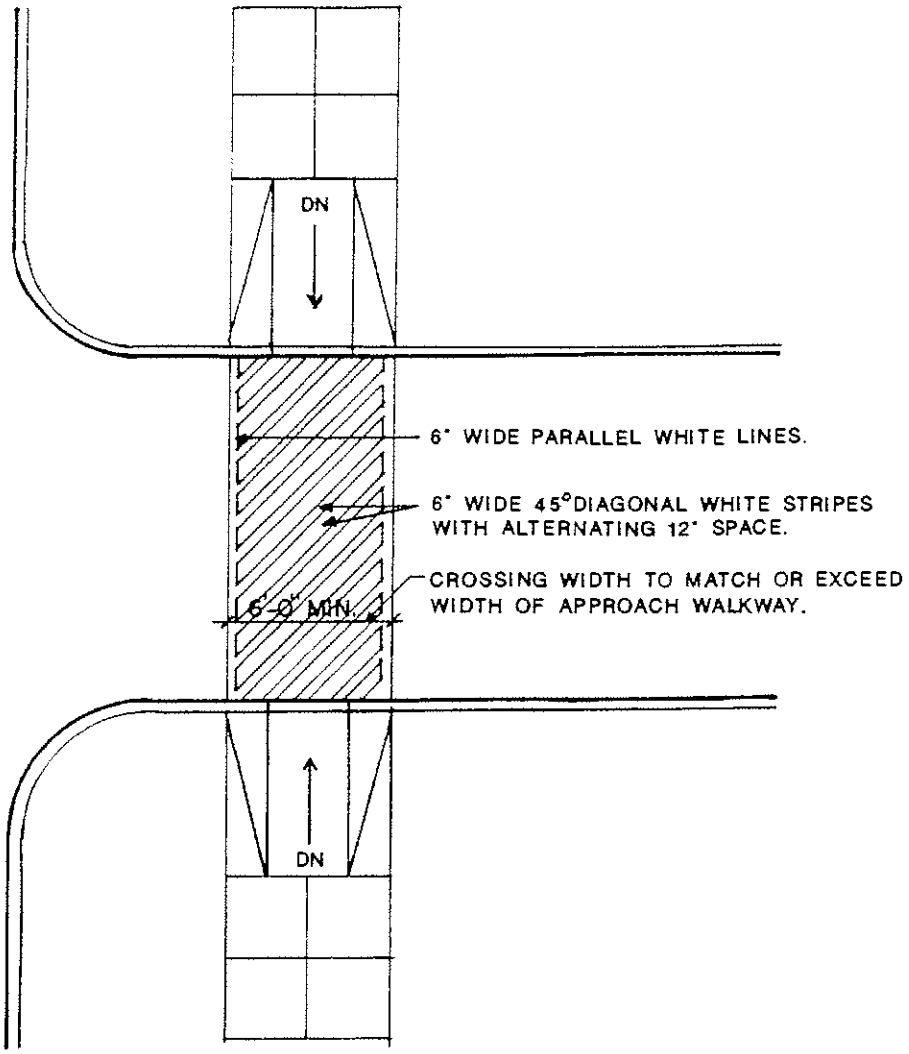
c. Pedestrian roadway crossings should be defined by white warning stripes painted on the surface of the roadway (See diagram following).

d. Curb cuts must be provided wherever an accessible route crosses a curb. The preferred minimum width of curb cuts shall be 40" (absolute minimum no less than 36"), not including sloped sides. The maximum slope of the curb ramp shall be 1:12.

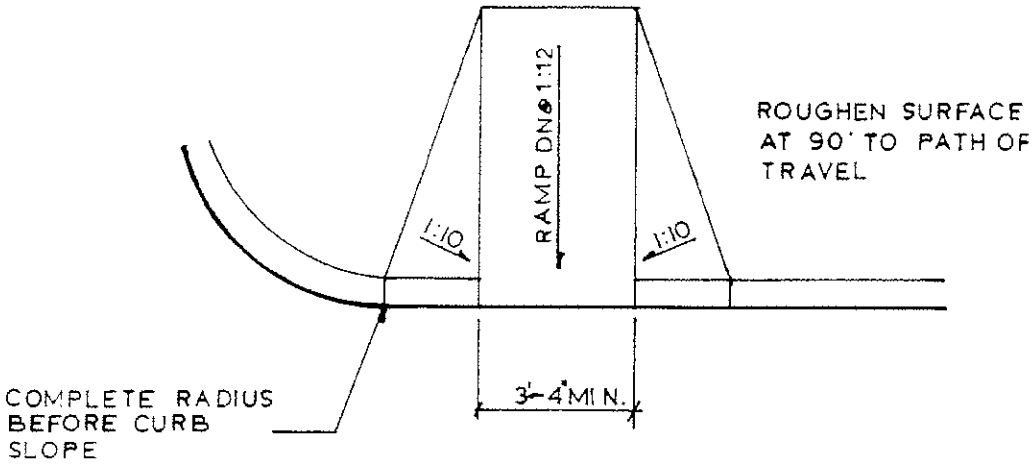
e. Curb cut ramps must be installed perpendicular to the curbs. Diagonal curb cuts are not allowed.

Note:
Consult the MBTA Guide to Access for additional information on the location and design of curb cuts.

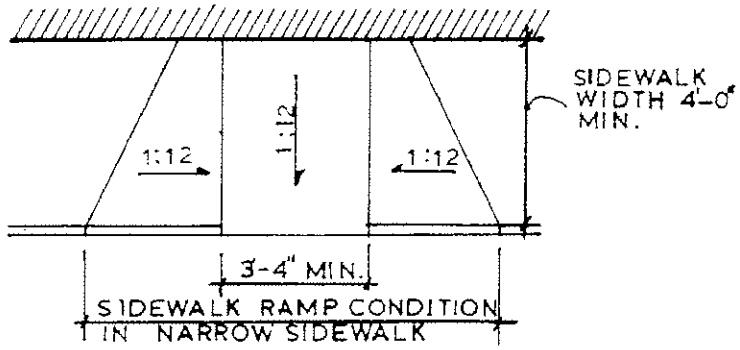
Typical Marking of Pedestrian Roadway Crossing



Typical Curb Cut



Curb Cut in Narrow Sidewalk



4. Ramps

Note:
The following section represents a partial summary of the design requirements for ramps. Consult the MBTA Guide to Access and applicable Federal and State codes for additional information.

a. Width: 4'-0" absolute minimum
(measured from inside to inside of railing)

b. Slope: 8% maximum
(1" rise in 12.5" run)

Note:
Ramps shall have a cross slope that is 1:50 (2%) or less.

c. Distance between landings: 30'-0" maximum

d. Length of Landings: Equal to width of ramp
(5'-0" minimum length)

Note:
Where a ramp changes direction the landing should be at least 5'-0" by 5'-0". Adequate drainage must be provided to prevent ponding of water at landings.

e. Provide a level area that is 5'-0" in length and equal to the width of the ramp (2% maximum slope in either direction) at the top and bottom of each ramp.

f. Ramps shall have a slip-resistant (minimum static coefficient of friction of 0.8) and a glare-free surface.

g. Run-off is the clear area between the end of a stair or ramp and the nearest obstruction conflicting with pedestrian movement.

(1) The run-off to an obstruction such as a wall, kiosk, or pier should be equal to 1.7 times the width of the ramp.

(2) The run-off to the edge of a queuing space, such as the front edge of a platform, should be at least 10'-0".

h. Ramps and landings with drop-offs shall have curbs, walls, railings or projecting surfaces that prevent people and wheel chairs from slipping off the ramp. Curbs shall be a minimum of 2" high. Protective railings shall allow a maximum 2" vertical gap above the ramp surface. Projecting surfaces must extend a minimum of 12" beyond the outside of the guard/hand rail.

i. Handrails at ramps:

(1) Provide continuous handrails on both sides of all ramps.

(2) Heights: 2'-10" and 1'-7"
(measured vertically from the ramp surface)

(3) Extension: 1'-0" minimum

Note:
Handrail should extend beyond top and bottom of ramp, return to a wall or post and must be parallel to ground surface.

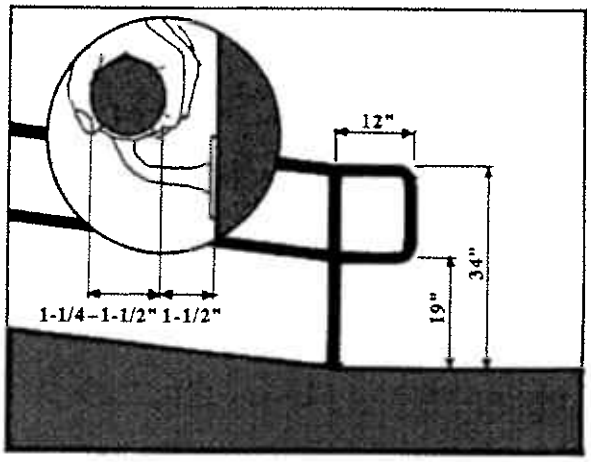
(4) Handgrip: Not less than 1 1/4"
Not more than 1 1/2"
(outside diameter)

Note:
Handgrip should be round or oval in cross-section, should have a smooth surface with no sharp corners, and should be uninterrupted for its entire length to provide a continuous gripping surface.

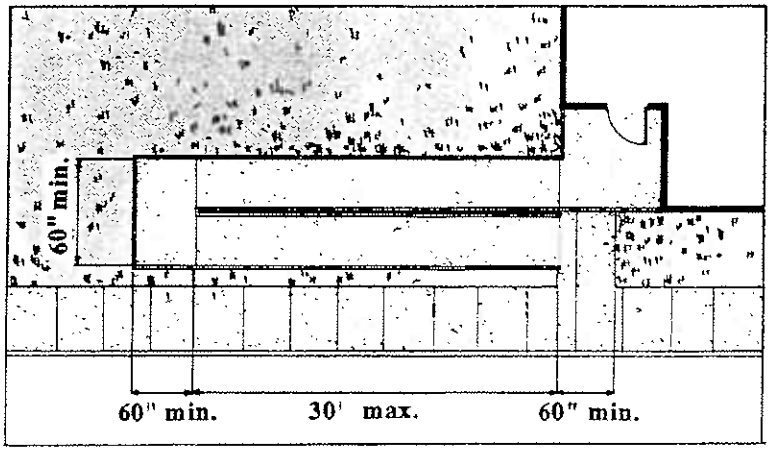
(5) Handgrip Clearance: 1 1/2"
(measured between wall and the wall-side face of the handgrip)

k. Where there is a vertical drop at the side of a ramp, provide pedestrian guardrail. (Refer to paragraph 6. Pedestrian Guardrails.)

Ramp Landings



Ramp Handrails with Extensions



5. Stairs

Note:
The following section represents a partial summary of the design constraints for stairs. Consult the MBTA Guide to Access and relevant codes for additional information.)

a. Width: 6'-0" preferred minimum
4'-0" absolute minimum

b. Landings: Every 12'-0" of vertical rise

Length: Equal to width of stair
(4'-6" absolute minimum)

c. Riser Size: 6"< R <7"
("<" = less than)

Tread Size: 11"< T <13"

Note:
These standards represent extremes; riser-tread ratios should be calculated using the following formula:

$$2R + T = 25"$$

The treads and risers of any stair must be of a uniform dimension. The minimum number of risers for any stair is three, and the risers themselves should be closed. Stair treads shall not have an abrupt projection of nosing.

d. Slope of riser: 1 1/4" maximum
(measured from the horizontal projection of the tread below)
Riser to tread angle: Greater than 70 degrees
(See diagram)

e. Stair treads should pitch to avoid ponding of water (a maximum of 1/8" per foot).

f. Stair treads shall have a slip-resistant (minimum static coefficient of friction of 0.6), glare-free surface.

g. Handrails at stairs:

(1) Provide continuous (not interrupted by newel posts or other obstructions) handrails on both sides of all stairs. When stairs are greater than 7'-4" in width, intermediate rails are required.
(2) Heights: 2'-10" and 1'-7"
(measured vertically from nosing)

(3) Extension: 1'-0" minimum (top)
1'-0" minimum + length of one tread (bottom)

Note:
At the top, the extension shall be parallel to the walking surface; at the bottom, the handrail shall continue to slope for the distance of the width of one tread, then shall be parallel to the walking surface. Both handrail extensions should return to a wall or post.

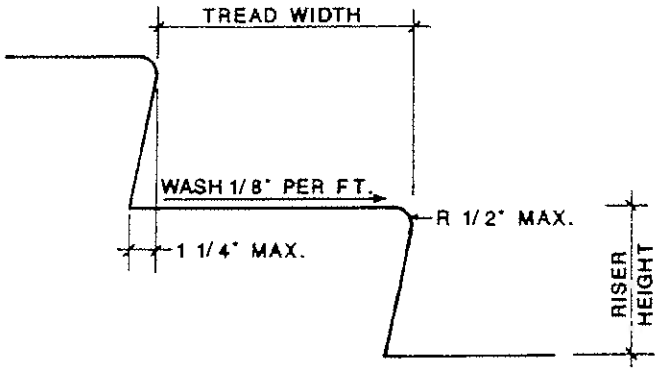
Handrail extensions are not require if they would impede travel or create a hazard on the landing.

(4) Handgrip: Not less than 1 1/4"
Not more than 1 1/2"
(outside diameter)

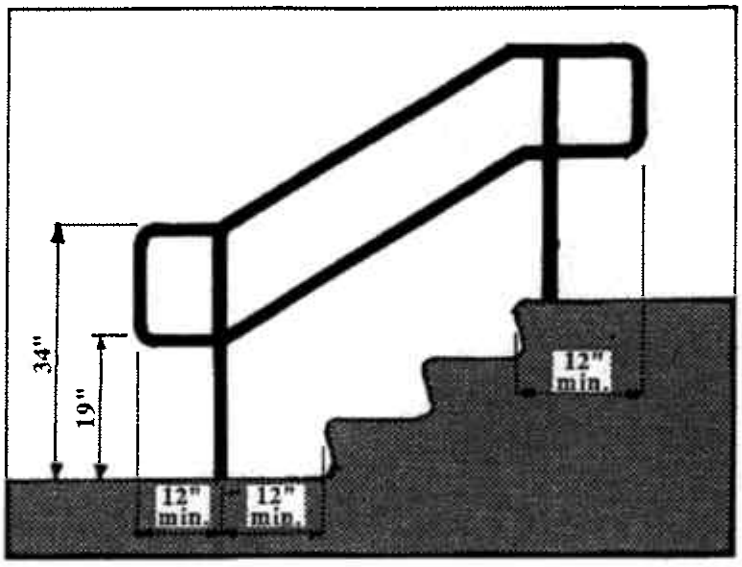
Note:
Handgrip should be round or oval in cross-section, should have a smooth surface with no sharp corners, and should be uninterrupted for its entire length to provide a continuous gripping surface.

(5) Handgrip Clearance: 1 1/2"
(measured between wall and the wall-side face of the handgrip)

Stair Nosing



Stair Handrail with Extensions



6. Pedestrian Guardrails:

Note:
The following section represents a partial summary of the design constraints for guardrails. Consult the MBTA Guide to Access and relevant codes for additional information.

a. A pedestrian guardrail is a system of building components located on the open side of walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to a lower level.

b. Use pedestrian guardrails where required by applicable code and in the following situations:

(1) Where there is a direct vertical drop in excess of 4'-0" closer than 2'-0" to a walkway, parking area, or roadway.

(2) Along all open-sided walkways, mezzanines, and landings.

(3) Where there is a vertical drop at the side of a ramp or stair.

c. Height: 3'-6" minimum
(measured vertically the leading edge of the tread or from the top of the walking surface)

d. Openings: 6" maximum opening

e. Loading Requirements:

All required pedestrian guardrails shall be designed and constructed to meet the structural loading conditions set forth in the most recent edition of the Massachusetts State Building Code.

f. Do not use unnecessary horizontal elements that may provide an easy surface for climbing.

7. Track Crossings

a The location and number of grade level pedestrian track crossings shall be determined on a site specific basis by the Authority.

Note:
Grade level crossings are not permitted at stations on high speed lines (speeds greater than 80 miles per hour).

b. Grade level crossings:

(1) Pedestrian crossings should be located where pedestrian traffic is greatest. Grade level crossings should be offset from areas on the platform where the train doors are likely to align when trains are stopped for loading or disembarking passengers. Crossings should be located to be blocked when a train is stopped within the station to prevent pedestrian track crossings.

(2) Grade level track crossings should be offset from access points to the platform. Design layout should seek to reduce the probability of pedestrians stepping out into the crossing without looking for on-coming trains.

(3) Width: 8'-0" minimum

(4) Slope in the direction of travel: 5% (approx. 5/8" per foot) absolute maximum

Cross Slope: 2% (approx. 1/4" per foot) absolute maximum

Note:
The above slopes apply to walking surfaces within the crossing. The platform should slope down at a maximum slope of one in twelve (1:12) to the level of the crossing to permit access for wheelchairs and maintenance vehicles.

No level change greater than 1/2" is permitted unless a ramp is provided. Level changes between 1/4" and 1/2" must be beveled with a maximum slope of 1:2.

(6) The crossing surface should be slip-resistant (maximum static coefficient of friction should be 0.6 for walking surface and 0.8 for ramped surfaces). Material should be impervious to oil and grease.

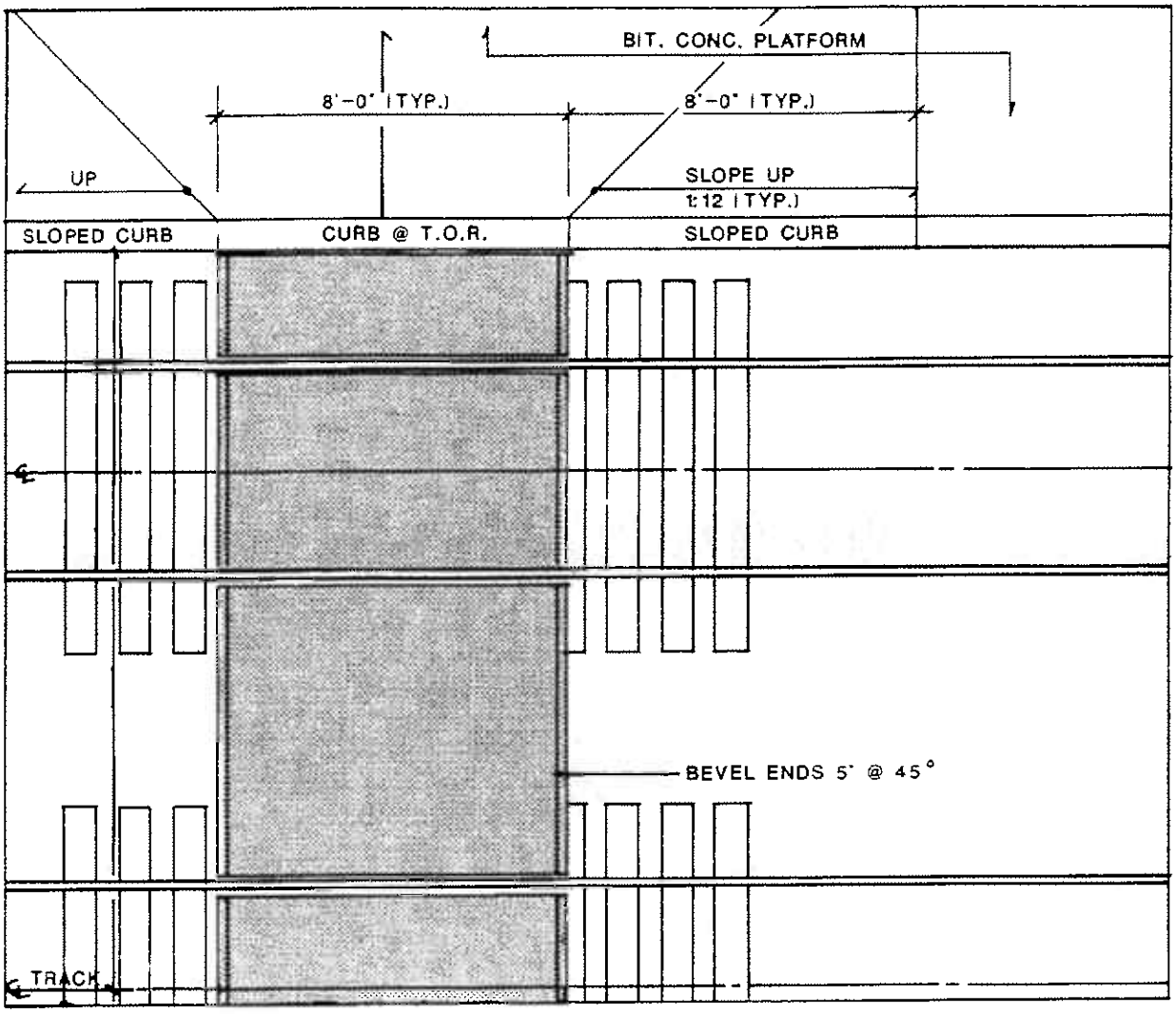
(7) The construction of pedestrian crossing construction should be 'panelized' for ease of removal for track maintenance.

(8) The gap between rail and adjacent track crossing surfaces shall be governed by American Rail Engineer's Association standards and shall comply with State and Federal accessibility rules, regulations and standards. The maximum permissible gap at the inner edge of each rail is 2-1/2".

(9) Detectable warning surfaces for persons with visual disabilities shall be provided at the edge of all track crossings.

(10) Provide fully automated crossing warning systems at each pedestrian crossing on main line tracks. Secondary and other low speed tracks may be exempted from this requirement on a site specific basis. Locate warning signs on all crossings to be visible from each entry to the crossing. These signs should have the phrase "Look Before Crossing" on both sides. (See Chapter on "Graphics" for design criteria for the standard sign.)

Pedestrian Track Crossing



c. Grade separated crossings:

(1) All new pedestrian crossings on the Providence line shall be grade separated.

(2) Locate new grade separated crossings where pedestrian traffic is greatest--e.g. at the midpoint of platforms or at the point of access to/from parking. Reuse existing grade separated crossings where possible.

(3) Width: 6'-0" minimum (open, elevated crossings)
12'-0" minimum (enclosed passageways, tunnels)

(4) Slope in the direction of travel: 5% (approx. 5/8" per foot) absolute maximum

Cross Slope: 2% (approx. 1/4" per foot) absolute maximum

(5) Grade separated structures must comply with rules and regulations governing accessibility. Access shall be provided by ramp or elevator.

(6) All grade separated crossings shall be illuminated in accordance with the guidelines presented in Chapter "Lighting".

(7) Elevated grade separated structures shall be enclosed with metal grating or fencing with a maximum openings of 1" between members as a means of preventing dropping or throwing debris at trains. Limit such protective enclosures to directly over the track area to facilitate snow removal.

(8) Pedestrian bridges and associated ramps must be covered to protect against rain and the accumulation of snow on the walkway surfaces.

D. Vehicular Circulation

1. General Principles

a. Provide the most direct roadway access possible between the entrance to the site and the drop-off/pick-up area.

b. Where site conditions permit, vehicle access to the site should favor the inbound side.

c. Provide convenient loop turn-arounds for drop-off/pick-up vehicles (buses, taxis, private automobiles).

d. Roadways in public rights-of-way that are to be relocated or improved shall be designed to current standards set forth by the Massachusetts Department of Public Works and as required by local codes.

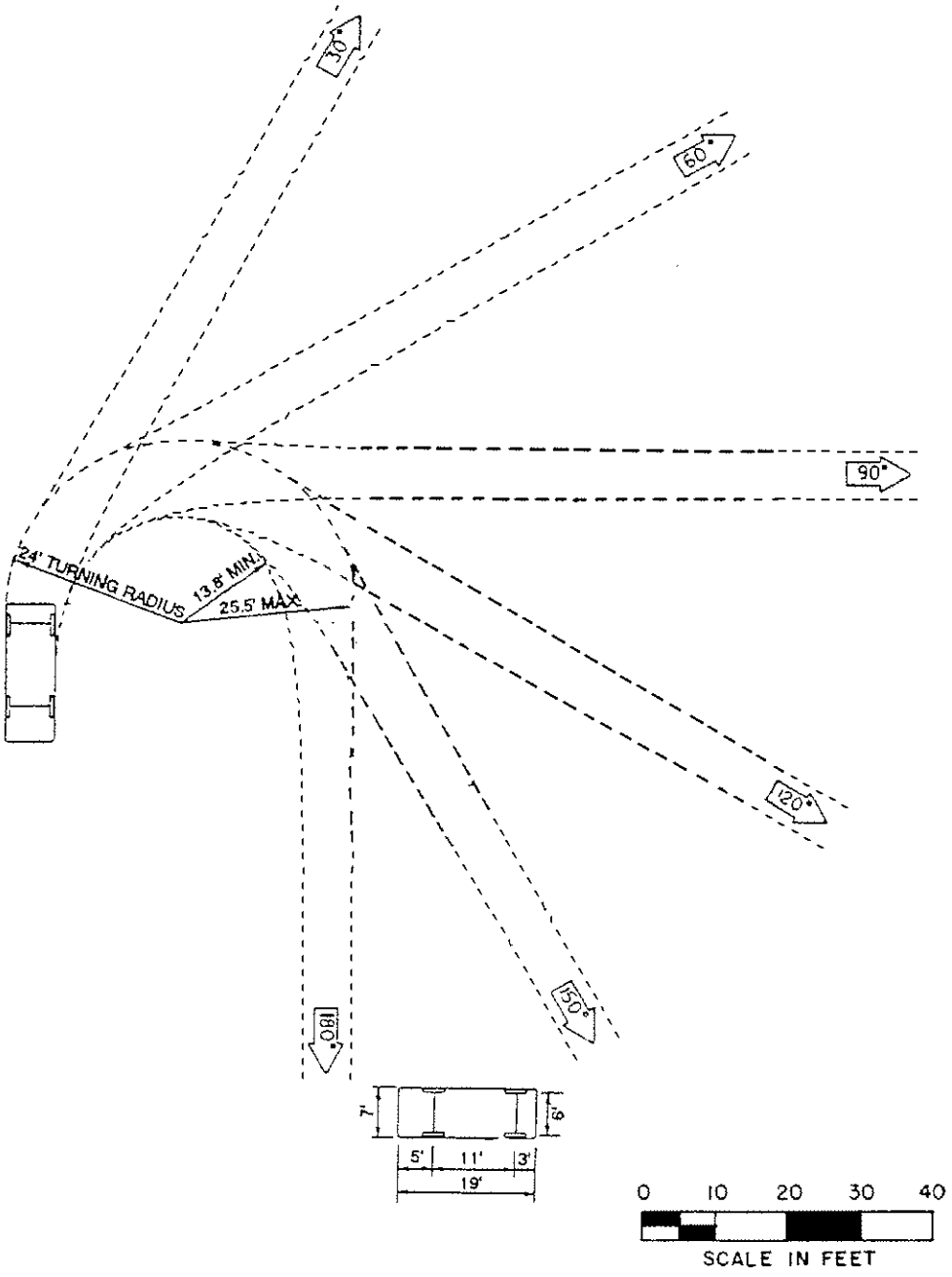
2. Vehicle Turning Radii

Note:
The following table is taken from the 1990 edition of A Policy on the Geometric Design of Highways and Streets.

Design Vehicle	Minimum Turning Radius	Minimum Inside Radius	Minimum Turning Path
Passenger Car (P)	24	13.8	25.5
Single Unit Transit Bus (BUS)	42	24.4	46.5
Single Unit Truck (SU)	42	27.8	44.1
Semitrailer (WB 50)	45	19.2	46.3

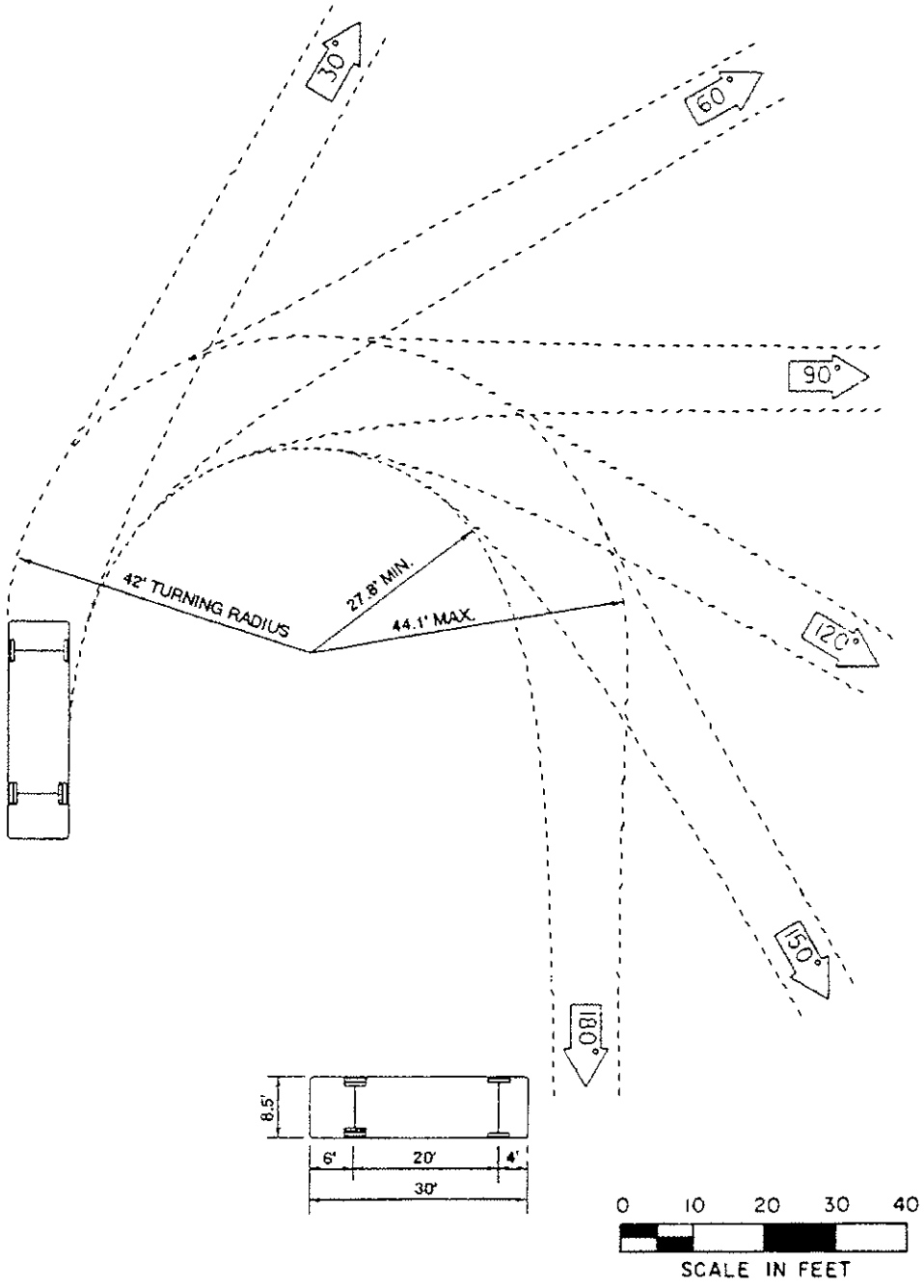
Minimum Turning Paths of Typical Vehicles

The following diagrams are take from
A Policy on the Geometric Design of Highways and Streets, 1990 ed.



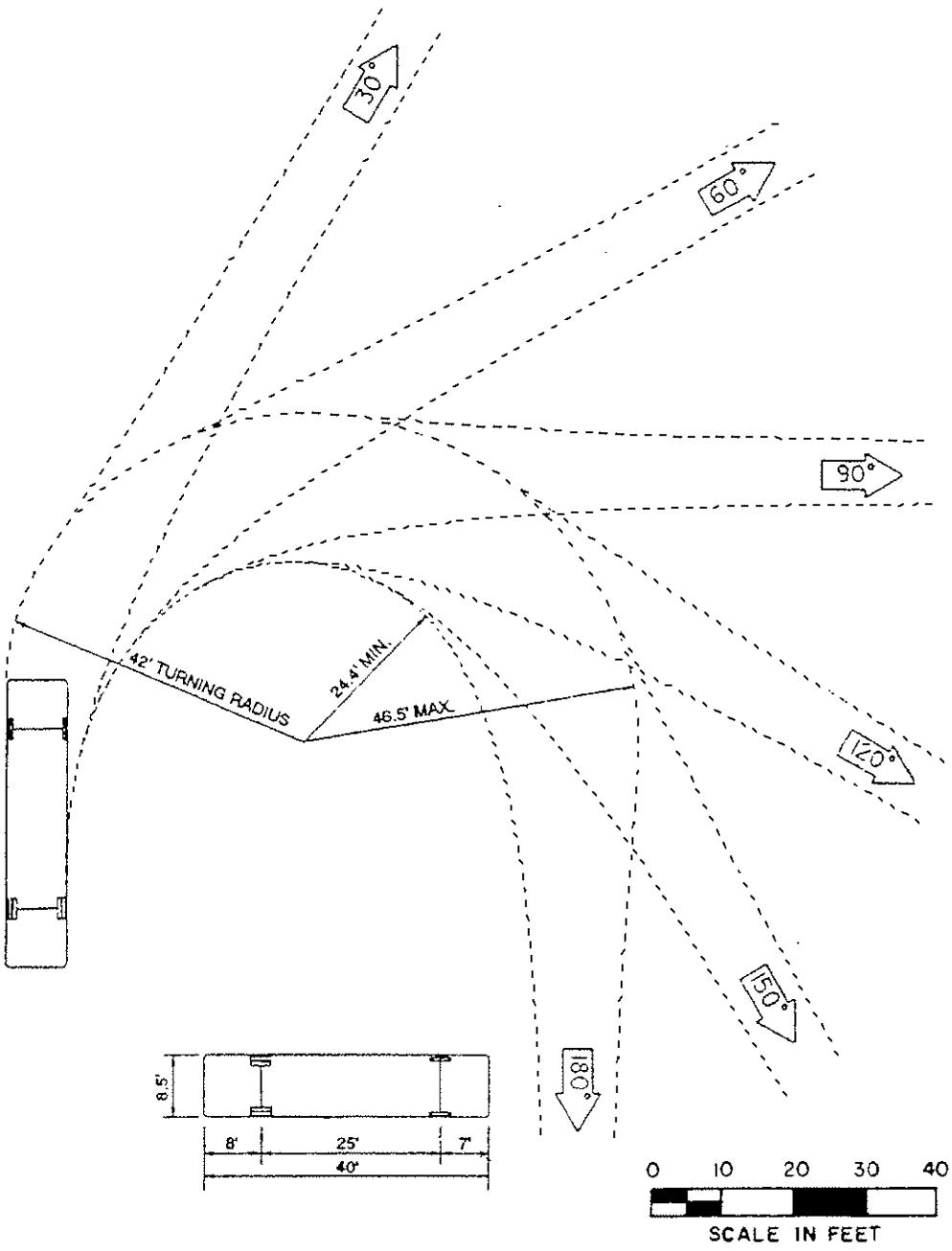
Minimum turning path for P design vehicle.

Minimum Turning Paths of Typical Vehicles



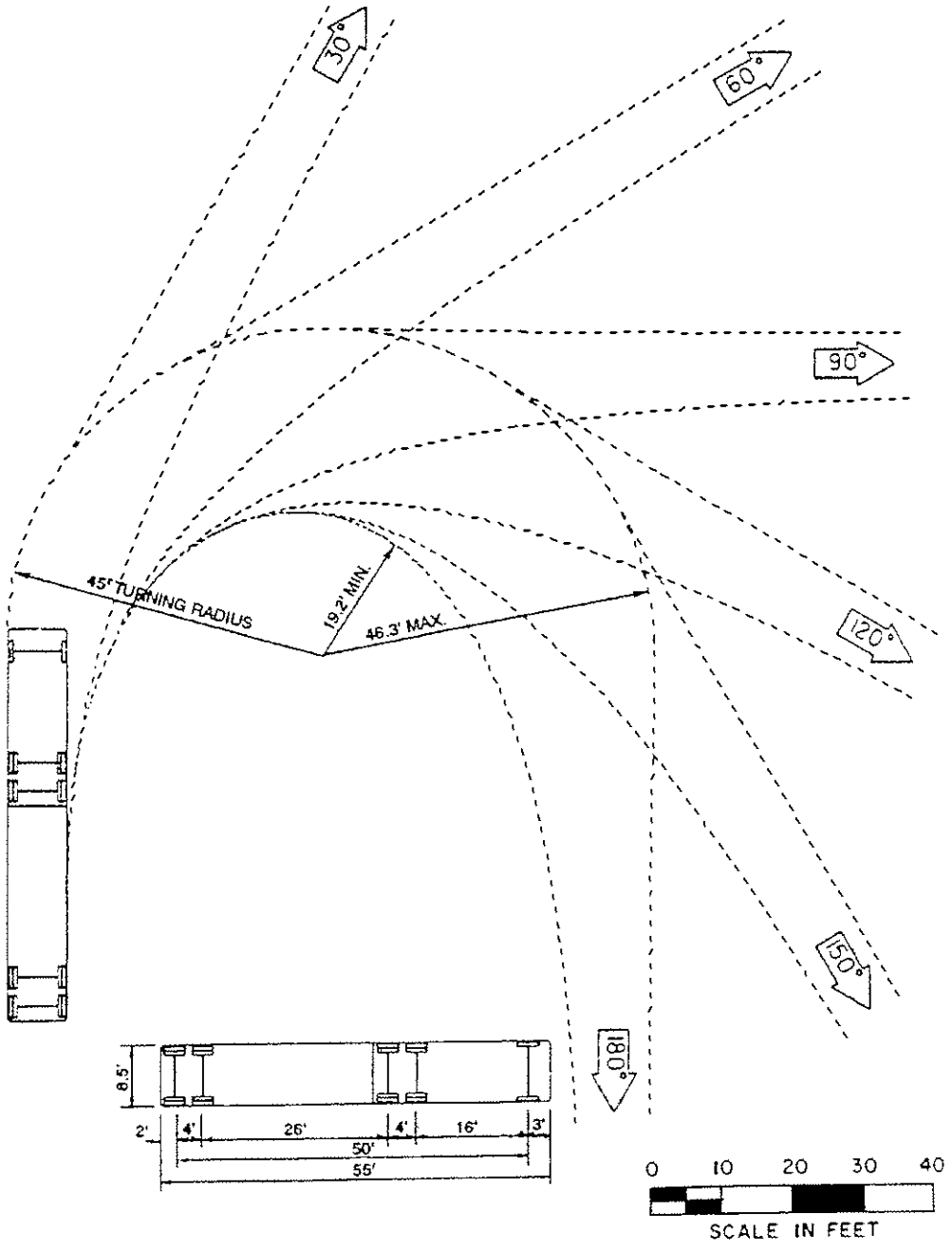
Minimum turning path for SU design vehicle.

Minimum Turning Paths of Typical Vehicles



Minimum turning path for BUS design vehicle.

Minimum Turning Paths of Typical Vehicles



Minimum turning path for WB-50 design vehicle.

3. Standard Roadway Dimensions and Gradients

a. The preferred minimum roadway lane width is 12'-0". The absolute minimum lane width is 10'-0". The absolute minimum lane width for a one-way single lane is 16'-0".

b. Roadways shall be cross pitched to provide positive drainage. The preferred cross pitch is 2% (approx. 1/4" per foot). The absolute minimum cross pitch is 1% (approximately 1/8" per foot). The maximum cross pitch is 3% (approx. 3/8" per foot). Where possible, roadways should be crowned in the middle and drain to the edges.

c. Roadway gradients:

Vehicle	Roadway Gradients (Slope)
Automobile	10% maximum (approx. 1 3/16" per foot) for ramps, access roadways, and driveways; 6% maximum (approx. 3/4" per foot) sustained grade for safe operation; 5% maximum (approx. 5/8" per foot) on roadways subject frequent ice, snow, sleet, and fog.
Bus	10% maximum (approx. 1 3/16" per foot) operating grade; 6.5% maximum (approx. 13/16" per foot) design grade--controlled by safety considerations and desirable operating conditions in the winter months.

d. Where an accessible route crosses a roadway, the maximum allowable slope in the direction of travel is 5% with a maximum cross slope of 2%.

4. Vehicle Entrances and Exits

a. The number and location of vehicle entrances and exits at a station is determined by many factors, including parking lot size, drop-off/pick-up volume, site topography, traffic volumes on adjacent streets, and adjacent land uses.

b. The recommended distance between site entrances/exits and adjacent street intersections along various types of roadways is presented below:

Type of Roadway	Minimum Distance (ft)	Preferred Distance(ft)
Major Arterial	200	400
Minor Arterial	150	300
Collector/Local Street	100	200

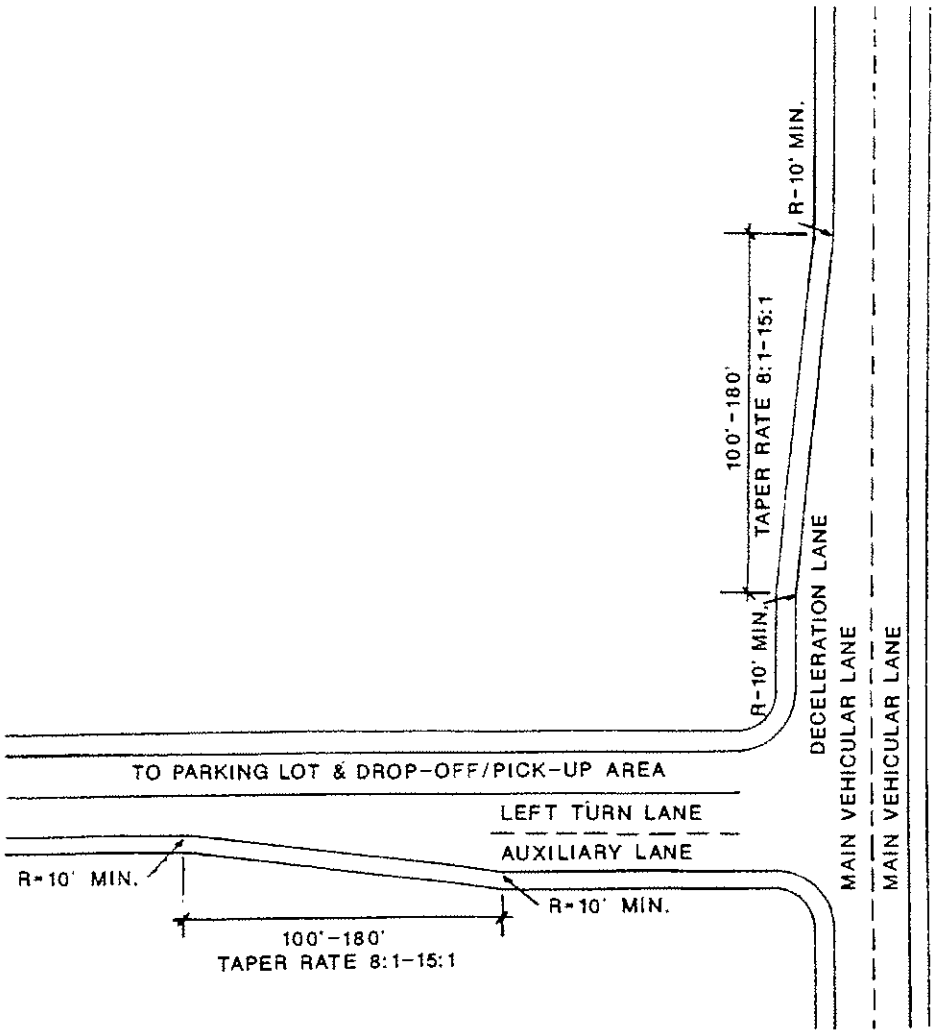
c. Entrance and Exit Design

(1) At exits where a moderate number of left hand turns is anticipated, a second auxiliary exit lane should be considered to separate left and right hand turns. The preferred width of auxiliary lanes is 12'-0"; the minimum width is 10'-0". (See Diagram following.)

(2) Vehicle storage length is the area required to accommodate vehicles exiting the site. This area should be separate from and not interfere with the operation of vehicles in the remainder of the parking lot.

d. For further information on the design of intersections, auxiliary lanes and deceleration lanes, see A Policy on the Geometric Design of Highways and Streets, published by the American Association of State Highway and Transportation Officials.

Layout of Auxiliary and Deceleration Lanes



5. Drop-off/Pick-up Areas (Passenger Loading Zones)

a. Provide drop-off/pick-up areas at all stations, even those sites where no long term parking is provided. Locate the drop-off/pick-up area within a maximum 100 feet of the station platform and ensure compliance with the Rules and Regulations of the Architectural Access Board (AAB) of the Commonwealth of Massachusetts. Accessible drop-off/pick-up areas shall be identified with international symbol of accessibility signs.

Note: As of the date of this writing, the requirement of the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for tactile warning material at curb-side locations has been suspended.

b. Limit the size of drop-off/pick-up areas. Without strict enforcement of parking restrictions, all-day parkers will utilize drop-off/pick-up areas. Parking lot aisles can be used for queuing of vehicles waiting to pick up passengers.

c. Drop-off/Pick-up Area Layout:

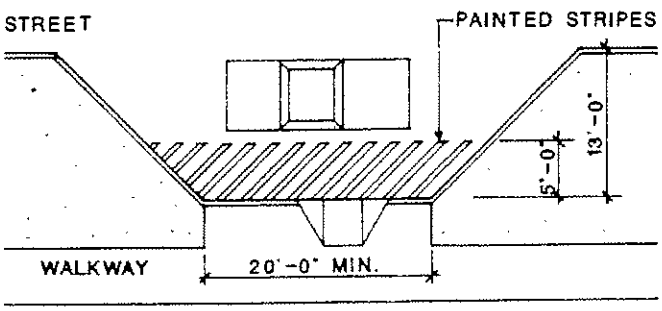
(1) The drop-off area must be designed for accessibility, providing a 5'-0" wide aisle space between the vehicle and the curb over its full length. Provide curb cuts within the drop-off area.

Drop-off areas should be designed for right-hand curbside drop. (See Diagram)

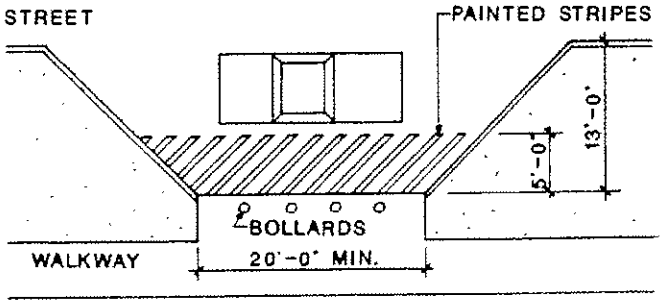
(2) Where passengers transfer from local bus lines to commuter rail, a bus drop-off/pick-up area with a berth size of 80'-0" by 11'-0" should be provided.

At bus stops where a lift will be deployed:
- Provide firm, stable surface a minimum clear length of 96" measured from the curb or vehicle roadway.
- Provide minimum 60" clear width, measured parallel to vehicle and roadway.

Passenger Loading Zone



Passenger Loading Zone Without Curb



Passenger Loading Zone With Curb

E. Parking Lot Layout

1. General Principles

Factors such as site topography, location of access roads, land availability, adjacent land use, and community requirements will determine in large part the layout of parking facilities. However, other factors to consider in the initial planning for parking lots are:

a. Where possible, parking layout should be designed to maximize use of the accessible route to the platform. At low platforms, this is typically toward the outbound end, where the access platform is located.

b. Avoid dead end aisles unless a turnaround is provided.

Where turnarounds are not possible in dead-end aisles, provide one striped space and sign it as a "turning-space-only" to eliminate the need to back out the length of the parking lot.

Provide for snow removal at the end of dead end aisles.

2. Parking Layout

a. Bay Orientation

Site conditions permitting, parking bays should be laid out perpendicular to the track and platform to allow people to walk down the aisles to the platform.

(As a rule of thumb, if a site has a curb to curb dimension measured at right angles to the track which is greater than 200 feet, the parking bays should be perpendicular to the track and platform. However, there may be specific site conditions or circulation requirements which dictate an orientation parallel to the track and platform.)

b. Parking Stall Orientation

90 degree parking is preferred. Use diagonal parking only when 90 degree parking is not feasible. Diagonal parking should not be used in structures. Follow accepted standards for diagonal parking such as the Handbook of Landscape Architectural Construction, published by the Landscape Architecture Foundation.

c. Perimeter Parking

Use 90 degree parking around the entire perimeter of the site where possible to maximize the capacity of the lot.

3. Dimensional Guidelines

a. General Notes:

Deviations from the dimensional guidelines shown in the accompanying diagram may be permitted in site-specific situations, however it is the responsibility of the design consultant to bring such deviations to the attention of the Authority for review and approval.

90 degree parking spaces may be shortened by up to 2'-0" where vehicles can overhang the curb. Vehicle overhangs must not interfere with the required clear width of an accessible pathway.

Avoid single row parking in parking structures.

b. Standards for 90 degree Parking for Use by the Physically Disabled

Provide minimum 8'-0" wide spaces with an adjacent 5'-0" wide striped access way. Depth, aisle, and bay dimensions should comply with those requirements for parking lots and structures of the Rules and Regulations of the AAB and the ADAAG.

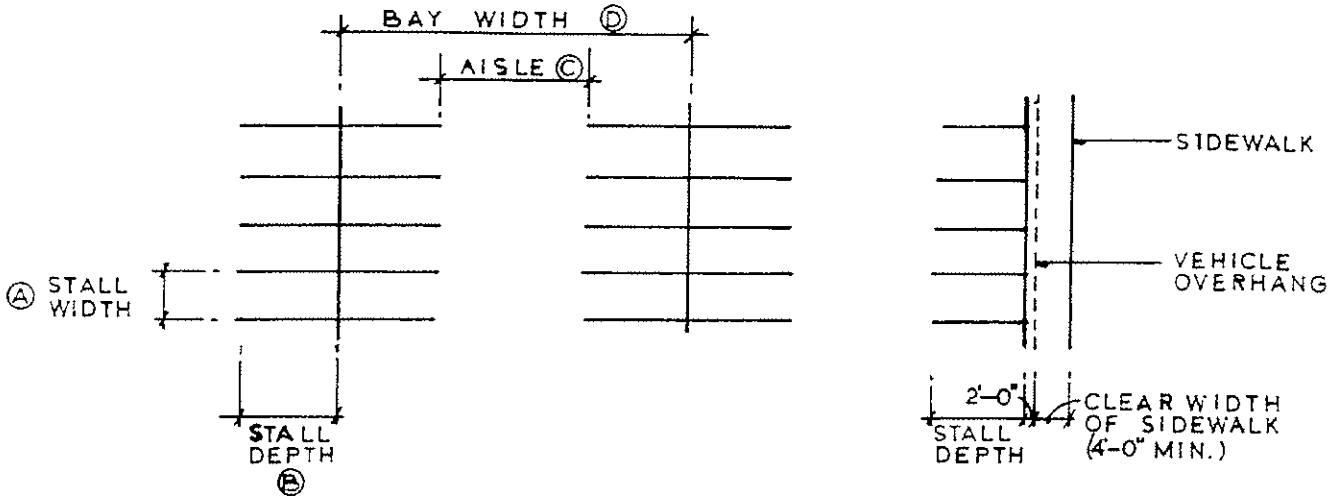
Two spaces may share the same 5'-0" access way. Provide sidewalk ramps as necessary at the end of access ways to connect with the accessible route to the platform. Where accessible spaces are grouped together, it may be advantageous to lower the sidewalk to the level of the parking spaces. Accessible parking spaces and access aisles shall have surface slopes not exceeding 1:50 (2%) in all directions.

c. Standards for Parallel Parking on Surface Lots

Use parallel parking only where other layouts are impractical. Do not use parallel parking in any location where it might interfere with heavily traveled vehicular access routes.

Parallel parking spaces should be 8'0" wide by 22'0" long.

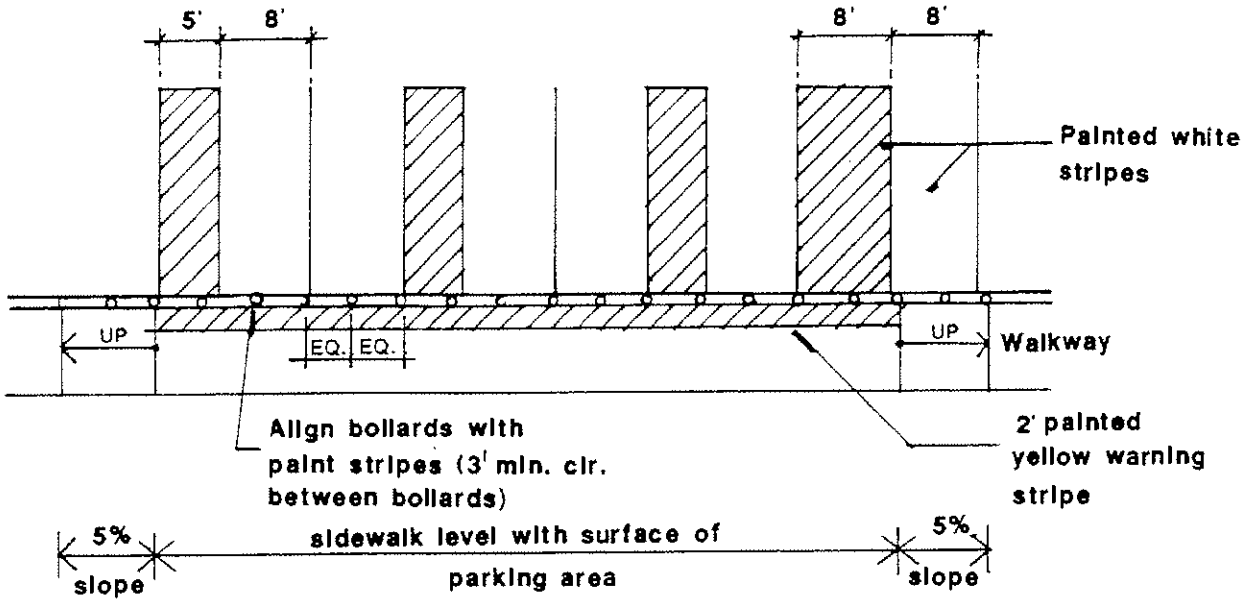
Standard Parking Stall Layout



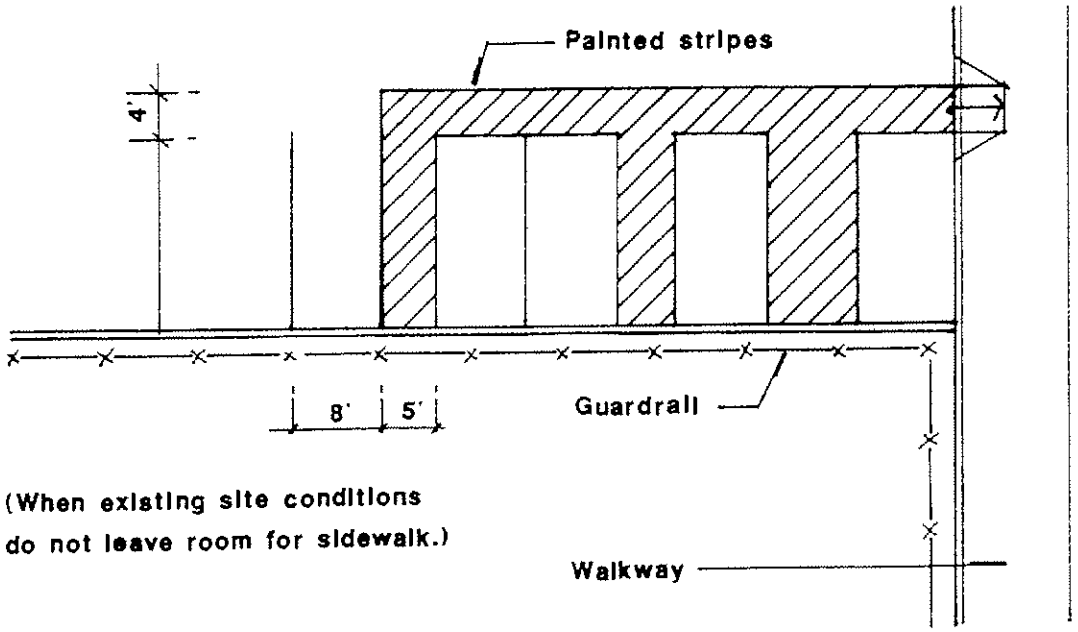
90° PARKING IN SURFACE LOTS	TWO ROWS OF CARS STANDARD PREF.	STANDARD ALT. BAY < 60 FT.	COMP.		ONE ROW OF CARS STANDARD PREF.	STANDARD ALT. BAY < 43 FT.	COMP.
Ⓐ STALL WIDTH	8'-3"	8'-6"	8'-0"		8'-3"	8'-6"	8'-0"
Ⓑ STALL DEPTH	17'-0"	17'-0"	15'-0"		17'-0"	17'-0"	15'-0"
Ⓒ AISLE	26'-0"	24'-0"	24'-0"		26'-0"	24'-0"	24'-0"
Ⓓ BAY WIDTH	60'-0"	58'-0"	54'-0"		43'-0"	41'-0"	39'-0"
90° PARKING IN PARKING STRUCTURE							
Ⓐ STALL WIDTH	8'-6"	N.A.	N.A.		8'-6"	N.A.	N.A.
Ⓑ STALL DEPTH	17'-0"	N.A.	N.A.		17'-0"	N.A.	N.A.
Ⓒ AISLE	26'-0"	N.A.	N.A.		26'-0"	N.A.	N.A.
Ⓓ BAY WIDTH	60'-0"	N.A.	N.A.		43'-0"	N.A.	N.A.
COL. SPACING	58'-0"	N.A.	N.A.		41'-0"	N.A.	N.A.

* CONSULT HANDBOOKS FOR DIAGONAL PARKING LAYOUTS. (E. G.: ARCHITECTURAL GRAPHIC STANDARDS OR HANDBOOK OF LANDSCAPE ARCHITECTURAL CONSTRUCTION)

Accessible Spaces Without Curb



Access Through Parking Area



(When existing site conditions do not leave room for sidewalk.)

4. Accessible Parking

a. The rules and regulations of the Architectural Access Board (AAB) of the Commonwealth of Massachusetts apply to the modernization or expansion of commuter rail parking facilities, including surface lots and garage structures. Federal regulations also require accessible parking be provided at these facilities.

b. The MBTA Guide to Access addresses accessible parking at commuter rail stations. Accessible parking spaces must comply with Section 23 of the Rules and Regulations of the Architectural Access Board of the Commonwealth of Massachusetts and Section 4 of the Americans with Disabilities Act Accessibility Guidelines.

c. Provide accessible parking spaces as follows:

Total No. Parking Spaces	Required No. Accessible Parking Spaces
1-25	1
26-50	2
51-75	3
76-100	4
101-150	5
151-200	6
201-300	7
301-400	8
401-500	9
501-1000	2% of total
1001 & over	20 + 1 for each 100 over 1,000

Note: One in every eight accessible spaces, but not less than one, shall be served by a minimum 96 in. access aisle and be designated "van accessible" as required by ADAAG 4.6.4.

Where there is more than one parking lot provided on the same side of the track, it is acceptable to place all accessible parking spaces in the parking lot closest to the platform. However, in such case, the total number of accessible spaces must be computed on a lot by lot basis and added together. They may not be computed from the total number of spaces in the lots. Provide signage at the auxiliary lots to indicate where the accessible parking spaces are located.

Where multiple lots are provided on both sides of the track, a proportionate number of accessible parking spaces must be placed on both sides of the track. If this is not possible, a variance must be obtained from the Massachusetts Architectural Access Board. Where there is more than one lot, the number of accessible parking spaces is calculated on a per lot basis.

5. Gradients

   a. The absolute maximum parking lot gradient is 5% (approx. 5/8" per foot). The absolute minimum acceptable gradient is 0.5% (approx. 1/16" per foot); the preferred minimum is 1% (approx. 1/8" per foot).

      Where an accessible route occurs within the parking area, the maximum slope is 5% with a maximum cross slope of 2% except at aisles between accessible spaces.

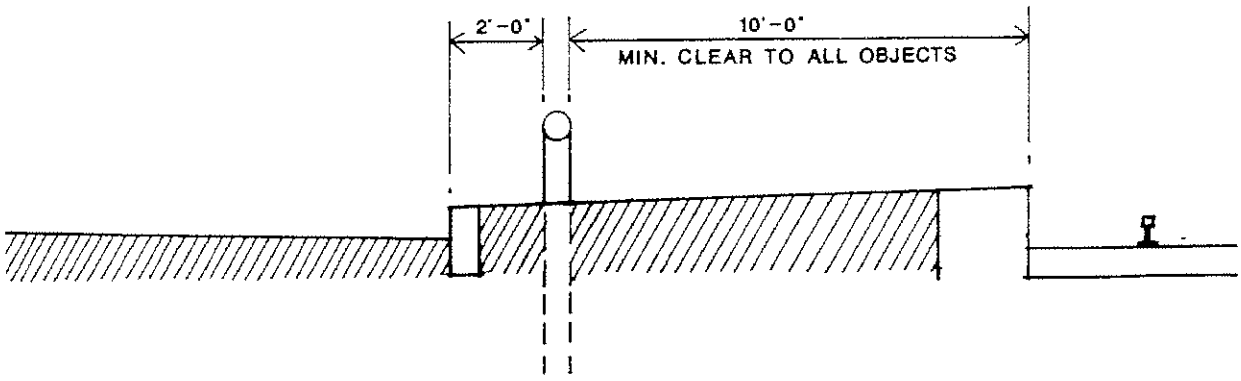
   b. Crown the pavement in each parking bay at the center and pitch to the outside edges to avoid water ponding within aisles where pedestrians will walk.

6. Clearances

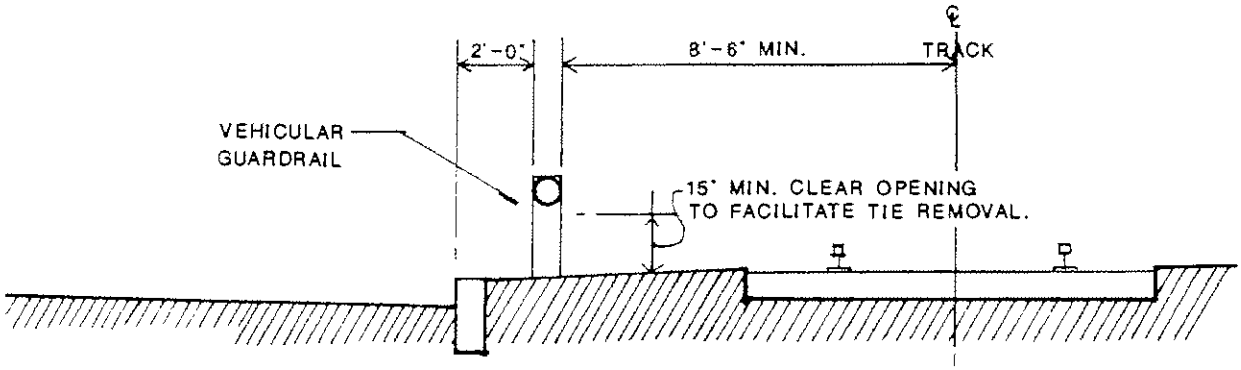
   a. To allow for vehicle overhang, the minimum clearance between the inside face of curbing in a parking lot and any object (such as signs, light poles, trees, fences and barrier walls) is 2'-0".

   b. Where parking is adjacent to track without a platform, provide vehicular guard rail mounted with chain link fence at a minimum of 8'-6" from the center line of track. Where vehicular guard rail is located less than 12'-6" from track centerline, provide a 15" clear space under the guard rail to facilitate cross tie replacement.

Typical Minimum Clearances, Low Platform

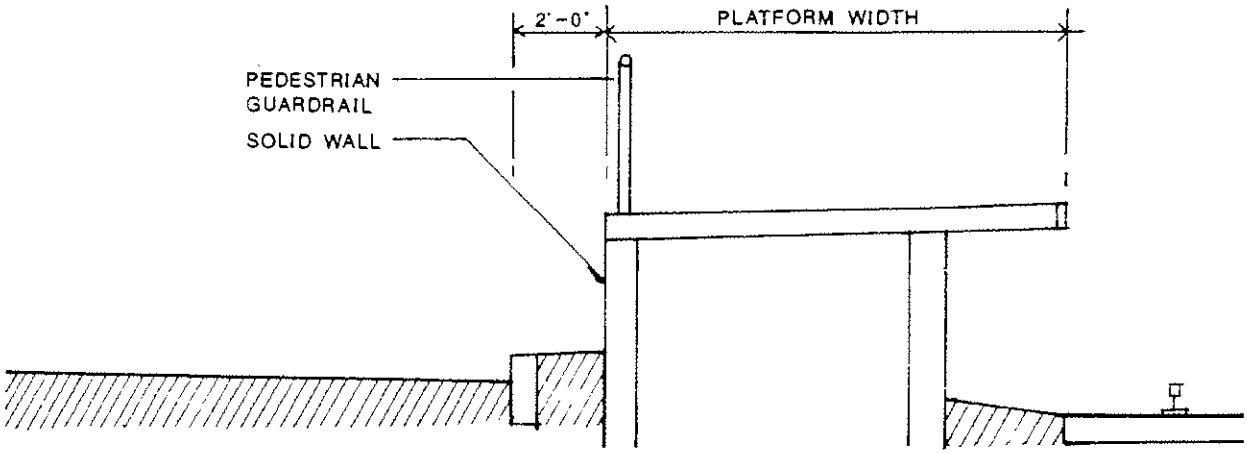


Minimum Clearance at Track, No Platform



NOTE:
WHERE RETAINING WALLS OCCUR ADJACENT TO TRACK, PROVIDE A MINIMUM CLEARANCE OF 12'-0" FROM CENTERLINE OF TRACK FOR REMOVAL OF TIES.

Typical Minimum Clearances (Platform More Than 8" Above Adjacent Surface)



NOTE:
FOR HIGH LEVEL PLATFORMS WITH SIDE PANELS WHICH ARE EASILY DAMAGED, PROVIDE A RAISED CURB 2'-0" AWAY FROM THE SIDE OF THE PLATFORM.

7. Pedestrian and Traffic Islands

   a. Avoid islands since they make snow removal more difficult, increase cost, and complicate drainage. Provide painted islands at the end of bays; raised islands impede snow removal.

   b. General Guidelines (if needed)

      (1) Islands should be a minimum of 4'-0" wide.

      (2) Use long islands perpendicular to parking stalls only when necessary for grading or circulation. Provide 8' to 10' wide breaks at every other parking bay (approx. 120' intervals) to allow for plowing and pedestrian access.

      (3) Avoid curbed inside corners since they make plowing difficult, trap debris and increase the number of drainage structures needed.

F. Use of Landscape Buffers

1. See Chapter 6 for specific design criteria governing the appropriate use of landscape buffers. In general, the Authority prefers to minimize unnecessary landscaping at commuter rail stations.

2. Where appropriate, lay out parking lots to preserve significant natural features--specimen trees, natural berms, outcroppings, etc--which may enhance the visual characteristics of the site. Such features should not detract from the operation, security, and capacity of the lot.

3. Lay out parking areas to leave sufficient space at the perimeter of the site to provide a buffer from surrounding neighborhoods or other sensitive receptors.

G. Use of Barriers

1. Use barriers in station parking areas to channel vehicular and pedestrian traffic, contain water run-off, and, in certain instances, limit pedestrian access to the site. Barriers should be used to maintain a safe separation between platform and vehicular circulation and parking. Typical barriers include curbing, guard rail, bollards,and fencing. (Conditions which govern the use of barriers are described below.)

2. Types of Barriers:

   a. Curbing

      Curbing is the preferred method of defining the limits of a parking lot. Use curbing to control water run-off, to separate

pedestrian and vehicular traffic, and to confine vehicle movements.

Granite is preferred as a curb material (7" maximum vertical reveal). Consider sloped granite as an alternative to vertical granite, but do not use sloped granite in areas of pedestrian circulation. Existing on-site granite curbing may be reused where possible.

If the lot can be easily drained to nearby ditches curbing may not be desirable. Guard rail or bollards should be used to confine vehicles to the paved lot where no curbing is provided.

Do not use the railroad right of way ditch for drainage of the parking area.

b. Vehicular Guard Rail

Vehicular guard rail is used to confine vehicle parking to specific areas. Under certain conditions, it is advisable to provide both curbing and guard rail (or bollards) as a secondary safety barrier (e.g. at the edge of an embankment).

c. Bollards

Use bollards for the same purposes as guard rail. However, bollards allow the free flow of pedestrians between them. Bollards interfere with snow plowing operations requiring either hand shoveling or the use of small machines. Therefor, their use should be minimized to short segments only where necessary.

d. Pipe Rail

Pipe rail may be used for pedestrian guardrails and as a means of channeling pedestrian movements. Typical applications occur along the back face of platforms with vertical drops in excess of 8", along the top side of retaining walls, and at stairs and ramps. Consult the pedestrian guardrail section of this chapter for design criteria.

e. Fencing

Use fencing to limit pedestrian access to the site for safety and security reasons. Fences adjacent to roadways and/or parking lots should be set back and protected by curbing or vehicular guardrail to allow for vehicle overhangs and the storage of plowed snow. Provide curbing or vehicular guardrail.

f. Inter-track Fencing

Inter-track fencing is chain link fence installed between tracks to prevent pedestrians from crossing the tracks except at designated locations.

Inter-track fencing should 4'-0" high and extend a minimum distance of 200'-0" beyond the ends of the platforms. Consult Standard Plan No. 3204 for design criteria.

H. Parking Area Drainage Requirements

1. Authority policy is to install a storm drainage system in all new parking lots as well as those being upgraded.

   Only small parking lots (generally those with under a twenty-five vehicle capacity) surrounded by porous soil capable of absorbing water run-off form the parking area may be designed without a storm drainage system. Do not drain toward the track right of way under any circumstances.

2. Storm drainage systems should conform with the Massachusetts Department of Public Works standards. See the Landscaping subsection for a description of drainage system design guidelines.

I. Parking Fee Collection

1. At stations where a parking fee is to be collected, the Authority uses a central coin-slot system to collect parking fees.

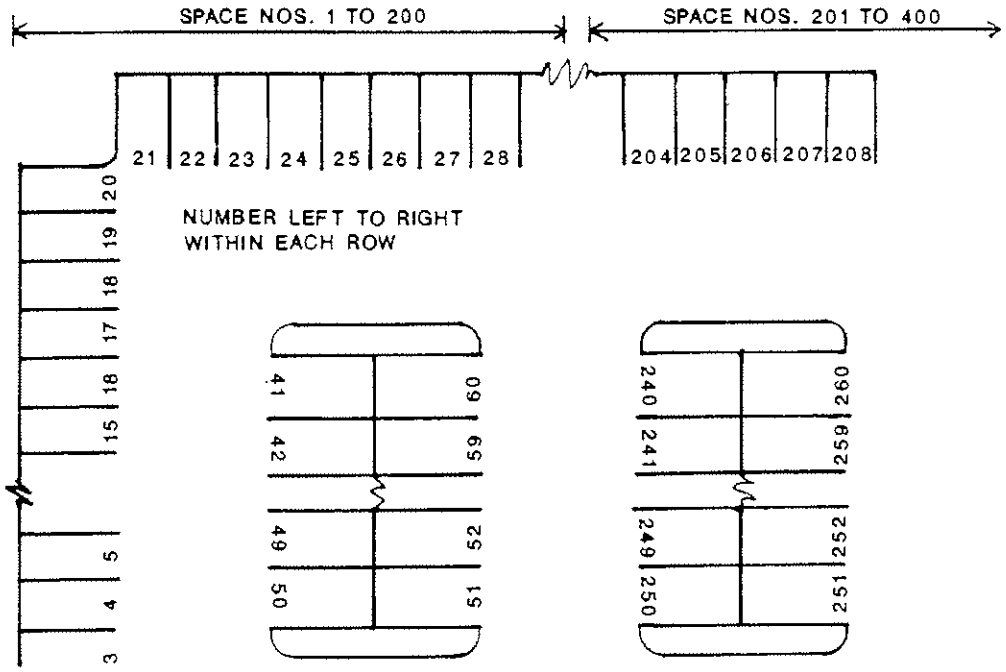
   a. The central coin-slot system consists of a centralized parking fee depository with numbered coin slots which are keyed to numbered spaces in the parking lot. The user deposits the fee as he or she walks to the platform. (See diagram following)

      Location of the central collection box shall be determined by the Authority . Where possible, the central collection box should be highly visible and should be located under a canopy and on the same side of the track as the parking in a central area adjacent to the inbound platform. In larger parking lots, divide the lot into numbering zones of not more than 200 spaces. (See diagram following)

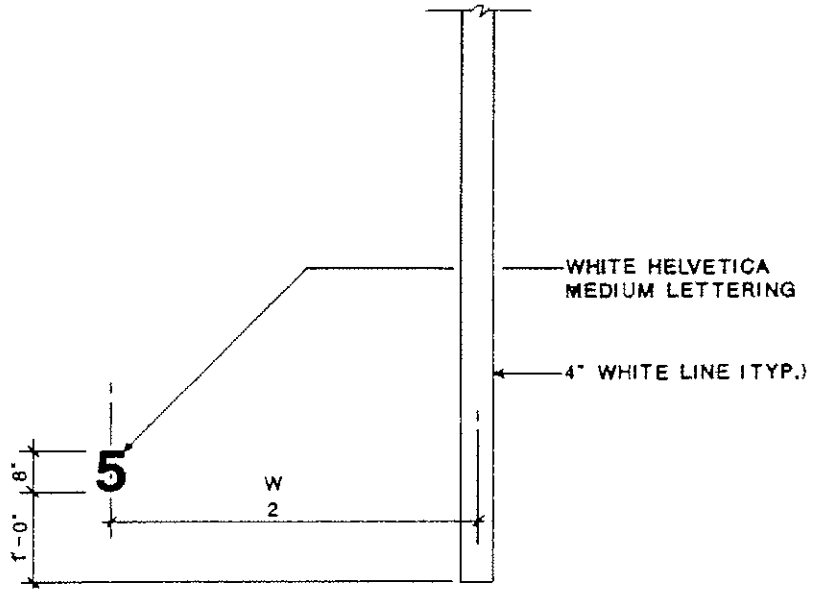
      See MBTA Guide to Access for guidelines on how to make collection boxes accessible to the physically disabled. Collection boxes must be located on an accessible route.

b. Parking spaces should be clearly marked and numbered consecutively.

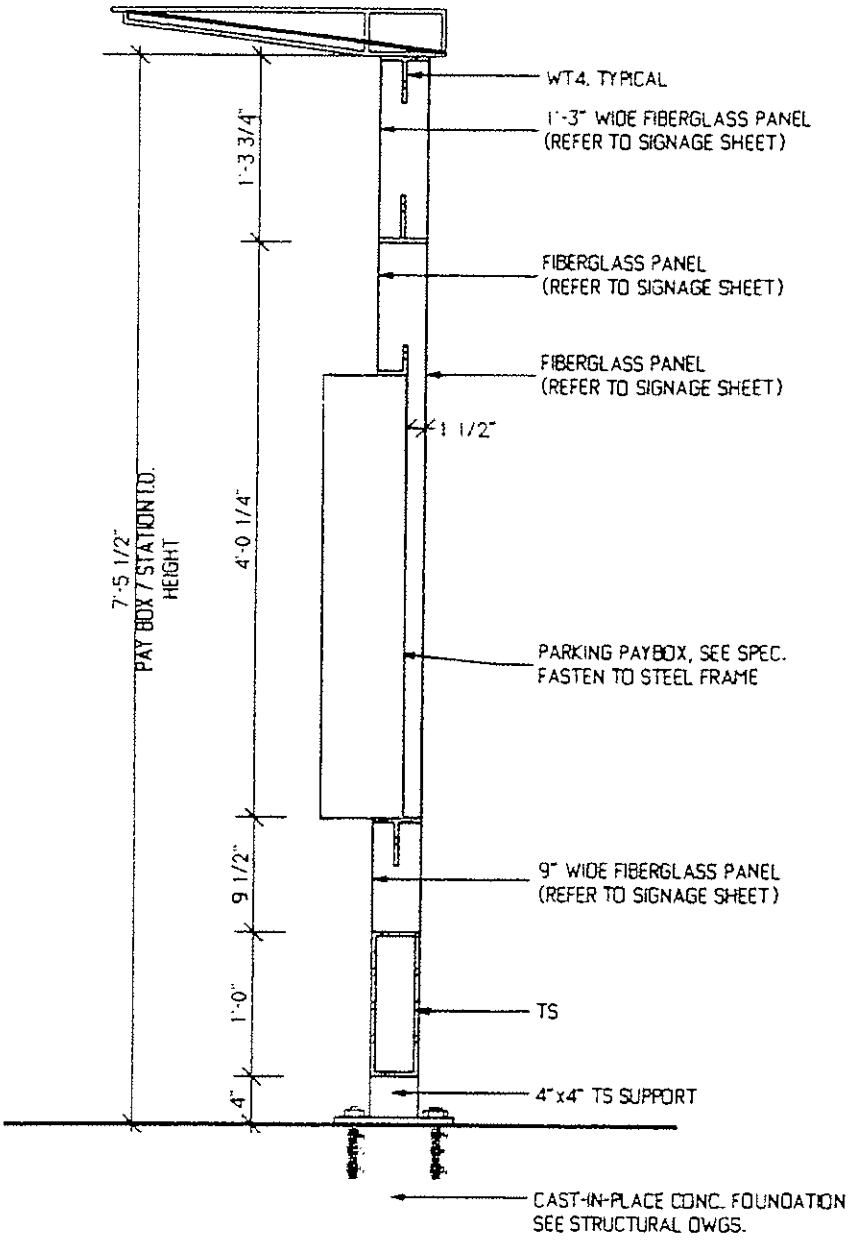
Parking Space Numbering For Fee Collection



Example of Space Numbering



Elevation of Cash Box Panel



IV. REFERENCE STANDARDS

Consult the following reference standards for more information:

- Architectural Graphic Standards, by Ramsey and Sleeper, Edited by the American Institute of Architects, Published by John Wiley and Sons.
- Handbook of Landscape Architectural Construction
- Mass D.P.W. Standard Specifications for Highways and Bridges (1988 Ed.)
- MBTA Guide to Access
- MBTA Standard Specifications
- A Policy on the Geometric Design of Highways and Streets, Published by the American Association of State Highway and Transportation Officials.

V. PREFERRED MATERIALS

A. Paving Materials

Material	Comments
Bituminous	The Authority prefers to use bituminous Concrete to pave parking lots because it is durable, inexpensive, and easily repaired. See details Mass DPW Standard Specifications for Highways and Bridges.

B. Curbing Materials

Material	Comments
Granite	The Authority prefers to use granite curbing in parking lots because it resists damage from salt and snowplows.
Bit. Conc. Swales	Used to channel runoff to a catch basin when a more substantial curb is not required; formed integrally with paving. Often used in combination with guard rail.

C. Barriers

Material	Comments
Vehicular Guard Rail	Used to confine vehicular traffic to designated areas. May be either galvanized steel highway guardrail or heavy duty steel

	pipe rail. See Mass DPW Standard Specifications for Highways and Bridges.
Bollards	Used to confine vehicular traffic while allowing pedestrians to pass through. Use concrete-filled galvanized steel pipe. Height varies: 2'-0" when used with a curb 2'-6" when used to define the edge of a parking area 4'-0" when used as a barrier (e.g. to close off a road)
Fencing	Used to limit access to a restricted area for security reasons, or to channel pedestrian traffic. Typically galvanized steel wire mesh. MBTA Standard Specifications.
Pipe Rail/Guardrail	Used to channel pedestrian flows and to minimize the possibility of an accidental fall from an elevated walking surface. Consult section on pedestrian guardrail for design criteria.

D. Striping Materials

Material	Comments
Roadway Marking Paint	Use roadway marking paint within the station to delineate traffic lanes, parking spaces, parking space numbers, crosswalks, etc. See Mass DPW Standard Specifications for Highways and Bridges.

I. INTRODUCTION

This section establishes design objectives, guidelines, and design criteria for the construction of new shelters and platforms at commuter rail stations. Both high and low level platforms are discussed.

The objectives and guidelines presented below are a response to user needs and to the practical operating and maintenance requirements of the Authority. Surveys have indicated that shelter is the most important feature of a station to the commuter rail user.

II. DESIGN OBJECTIVES

Comfort, safety, efficiency, and durability are the principal objectives to be considered in the design of platforms and shelters at commuter rail stations. The station shelters function primarily as a protection from the elements. However, they should be designed to include good lighting, visibility from both the inside and out, as well as multiple means of egress to enhance the users sense of safety. These objectives should also address specific issues of maintenance and snow removal.

III. DESIGN GUIDELINES

A. PLATFORMS

1. LOCATION

   a. All commuter rail stations should have a paved platform(s).

   b. A major consideration in determining platform location is achieving maximum visibility of the platform from the surrounding area for security reasons. Access should be as direct as possible from the surrounding area and parking lot.

   c. Platforms should be located to avoid conditions where a stopped train or a grade crossing gate will back-up local traffic on the crossing street (see illustration). The preferred platform arrangement at stations adjacent to grade crossings is a split configuration in which trains pull beyond the grade crossing far enough to clear the crossing signal circuit. Where this arrangement is not feasible, the preferred alternative is a configuration locating both platforms on the outbound side of the crossing. This arrangement clears the crossing during the evening period when traffic is typically heaviest.

   d. Locate platforms so that trains held at interlocking signals can load/unload.

   e. An important consideration in the location of platforms is the topography and access for maintenance and snow removal equipment.

It is not desirable to locate platforms where the right-of-way topography is severe, since this will require the construction of retaining walls that will increase the cost per linear foot of the platform.

2. SAFETY

   a. Platforms should have adequate space for passengers gathering on the platform and waiting in line to board the train during peak times.

   b. Platform areas should be well lighted and drained and should have a slip-resistant surface.

   c. The track side edge of the platform must have a tactile warning strip.

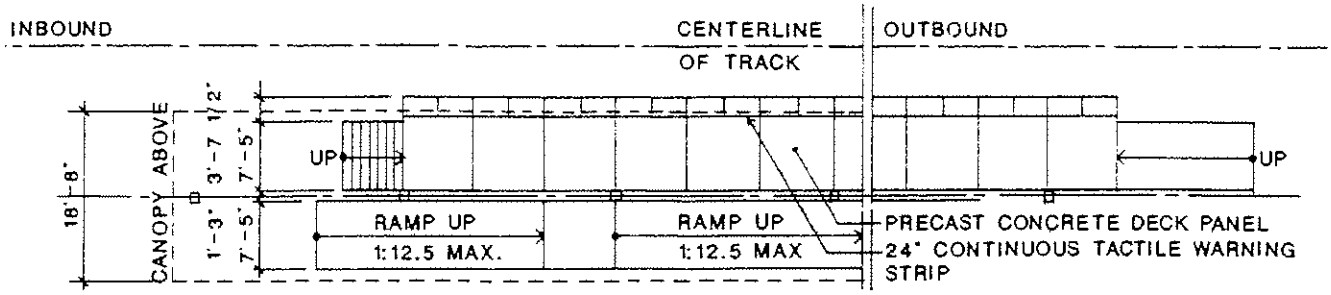
   d. Minimize the number of obstructions on the platform to insure maximum visibility of the platform by the train crew, as well as to insure good pedestrian flow and access of maintenance vehicles.

3. EFFICIENCY

   a. Access to platforms should be highly visible and direct from drop-off/pick-up points and pedestrian walkways.

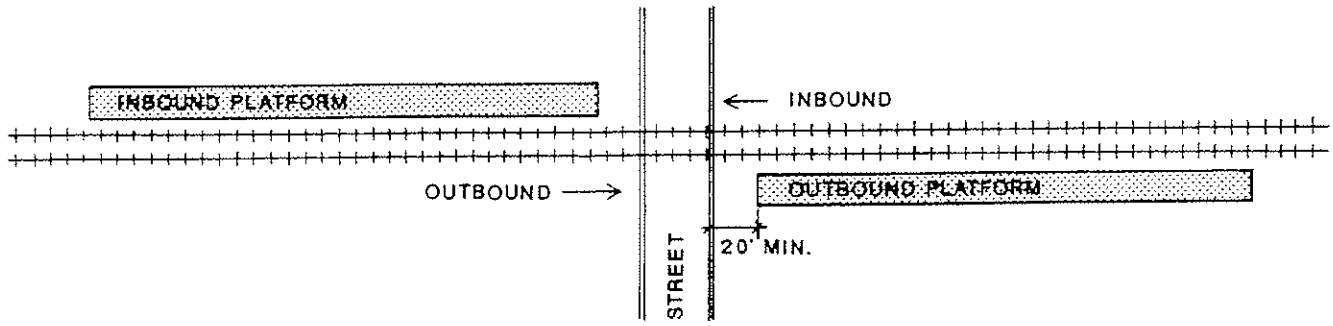
   b. Platforms should be free of columns, utility poles, and other objects impeding free pedestrian flow.

Platform Location Diagram

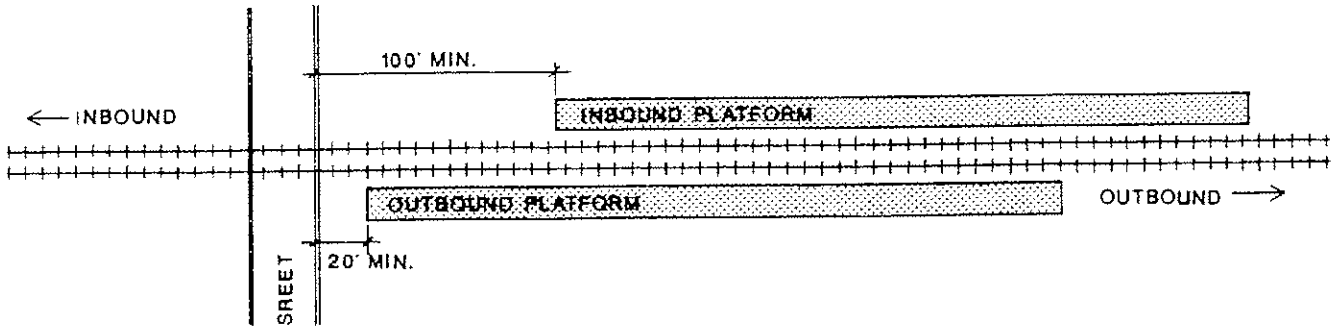


Note: Coordination of track alignment and profile with the precast concrete station platform is critical! Track alignment and profile must be surveyed and verified by Massachusetts licensed surveyor.

Preferred Arrangement of Platforms at Grade Crossing



Alternative Arrangement of Platforms at Grade Crossing



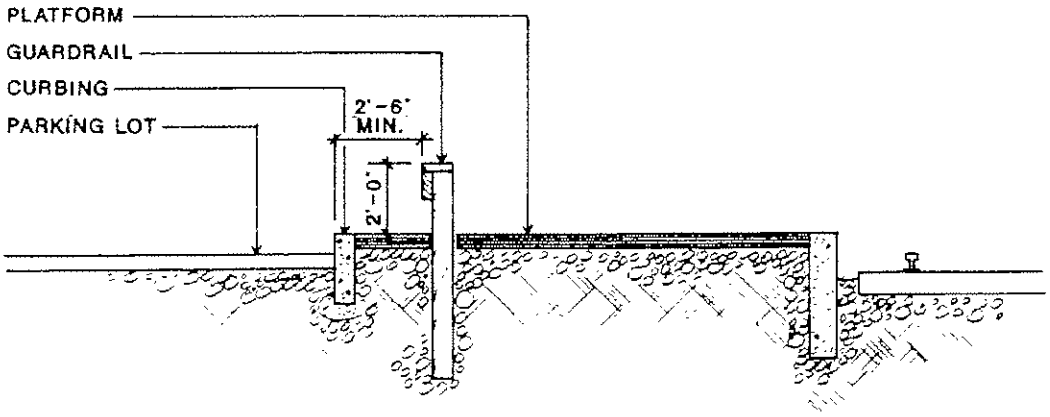
4. USE OF BARRIERS

a. Provide barriers along the back face of a platform under the following conditions:

- Where there is a sharp drop in elevation exceeding 2'-0".
- Where active freight tracks are located behind the platform. Random pedestrian crossing of these tracks is a potential safety hazard that can be minimized trough the use of a barrier that channels pedestrian movements to specific points.
- Where a parking lot abuts the platform. Under this condition the barrier serves as a primary or secondary deterrent to vehicle access to the platform. When a barrier system such as a guard rail is used in this situation it may also double as a sitting area for waiting passengers, as the accompanying detail illustrates.

b. Typical barrier systems that might be used along the back face of a platform include pipe rail, guard rail, and wire mesh fencing. The choice of system will depend on factors such as the magnitude of the safety problem (i.e. protecting a person from a ten foot fall or it may simply be a reminder to cross tracks at a specified location) and specific project funding limitations.

Detail of Barrier System Limiting Vehicle Access to Platform Area



B. SHELTERS

1. GENERAL

   a. Canopy structures should provide overhead and wind protection along portions of the platform(s). When combined with a vertical windscreen panel, the canopy provides the user a moderate amount of protection from rain, snow, and wind. At the same time, it is a relatively economical and low-maintenance form of shelter.

   b. It is not economically feasible to provide heat in this type of open-air shelter.

2. LOCATION

   a. New shelters should be located on or adjacent to the platform in areas that are the most visible from adjacent streets and neighborhoods. For low level platforms, canopies must be provided for the protection of access paltforms and ramps. Generally a second canopy should be provided at a central location on the low platform. High level platforms may only require a single shelter, however the location(s) must provide for the protection of any access ramp(s) serving the platform(s).

   b. New shelters should also be located on the most directly accessible route from the site entrance(s) to the platform when this location does not conflict with the high visibility guidelines described above.

   c. New shelters should be designed and located in a manner that does not obstruct the visibility of the conductors in the approaching trains.

3. CONVENIENCES

   A detailed description of the types of conveniences that should be provided appears in the Comforts and Conveniences chapter.

4. LIGHTING

   Lighting design guidelines for buildings and canopies are presented in the Lighting chapter of this manual.

C. ACCESSIBILITY FOR SHELTERS AND PLATFORMS

1. All shelters and platforms should be readily accessible via primary site entrance/exit.

2. Persons with disabilities must have full access to all shelters and platforms, as specified in the Rules and Regulations of the

Massachusetts Architectural Access Board, Americans with Disabilities Act Access Guidelines, and the MBTA Guide to Access. For 'key' station sites, refer to ADAAG Section 6, the MBTA Guide to Access and consult with the Authority for specific requirements. Some of the requirements pertaining to shelters are summarized below.

a. The approach to the primary entrance/exit of all shelters shall be uninterrupted by steps. If there is a change of elevation, a ramp will be provided in conformance with the ramp design requirements described in the Circulation subsection of this manual.

b. Access should be as direct as possible from the surrounding area and parking lot to platform.

c. New stations shall have full length high level platforms.

IV. DIMENSIONAL GUIDELINES

A. PLATFORMS

1. ELEVATION

a. The standard height of low level platforms is 8" above top of rail on non-super-elevated tracks; the horizontal clearance between the centerline of track and the track-side face of a low-level platform curb shall be 5'-1" on tangent track. Mini-high level platforms are required on the outbound end of low level platforms.

b. The standard height of high level platforms is 4'-0" above top of rail on non-super-elevated tracks; the horizontal clearance between the centerline of track and the track side of a high level platform shall be 5'-7" on tangent track. This horizontal dimension applies only to locations where freight clearance is not a problem.

c. Mini-High level platforms requiring additional freight clearance shall be equipped with a "flip-up" platform edge (Consult the Authority for details of this special edge detail).

2. LENGTH

a. Unless otherwise directed, platforms must accommodate a 9 car train. On low platforms, the access platform (mini-high) is included in the length of the platform.

b. The length of outbound platforms should be equal to the length of the longest train serving the station plus a 20'-0" allowance for a train overshooting or undershooting the platform. The intention is to provide disembarking passengers the opportunity

to exit the train directly from any coach. Typically, trains are 2 to 12 coaches in length. The following formula can be used to calculate outbound platform length:

- Number of coaches on longest train x 85'-0" + 20'-0"= length of platform. (In general, design for 9 cars unless directed otherwise).

c. The length of the inbound platform may be shorter than the longest train. It is standard MBTA practice to run the locomotive always on the "country" or outbound end of the train set. As a result, the engineer on an inbound train in the control cab of the front car of the train set is always blocking passenger access to the front door of the first car. However,the rear door of the first car remains accessible. The inbound platform may therefore be 55'- 0" shorter than the length calculated by the above formula for the outbound platform.

d. The absolute minimum platform length is 2 coach modules + 20'-0" or 190'-0".

3. WIDTH

a. Platforms should be sufficiently wide to comfortably accommodate peak loading requirements. The width is also affected by line, available space, and ridership only at short platforms. Adequate comfort levels for waiting and boarding movements can be achieved at a maximum density of 5 sq. ft. per person. As the following example illustrates, the maximum density level will rarely be approached at commuter rail stations.

- Assume a peak train boarding level of 200 people (about 1/3 system stations average this number or more). At a density of 7 sq. ft. per person, the space requirement is 1,400 sq. ft. Assume an absolute minimum length platform that is 190'-0" long and 10'-0" wide. The effective width of the platform (allowing for 2'-0" safety clearance at the track side face of the platform) will be 8'-0"and the effective area of the platform will be 1,520 sq. ft. or in excess of the 1400 sq. ft. minimum. With platforms generally in the range of 700-800 feet in length, standing/boarding capacity is normally of no concern.

b. The preferred platform width is 12'-0"; 10'-0" is acceptable and 8'-0" is the absolute minimum width.

c. For reasons of economy, long platforms may be tapered at the ends to a minimum width of 8'-0".

d. The preferred island platform width is 22'-0" for a minimum of

1/2 the platform length. Ends of island platforms may taper to a minimum width of 12'-0".

4. GRADIENT

Platforms should comply with accessibility regulations which state that the cross slope (the slope perpendicular to the direction of the tracks) can be a maximum of 2%; or not exceeding 1 ft. of rise for every 50 ft. of run.

5. WARNING STRIPE

All platforms must have a 24" yellow tactile warning strip running the length of the platform to comply with ADA access guidelines. Tactile warning strip should not be installed at low level platform ends.

B. SHELTERS

1. Size

a. The sheltered area at each station should accommodate approximately sixty percent of the passengers boarding at times of peak volume. This figure reflects two considerations: first, that about twenty percent of the passengers either wait in their automobiles or arrive at the last minute and do not use the shelter. Secondly, economic considerations do not allow the Authority to fully accommodate peak period needs.

b. The optimal size of the platform canopy should be determined as follows:

- Assume no shelter is currently at the station.
- Number of passengers using peak volume train = 100.
- Design capacity of shelter = 60 % of 100 = 60
- Net area required = 60x7 sq. ft. = 420 sq. ft.
- Gross area required = 420x1.05 = 447 sq. ft. or approximately 400-450 sq. ft. of shelter.

2. MINIMUM CLEARANCES

a. The preferred minimum horizontal clearance between vertical support for a canopy and the track-side edge of platform is 10'-0". The absolute minimum is 8'-0".

b. The minimum horizontal clearance between a canopy roof overhang and the centerline of any track is 7'-6" (8'- 6" on the Framingham/Worcester Line) except where the canopy is at a height that overhangs operating equipment. The minimum clearance from the track centerline to face of canopy columns, wall, or other obstruction is 15'-1".

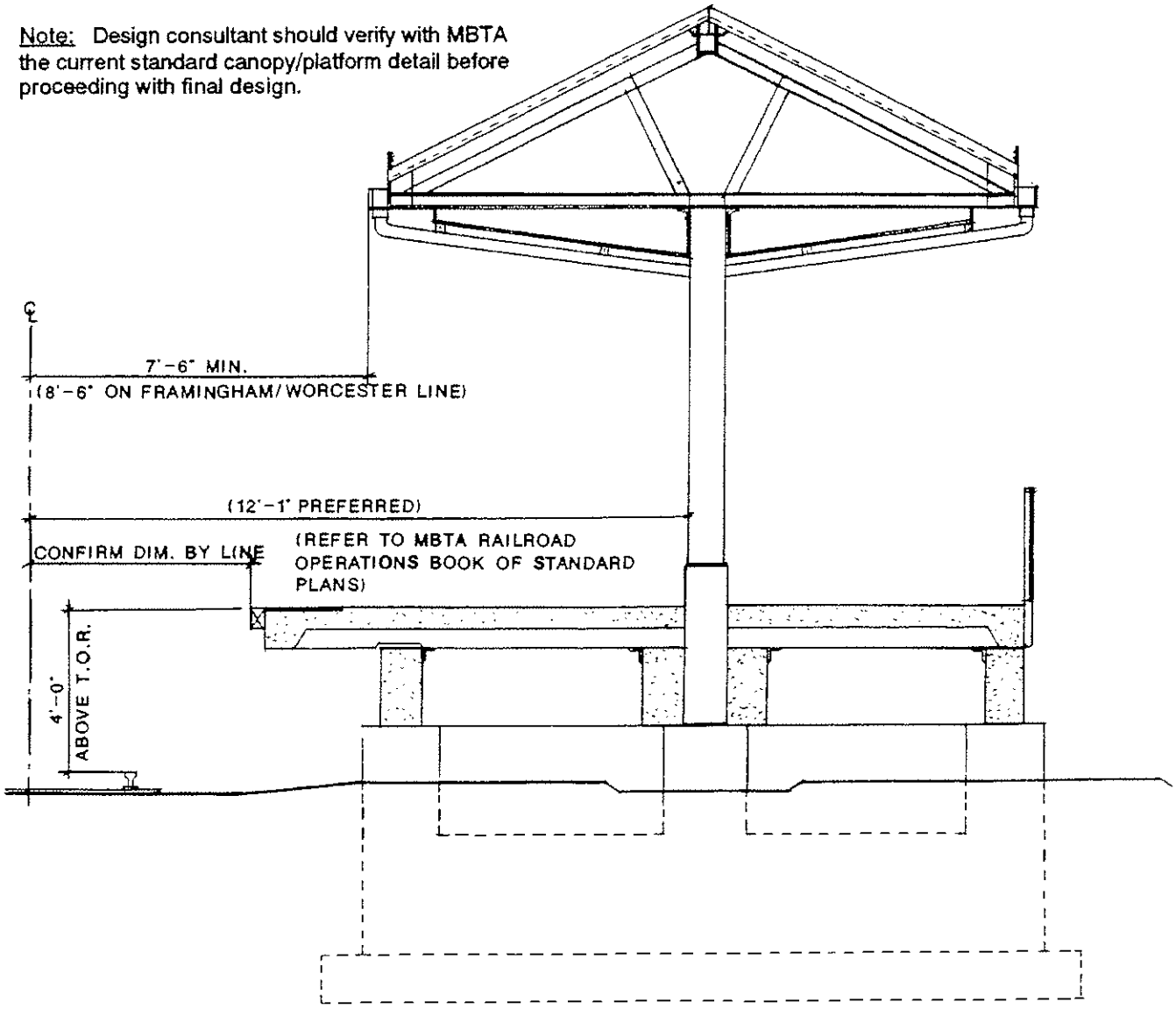
c. The minimum clearance between the floor and the vertical panel in a canopy is 6". This clearance prevents the accumulation of leaves and debris in corners of the canopy.

d. The vertical clearance from the top of rail to the bottom face of the canopy adjacent to track is 12'-1".

e. Refer to MBTA Railroad Operations Book of Standard Plans, Roadway and Track for further clearance information, drawing No. 1013 in particular for station requirements.

Detail of Minimum Shelter Clearances

Note: Design consultant should verify with MBTA the current standard canopy/platform detail before proceeding with final design.



V. DESIGN CRITERIA AND DETAILS

A. PLATFORM

1. PAVING MATERIALS

High level platforms shall be architectural precast concrete. Please refer to structural drawings provided by the Authority for reinforcing, connections, and bearing. Low level platforms are constructed of bituminous concrete with timber or pre-cast concrete curbing. Design and construction of all work shall conform to the following:

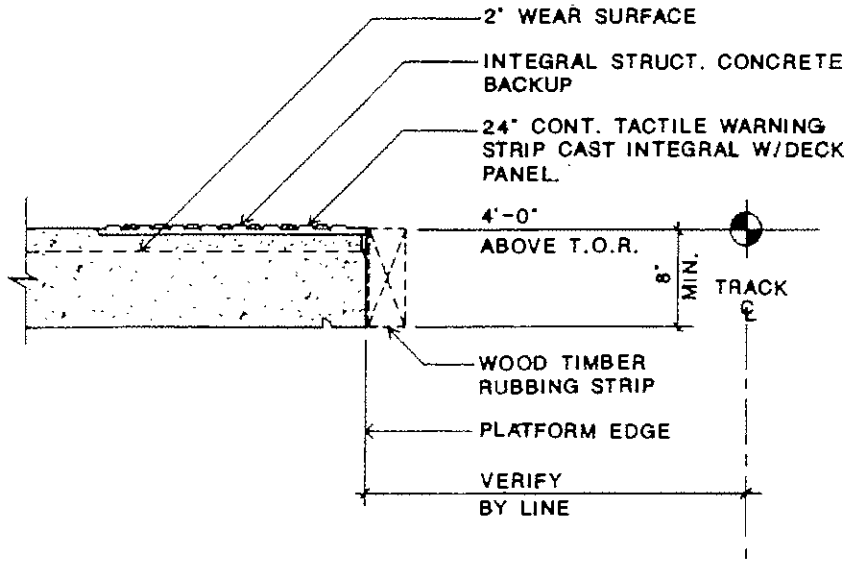
- MBTA Standard specifications including special provisions
- Massachusetts Building Code, 5th edition
- Americans with Disabilities Act Accessibility Guidelines (ADAAG)
- Rules and Regulations of the Architectural Access Board (AAB) of the Commonwealth of Massachusetts

In case of conflict between the codes, standards, regulations, specifications, general notes and/or manufacturer's requirements use the most stringent provisions.

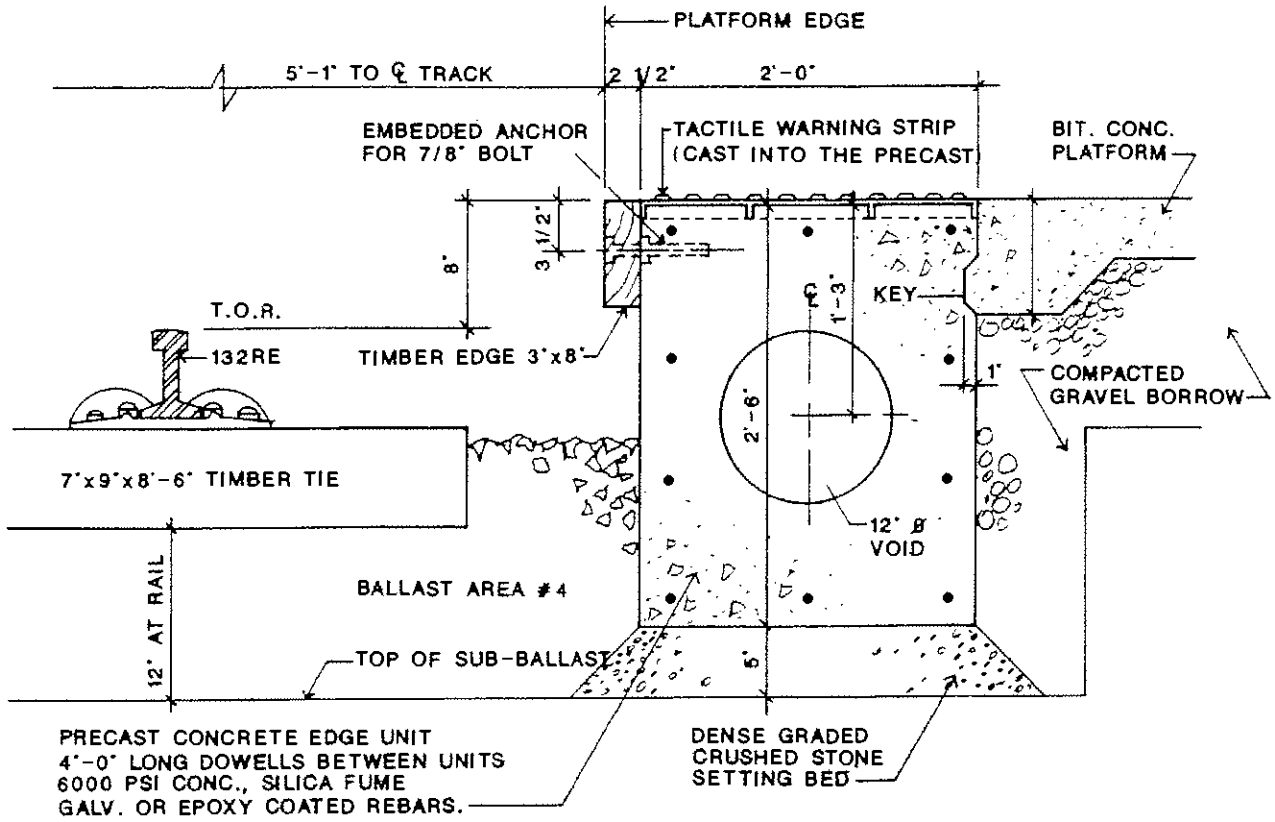
2. PLATFORM CURBING WITH TACTILE WARNING

Platform curbing is essential to the creation of a safe and durable transition between the train and the platform. All platforms must be curbed with a 24" tactile warning strip. See accompanying details for precast and timber curbing

Precast Concrete Edge for Commuter Rail High Platforms



Precast Concrete Edge Unit for Commuter Rail Low Platforms



3. BARRIERS

a. Pipe Rail: should be used to channel pedestrian movements, not as a safety barrier. Typical details are presented in the Circulation chapter.

b. Guard rail: should be either galvanized steel, heavy timber, or either type of rail used in conjunction with concrete posts. Steel guard rail should conform with the MDPW Standard Specifications for Highways and Bridges, Division III, Section M8. Heavy timber guard rail is typically less expensive than galvanized steel and should be of a type similar to that described in the Circulation chapter.

c. Fencing: A wire mesh type of fencing may be used in certain platform locations. Standard Authority details for wire mesh fencing are shown in the Circulation chapter.

B. SHELTERS

The MBTA has established design standards that specify the appropriate materials and types of construction that must be used for shelters. This documentation may be obtained directly from the Authority.

I. INTRODUCTION

This section describes commuter rail station illumination requirements. Station area illumination is a critical factor in the enhancement of the rider's comfort and perception of safety. Therefore, careful consideration to both the quality and quantity of light is necessary.

II. DESIGN OBJECTIVES

Security, visual comfort, compatibility with surrounding uses, efficiency, and attractiveness should be addressed in the design of commuter rail station site lighting.

A. SECURITY

The primary function of lighting is to make the commuter rail station and site safe and secure, as well as visible from surrounding areas.

B. EMPHASIS

Highlighting should be used to emphasize potential hazards, informational signage, and major focal and access points which include:

- Stairs
- Ramps
- Vehicular and pedestrian track crossings
- Platforms
- Pedestrian crosswalks
- Tracks
- Shelters
- Drop-off/pick-up areas
- Building entrances and exits
- Vehicular entrances and exits
- Signage

C. VISUAL COMFORT

To insure visual comfort, station and site lighting should:

- Provide the appropriate level of lighting.
- Provide the appropriate contrast between lighting levels.
- Minimize glare. Light sources should not be located within the normal visual angle of pedestrians or drivers.
- Minimize reflected glare from smooth surfaces, such as signs.

D. COMPATIBILITY WITH SURROUNDING USES

Station and site lighting should not interfere with:

- Adjacent residential neighborhoods
- Train operation and signals
- Operation of vehicles off-site

E. EFFICIENCY

One consideration in the selection of lighting type should be its lifetime cost. This includes the cost of purchase, installation, operation, maintenance, and replacement of lamps and standards.

F. ATTRACTIVENESS

Commuter rail station and site lighting hardware should be:

- Compatible in appearance with the surrounding environment.
- Durable under the following conditions: extreme weather conditions, vandalism, dirt accumulation, and limited maintenance.

III. DESIGN GUIDELINES

A. ILLUMINATION LEVELS

The following illumination levels satisfy the objectives discussed above. However, the designer may deviate from the standards listed below to compensate for specific operating or site conditions.

LOCATION	AVERAGE MAINTAINED FOOTCANDLES
Parking Lots	1-2
Platforms	2-5
Canopies	5-10
Station Buildings	5-10
Shelters	10
Stairs	5-10
Underpasses, Enclosed Overpasses	5-10
Sidewalks and Overpasses	5
Handicap Access Ramps/Parking	5-10

B. OPTICAL CONSIDERATIONS

In the design of station building and site lighting, the contrast between various surfaces within eye contact should be maintained at ratios that will not reduce visual acuity, result in visual discomfort, or cause direct or reflected glare.

1. Contrast Ratios

The ideal contrast ratio between illuminated areas and adjacent or surrounding areas should be limited to 20:1. In no case should it exceed 80:1. The contrast between emphasis lighting and surrounding surfaces should not exceed a ratio of 3:1. The relative levels of luminance of signs and information panels to adjacent and background surfaces should not exceed a ratio of 5:1.

2. Glare

Luminaires should be designed and located to prevent the source's full brightness from being visible to the eye within normal viewing angle as shown in the accompanying illustration.

3. Reflected Glare

The angle of view of a vertical surface should exceed the angle at which light strikes the surface to avoid direct reflections from the source, as the accompanying diagram illustrates.

4. Methods of Control

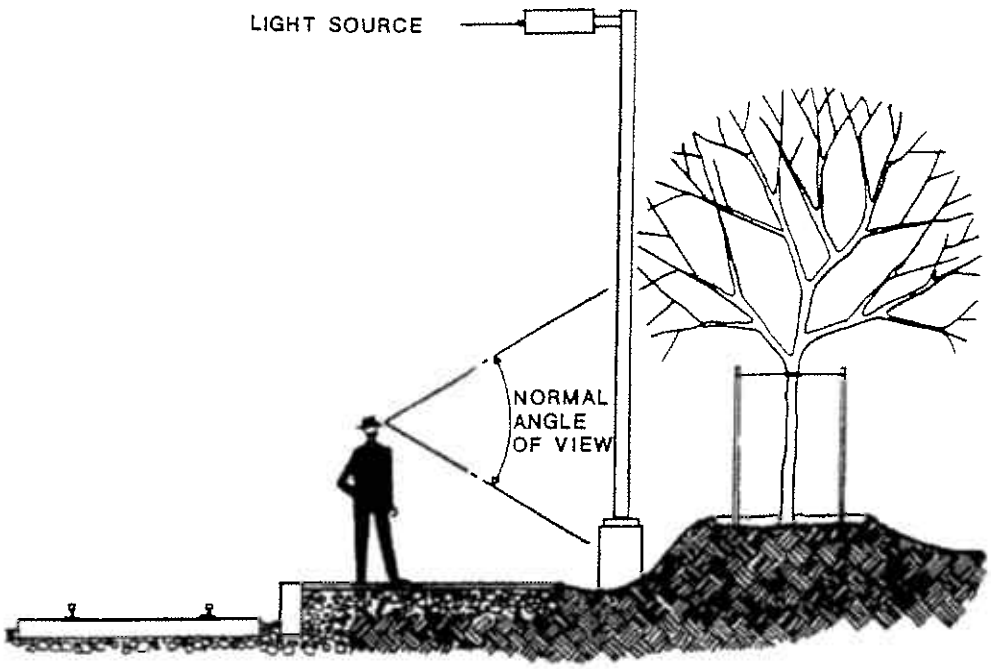
Contrast ratios, glare, and reflected glare can be controlled through use of the following:

- Diffusers to moderate source brightness whenever possible.
- Indirect lighting, such as "wall washing" with light, to control glare and reduce the contrast ratio between a light source and the surrounding environment.
- Parabolic reflectors within light fixtures to control a light source without sacrificing light intensity on the lighted surface. They are especially useful with High Intensity Discharge (HID) lighting near residential neighborhoods.
- Contrast ratios and glare can also be controlled by adjusting the location and intensity of the source.

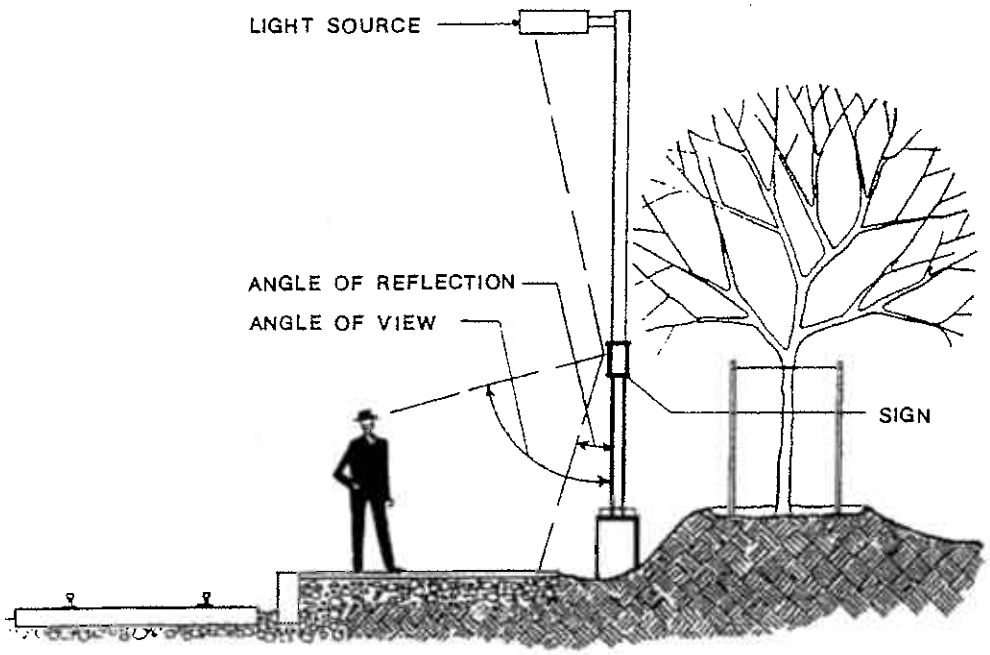
C. EMPHASIS OF HAZARDOUS AND TRANSITION AREAS

Higher levels of light should occur at potential danger or decision areas (stairs, track crossings, street crossings, platform edges, hidden corners, railings, and signage). This illumination should be at least 5-10 average maintained footcandles at the surface being lighted.

Example of Method Minimizing Direct Glare



Minimize Reflected Glare by Insuring That Angle of View Exceeds Angle of Reflection



D. EMERGENCY LIGHTING

Emergency lighting should be limited to the interior of enclosed station buildings and enclosed stairs. The system should have a self-contained battery pack and should be mounted at a height sufficient to prevent vandalism and to provide adequate emergency lighting with a minimum of fixtures.

IV. DESIGN CRITERIA AND DETAILS

A. GENERAL LUMINAIRES SELECTION CRITERIA

Luminaires used at commuter stations should meet the following criteria:

- Function effectively for a minimum of 20 years.
- Resist vandalism, with polycarbonate or high impact acrylic diffusers and vandal-proof access devices such as latches, screws, and locks.
- Minimize maintenance time and costs. Replacement of lamps and ballasts shall be easily accomplished. Lamps and ballasts shall be readily available and standardized to the greatest extent possible. All lenses, diffusers, access devices, and fasteners shall be of the captured type; hinged and removable to provide easy access and prevent loss or damage of parts.
- Contain only non-corrosive materials.
- Function effectively within a -20 to + 110 F ambient temperature range (-28 C to +43 C).
- Provide fixture enclosure that keeps moisture and dust out, but allows heat to dissipate.

B. GENERAL LAMP SELECTION CRITERIA

1. A variety of lamp types is available today. Three factors should be considered in selecting the lamp type.

   - Lumen/watt efficiency of the lamp.
   - Effect of the light source color on the surface color appearance of the surrounding areas and objects.
   - Mounting flexibility.

2. Due to the effect of light source color on surface color appearance, the result of lamp choice on user perception should be considered. A given lamp's lumen/watt efficiency and mounting flexibility should also be considered.

3. The lamp types available are:

   a. High Intensity Discharge

      High Intensity Discharge (HID) is the preferred light source for

commuter rail stations because it is highly energy efficient. HID lamps are point light source, electric discharge lamps requiring ballasts. Starting requires several minutes. The preferred HID lamps are:

- Mercury vapor lamps, which emit a greenish-blue light and cause a perceptible shift in color rendition. They are highly efficient (30-65 lumens/watt) with long rated lives (16,000-24,000 hrs.) and excellent lumen maintenance. Mercury vapor lamps are primarily suited to high bay (over 13'-0" mounting height) applications.

- Metal halide lamps, which produce a white light. Color rendition is as least equal to mercury vapor. Metal halide lamps are smaller in size than mercury vapor lamps, yet produce a substantially greater output of lumens/watt.

- High pressure sodium lamps, which emit a distinctly yellow-orange light and have a very perceptible effect on color rendition. High pressure sodium is the preferred HID lamp because it is the most efficient lamp currently available (approximately 100 lumens/watt). It should be used for lighting large exterior areas such as parking lots and walkways. A typical fixture that might be used in these applications is described in accompanying illustrations.

b. Fluorescent

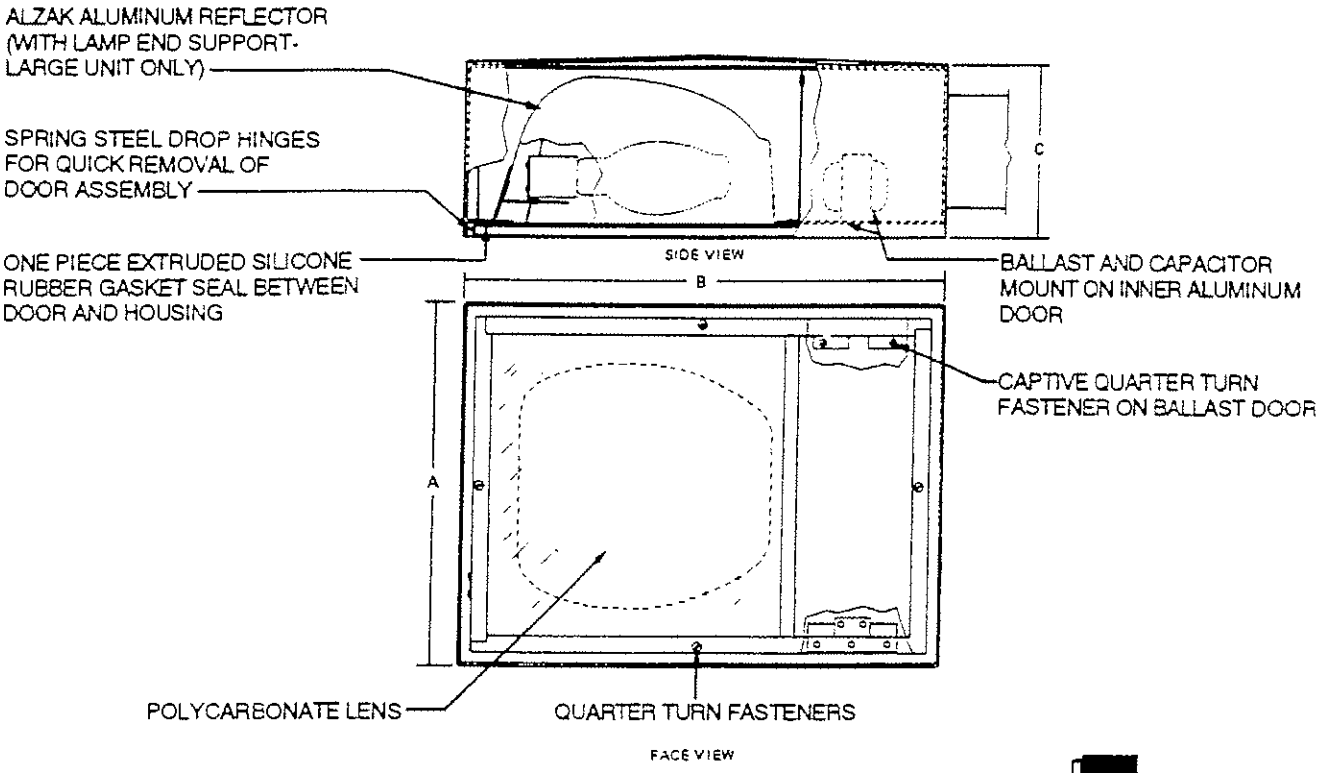
- Available in several colors. Warm white fluorescent lamps produce good color rendition and mix well with incandescent. Cool white lamps tend to dull warm colors and intensify cool colors, but are the most efficient (lumens/watt) fluorescent color. Fluorescent is a linear light source characterized by higher light efficiencies, cooler operating temperatures, and longer life expectancies than incandescent.

- Fluorescent lamps are effective in low and medium level lighting applications due to their efficiency and low source brightness. Fluorescent lamps are appropriate under most interior conditions and preferred over incandescent. They are recommended for lighting under canopies and shelters.

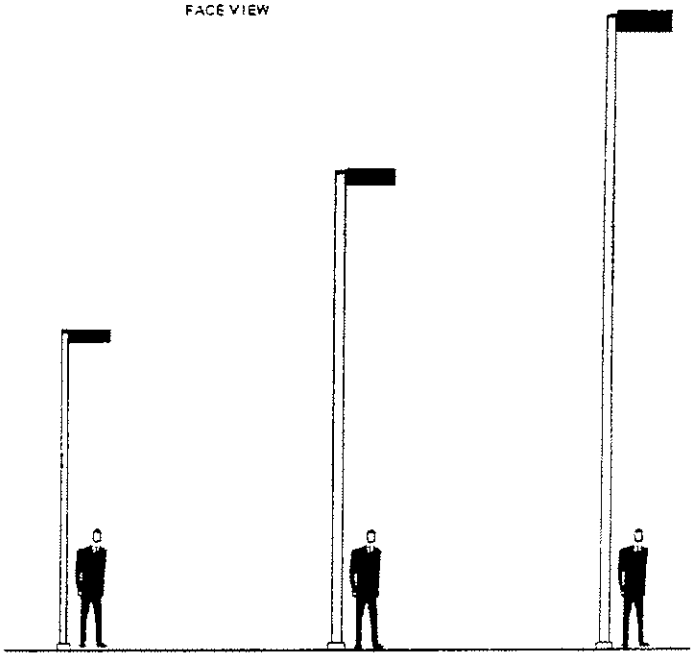
c. Incandescent

- Incandescent lamps are the least efficient light source (lumens/watt) and should not be used.

Fixture Example



EXAMPLE OF FIXTURE APPROPRIATE FOR USE IN PLATFORM, PARKING LOT, AND WALKWAY AREAS: CROUSE-HINDS ASL SERIES OR EQUAL. RIGHT: TYPICAL MOUNTING HEIGHTS FOR FIXTURE OF THIS TYPE. 20'-0" TO 30'-0" POLE LENGTH IS TYPICAL AT COMMUTER RAIL STATIONS.



SMALL UNIT RECOMMENDED MOUNTING HEIGHT 10' - 25'	MEDIUM UNIT RECOMMENDED MOUNTING HEIGHT 20' - 35'	LARGE UNIT RECOMMENDED MOUNTING HEIGHT 25' - 40'

C. WIRING

1. At all sites where regrading or resurfacing is planned, underground wiring shall be used. Underground wiring installed in Fiberglass Reinforced Epoxy (FRE) conduit sized in accordance with then Massachusetts Electrical Code (MEC) is preferred to overhead wiring for reasons of safety, reliability, lower long-term operating cost, and site appearance.

2. Wiring within canopies should be concealed whenever possible.

3. Any exposed wiring must be enclosed in conduit. The conduit should be installed in a manner consistent with the following criteria:

   - Follow architectural structural members, moldings, or ornamental details in as unobtrusive a manner as possible.
   - Match the color of the background on which it is mounted.
   - Resist vandalism with supports at intervals per the MEC within 9'-0" of ground level.

D. CONTROL COMPONENTS

1. Lighting control components at commuter rail stations include outdoor control centers and switches.

2. Outdoor control centers shall be provided at all stations. They shall be weatherproof and contain panelboards, lighting contactors, time clocks, and selector switches.

3. Recommended manufacturers of the control center enclosure are Hoffman Engineering Company, Lee Products Co., Russell L. Stroll, the Harry Richmond Company, or equal.

4. Control equipment utilized in commuter rail station lighting systems include:

   a. Selector Switches

      Selector switches provide control operation in three positions: Hands-Off- Automatic.

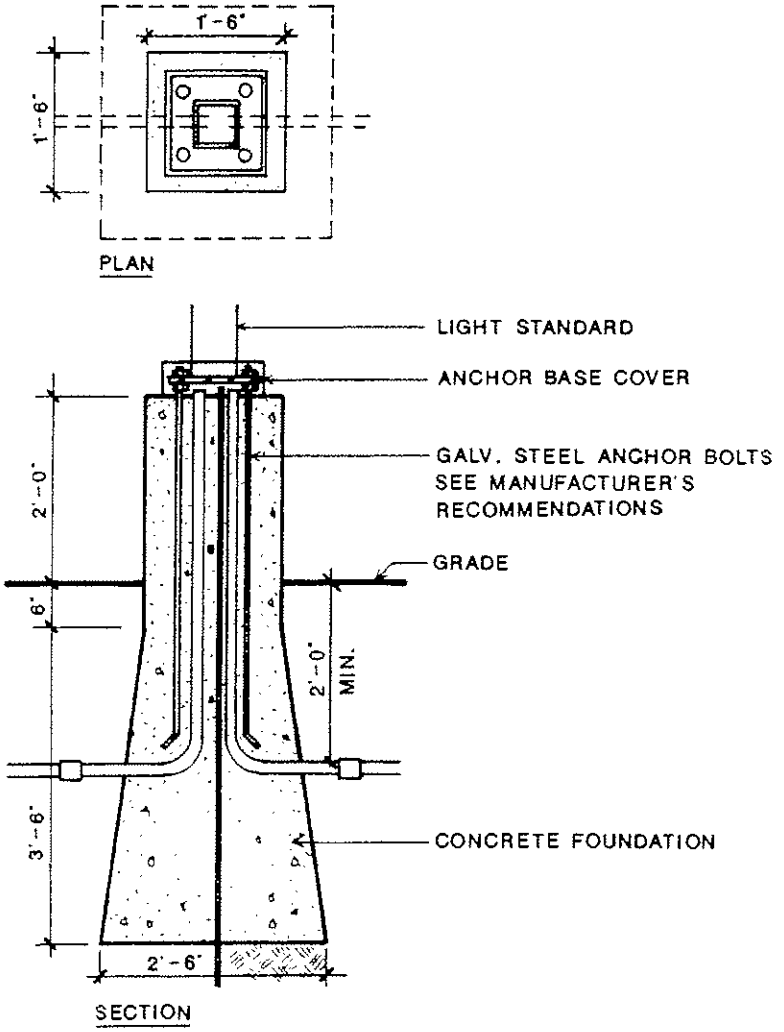
   b. Photoelectric Sensors

      Photoelectric sensors are fully automatic and provide illumination from dusk to dawn. Photoelectric switches are particularly applicable at locations where security and safety is a concern, such as shelters, station buildings, and track crossings.

c. Time Clocks

Time clocks shall be 24 hour and fully automatic and provide light at pre-set hours. Time clock components include such features as a seven day or astronomical dial, manual bypass lever, and sixteen-hour power reserve units. Time clocks are the most appropriate for parking area and platform lights that need not operate during the entire night. Time clocks shall be equipped with mechanically held contacts.

Typical Detail of a Pole Mounted Lighting Fixture Mounted on a 2'-0" High Concrete Pedestal for Protection from Vehicles



E. FIXTURE MOUNTING AND LOCATION

1. The following general fixture mounting criteria apply to commuter rail stations:

   - Minimum clearance between the bottom face of the luminaire and ground level is 9'-0"; the preferred minimum clearance is 11'-0".
   - Placement should be beyond the reach of persons standing on benches, trash receptacles, retaining walls, or other site furniture.

2. Criteria listed below apply to pole-mounted fixtures:

   - Fixture height: minimum of 9'-0" in pedestrian areas (platforms, walkways, etc.), 20'-0" minimum in vehicular areas such as parking lots and roadways; maximum of 30'-0".
   - Number of fixtures per pole : capable of receiving 1,2,3, or 4.
   - Location must be accessible for servicing by a bucket truck.
   - Poles shall be fixed, rather than hinged type base.
   - Do not use aluminum poles. Experience indicates that they break more readily than the steel pole.
   - Poles shall have handholes.
   - Fixture shall have individual cut-off optics.
   - Poles shall be mounted on a base extending a minimum of 2'-0" above finished grade at locations where poles are susceptible to damage by snowplows or other vehicles.
   - Shorter poles (20'-0" long) shall be able to resist damage from "whipping" and other acts of vandalism.

3. Typical pole-mounted fixtures which meet the above criteria include the Crouse Hinds ASL series, Sterner Lighting Systems (Model Type "Executive 25"), Gardco Lighting (Model Type "Form Ten EH"), or equal.

4. Fluorescent fixtures should meet the following criteria:

   - Be available in standard 4'-0" and 8'-0" lengths.
   - Provide single or double lamp capacity.
   - Have a 430 or 800 MA lamp capability.
   - Have a capability for use as a strip or individual fixture.