

## SECTION 5 - STATION DESIGN CRITERIA

5.1.0	GENERAL .....	2
5.1.1	Basic Goals .....	2
5.2.0	SITE PLANNING .....	5
5.2.1	Jurisdictional Codes .....	6
5.2.2	Site Analysis .....	7
5.3.0	CIRCULATION AND SITE REQUIREMENTS.....	8
5.3.1	Modal Interchange .....	8
5.3.2	Access Modes .....	8
5.3.3	Parking .....	11
5.3.4	Emergency Exiting .....	11
5.3.5	Historic Preservation .....	11
5.4.0	PLATFORM ARRANGEMENTS .....	12
5.4.1	Platforms (concourse).....	12
5.5.0	TRANSITION PLAZA .....	13
5.6.0	SHELTERS AND FURNITURE .....	14
5.6.1	Passenger Shelters.....	14
5.6.2	Windscreens .....	15
5.6.3	Furniture.....	15
5.6.4	Service Buildings.....	15
5.6.5	Materials and Finishes .....	16
5.6.6	Performance Standards.....	16

## SECTION 5 - STATION DESIGN CRITERIA

### 5.1.0 GENERAL

These criteria are intended to direct the Design Engineer in the design and preparation of light rail transit (LRT) station contract documents.

These criteria have also been established to enhance the safety and quality of the LRT system, which has a fundamental impact on the ability to attract and sustain patrons.

A LRT station comprises site access, parking (multi-modal access), transition plaza, platform (concourse), tracks and all appurtenances necessary to provide for the public safety, protection from the elements and public information. The station also serves as a gateway in and out of a community as the origin/destination source of passenger traffic.

See figures 5.1 through 5.5 for various platform configurations.

#### **5.1.1 Basic Goals**

The goals for this Design Criteria were derived from a rigorous evaluation and review of the station design for other transit agencies as well as lessons learned through RTD past projects. These goals provide the basis for decisions and will be used to evaluate designs for new and renovated facilities.

The goals are presented in several categories: Inter-Modal Function, Alignment, Architecture, Station and Community Relationship and Basic Design Objectives are applicable to all sections of this section.

##### **5.1.1.1 Inter-Modal Function**

Inter-Modal Functions are defined as bus automobile, bike and pedestrian means of travel to the station.

- Provide a safe, efficient and convenient configuration for inter-modal transfer at the station.
- Provide clear and easily understood transit information that can be referenced quickly and that minimizes disorientation.
- Develop operational efficiencies that simplify modal interchange and passenger processing.
- Minimize congestion and LRT crossings of inter-modal functions.
- Provide the best service possible at a reasonable cost.

### 5.1.1.2 Alignment

- Follow FTA TCRP Report 57, Track Design Handbook for Light Rail Transit, applicable AREMA standards, FRA guidelines for track geometry and Section 4 of this Design Criteria.
- Adhere to AREMA and FRA guidelines for at grade and grade separated LRT crossings.
- Locate stations on horizontal and vertical tangent sections.
- Coordinate track alignment and at grade/grade separated crossings with CDOT and local agencies, i.e. planning departments, traffic and emergency access.

### 5.1.1.3 Architecture

In general, on corridors with existing light rail, the extension design should match the existing architectural elements. On new alignments:

- Create a civic architecture that is permanent, functional and pleasant, has a LRT character and contributes to its context -- one that is not entirely a derivative of the transit system, but of the neighborhoods and community of which it is a part, yet maintains an overall line recognition and system identity.
- Develop a family of station parts and furniture that are interchangeable and allow for the individual character of each neighborhood or community as appropriate.
- Protect transit passenger from adverse weather conditions (snow, rain, wind and summer sun) and vehicular traffic. Provide seating at shelters and other protected locations on the platform.
- All designs must conform to Uniform Building Codes, ANSI 117.1, Americans with Disability Act Accessibility Guidelines for Buildings and Facilities (ADAAG), current editions and other applicable codes.
- Make transit a safe, secure, friendly and enjoyable experience and accessible to all, including the disabled.
- Develop systems that use maintainable materials and minimize life cycle costs.
- Provide an architectural and urban design framework that defines and encourages joint development opportunities.

#### 5.1.1.4 Station

Stations consist of three elements; **platform** (concourse) area where passengers walk to and from the trains and where passengers queue in anticipation of boarding trains. The **transition plaza**, a space necessary to facilitate the movement of patrons from the parking areas or other means of access (modal access) to the platform and from the platform to their modal access. The **multi-modal access** is defined as the choice of transit used by a patron to access the station, i.e. car, bus, bike or walk. The basic design criteria for stations are as follows:

- Meet setback from centerline of track and dynamic envelope requirements for clearances at the platforms.
- Meet requirements of ADA, ADAAG and ANSI 117.1, NFPA 130, and Part IV DOT, 49 CFR Parts 27, 37 and 38.
- Adhere to FRA AREMA and TCRP Report 57 governing railroads and RTD guidelines for platform safety requirements.
- Minimum platform and transition plaza areas are defined by the crush load of the train consist x2 x5 sf. Length of the platform is determined by the length of the train consist plus 50 feet of tangent section at each end.
- Coordinate platform and transition plaza with bus, kiss-n-ride, park-n-ride, pedestrian and bike access.
- The transition plaza is a space described as an area necessary to facilitate the movement of patrons from the parking areas or other means of access to the platform. The transition plaza is where patrons can obtain, tickets, view public information systems and wait for pick-up. In many instances the transition plaza also acts as a side loading platform, and should be held to the same clearance and lighting requirements as a platform.
- Coordinate platform and transition plaza design with neighboring community. Community involvement is necessary to establish a sense of place of the station in the community and to develop a design for shelters, windscreens and other elements. As a part of the community development, RTD, its design team and community planners could facilitate a plan to develop transit-oriented development (TOD) adjacent to the mass transit site. This is only viable if, the governing body has zoning ordinances in place that allow a mixed use TOD to occur. TOD however needs to occur with a balance toward providing a convenient and pleasant experience for the

transit user as well as providing opportunities for mixed use development.

#### **5.1.1.5 Community Relationship**

- Protect, maintain and enhance existing qualities which are valued.
- Promote desirable TOD.
- Recognize emerging development that can compliment station development and increase ridership.
- Initiate and coordinate programs with the community that limit local traffic impacts and minimize disruption during and after the implementation phase.
- Utilize local jurisdictional processes and agencies throughout project design and implementation.
- Implement an Art-at-the-Station program to instill a sense of ownership by the community and a sense of “place” for the station in the community and as a recognizable feature along the corridor.

### **5.2.0 SITE PLANNING**

The purpose of this section is to describe the system-wide design philosophy for station layout and related site development. The facilities to be designed shall address the following:

- Rail track way – use existing commercial railroad ROW or public ROW where possible. Keep consistent with system goals and objectives.
- Rail platforms – develop on tangent sections of track, linear progression from train to platform to transition plaza to multi-modal means of station access.
- Bus and auto roadways – primary multi-modal means of accessing station. Coordinate with local traffic patterns and segregate from secondary multi-modal means of access. It is also necessary to separate bus and automobile traffic, particularly as they enter and exit the park and ride and move through the park and ride.
- Pedestrian walkways – coordinate with local jurisdictions for connections to existing or planned pedestrian access ways; segregate from motorized vehicles.
- Bicycle paths – coordinate with local jurisdictions for connection to existing and proposed bicycle access ways, segregate from motorized vehicles. Bicycle paths shall not cross platforms at grade and shall be separated from platforms with a barrier when parallel.
- Auto and taxi drop off and waiting zones - Coordinate through RTD Design Guidelines and Criteria for Bus Transit Facilities.
- Parking lots/structures – elements that are determined by ridership and available land use and ownership. RTD Design Guidelines and Criteria for Bus Transit

Facilities shall be used as a reference for the overall design. Coordinate through local jurisdiction for parking lot requirements.

- Shelters – passenger shelters shall be designed to reflect the context of the overall urban design of the corridor and the neighborhoods that are adjacent to the station. Bus shelters shall be a standard design shelter provided by RTD.
- Landscaping – is used to enhance the overall aesthetic value of the station. Landscaping can be used to define the boundary from multi-modal access to the transition plaza and from the transition plaza to the platform. Landscaping shall not impede visibility of the platform areas or create hiding spaces or security barriers. At the transition plaza landscaping can be used to define edges, direct pedestrian traffic, provide shade and separate the transition plaza from the platform. Generally landscaping shall not be included on the platform (concourse).
- Elevators, escalators, ramps and stairs – Site selection should serve to eliminate the need for vertical circulation. In cases where this is not possible, follow local jurisdictional agencies regulations, RTD standards and practices, building codes; IBC, UBC, ADA, ADAAG, ANSI 117.1, NFPA 130, 101 and other applicable codes and standards. At a minimum elevator shafts and cars shall have three sides that are transparent the full length of travel and full height of the car.
- Site Furnishings - Bicycle lockers/racks, benches, blast resistant trash receptacles, fare collection equipment, newspaper racks, etc. shall be standardized for each corridor to provide a uniform appearance and for ease of maintenance and replacement. Bicycle lockers, news racks, trash receptacles and other publicly accessible receptacles shall meet the security requirements in section 14.15 Publicly Accessible Receptacles.
- Driver Relief Station (restrooms) – drivers restroom facilities shall be located in an area that is both convenient for the train operators and the bus operators. These facilities are not open to the general public. Buildings shall be constructed of durable materials with a low possibility of replacement needs. Building design shall follow standard layout for restroom facilities in RTD Standard Plans. End of the line facility shall be large Driver Relief Stations as shown in the Standard Plans. All facilities shall utilize approved card reader system for access.
- Signage – review RTD’s Rail System Signage Standards.

These elements are to be located at each station site in a manner that is functional, safe, easily maintained and attractive to passengers and neighboring residents.

### **5.2.1 Jurisdictional Codes**

The nature of LRT causes its alignment to travel through numerous districts, cities, and counties. Each of these legally defined areas has different land use and development regulations and legislative procedures directly affecting station site planning and design. Each individual jurisdiction may have special amendments or supplements to codes and standards that apply on a statewide and national basis. Therefore:

- Identify the governing jurisdiction for each site at every governmental level.
- Locate jurisdictional boundaries.
- Review applicable adopted master plans and municipal codes.
- Use the latest edition of the following:
  - International Building Code
  - Uniform Building Code
  - Fire protection codes
  - State of Colorado "Building Regulations for Protection from Fire and Panic."
  - Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG)
  - Americans with Disabilities Act Accessibility Guidelines for Transportation Vehicles
  - "Standards for Accessible Transportation Facilities",
    - ANSI 117.1
    - ADAAG
    - NFPA 130 101
    - AREMA
    - FTA
  - Rail Agency requirements when applicable.

In general, station facilities should be designed to meet all requirements of all applicable federal, state, and local codes and regulations. Codes shall be analyzed with regard to this Criteria Manual, the governing jurisdictions interpretation and the code that provides the most stringent application for the public good.

### 5.2.2 Site Analysis

Site analysis is the process in which the characteristics of a potential station site are gathered together. Typical physical characteristics to be evaluated are:

- General circulation and access
- Context
  - Views to and from the site
  - Weather conditions
  - Topography
  - Existing infrastructure and building improvements
  - Land use
  - Existing vegetation
  - Drainage
  - Solar orientation
  - Traffic counts
- Soils information
- Existing utilities

### **5.3.0 CIRCULATION AND SITE REQUIREMENTS**

Each mode of transportation has specific circulation and operational requirements. While each mode has its own unique characteristics, it is recognized that all modes must respect and enhance the operation and access of other modes that interface in and around rail transit facilities.

Underlying site requirements that support transit such as parking, furnishings, operating equipment, shelters, and landscaping provide convenience, comfort, accessibility and an enhanced quality of life for transit passengers and employees.

Performance standards based on design objectives shall be the basis for all design decisions. They provide the fundamental framework for resolving the inter-relationship between each of the station activities and the means for minimizing conflicts and maximizing efficiency.

Above is a broad description of circulation and site requirements, it and the following descriptions need to be developed with the use of the RTD Design Guidelines and Criteria for Bus Transit Facilities

#### **5.3.1 Modal Interchange**

Modes are the means that passengers and employees access LRT stations. Typical access modes considered in these criteria are:

- Light Rail Transit (LRT)
- Bus
- Walk
- Bike
- Automobile
- Commuter Rail

There are distinct differences between each mode in terms of maneuverability, safety, speed, visibility, space requirements, compatibility, and reliability. The following describes the basic characteristics for each mode.

#### **5.3.2 Access Modes**

LRT is a more predictable and confined form of transit in that it operates within a semi-exclusive ROW.

Passengers tend to arrive at or near the scheduled LRT departure time and do not spend a lot of time waiting. Therefore, modal interchange becomes a key consideration in station design.

### **5.3.2.1 Bus Access**

The bus system will be integrated with LRT and provide feeder routes to station facilities. Where applicable, there will be a hierarchy of vehicular modes of access, giving priority to feeder buses. The following are general criteria that will help guide the site planning process:

- Buses should be able to get as close to LRT transition plazas as possible with a maximum walking distance of 400 feet to the platform.
- Eliminate situations where buses are required to cross LRT tracks.
- Make provisions to provide emergency bus service in the event of an LRT system failure.
- Bus and automobile access should be separated wherever possible.
- Minimize conflicts between buses, trains, automobiles, bicycles and pedestrians.

### **5.3.2.2 Walk Access**

Good pedestrian circulation to, from, and across train platforms is essential for the smooth and safe operation of stations. Circulation patterns should be as simple, obvious, and comfortable as possible. Some of the points that warrant careful review for applicability and consideration in achieving good pedestrian orientation and circulation follow:

- Avoid unnecessary turns and dead ends.
- Pedestrian access from bus, kiss-and-ride and park-and ride areas must be as clear and as simple as possible.
- Circulation elements shall use color, texture and sight distances to increase visual pleasure, guidance, patron safety and security.
- Provide adequate space to avoid bottlenecks.
- Avoid cross-circulation at fare collection and decision points. Generally provide right-hand circulation.
- Provide well lit pedestrian walkways.
- Provide a minimum of 7' wide of clear space where possible between the edge of the platform and obstructions such as stairs, escalators, railings or columns.
- Provide adequate space so that queues at fare collection areas do not block traffic.

- Provide separate facilities, where feasible, for entering and leaving the station.
- Locate passageways, shelters and stairways to encourage balanced train loading and unloading. Passengers tend to board at such connection points on the platform.
- Provide ramps and elevators as required for disabled patrons. Walkway, highblock and structural access ramps shall not exceed 4.75%.
- Grade changes are to be minimized, and where necessary they shall conform to slope criteria for disabled access.
- Cross flows, dead ends, and turns greater than 90 degrees are undesirable for both patron security and circulation.
- Circulation shall be designed to provide ample space adjacent to, but out of the mainstream of, pedestrian flow. This will accommodate for disabled, infrequent or waiting patrons.
- Surge and queuing spaces shall be provided ahead of every barrier and change in circulation, direction, or mode.
- Obstructions such as telephone booths, pylons, advertising displays, coin changers, concessions, seating or maps are not allowed within the pedestrian through zone.
- Shelter elements shall have sufficient transparency to provide adequate visual surveillance of the station area to discourage vandalism and enhance patron safety.
- Provide adequate sight distance and visibility along pedestrian routes.
- Provide track crossing clear of four car train for pedestrians to clear center platform.
- Provide a minimum of two points of access/egress from the platform that meet the requirements of NFPA 130.

### **5.3.1.3 Bike Access**

Those passengers arriving by bicycle shall be accommodated in the safest and most inviting manner possible. Except at the downtown Denver stations, space shall be provided for racks for at least 10 bicycles if possible at every station. These facilities shall be located to minimize conflicts with pedestrian and vehicular traffic, make the most effective use of roadways and curb cuts, and reduce the need for special graphics. To promote security, bicycle storage areas should be visible from the street or station entrance. Where possible, bike racks and lockers should be located on the transition plaza and segregated from large group gathering areas. No bike racks or lockers are to be located on the platform (concourse).

#### **5.3.1.4 Auto Access**

Auto access shall be provided in a manner that meets all state and local codes and does not interfere with access modes of higher priority.

#### **5.3.3 Parking**

Reference the RTD Design Guidelines and Criteria for Bus Transit Facilities

#### **5.3.4 Emergency Exiting**

Design Objectives

- Any fully loaded station platform shall be able to be evacuated in accordance with NFPA 130.
- Provide not less than two exits from any station area or platform.

#### **5.3.5 Historic Preservation**

At the beginning of the station siting process, potential applicability of requirements of the Historic Preservation Act and Section 4(f) of the Transportation Act of 1966 should be addressed.

Where LRT stations may affect historical areas or structures, potential impact zones should be identified. These would include areas where station placement would block views or interfere with pedestrian circulation and access.

If joint use were to be planned, the Design Team should develop a design program which identifies those agencies or citizen groups which are likely to be involved and the procedure to be followed for approach of design. The program should also identify significant architectural features which should be taken into account in station and site design.

If a portion of a historic structure is to be retrofitted to accommodate an LRT station, security and safety features necessary to preserve the significant historic characteristics of the structure should be incorporated into the station design. Approval from SHPO is required.

## **5.4.0 PLATFORM ARRANGEMENTS**

Three alternative platform arrangements for on-line stations exist as follows:

- Side Platforms - Side platforms are located directly opposite one another, each servicing one mainline track.
- Center Platform - Single platform to service tracks located on each side of the platform.
- Side Center Platform – Side platform located on one side only and a center platform to service the other tracks.

The center platform arrangement offers the most efficient use of platform space and furnishings.

### **5.4.1 Platforms (concourse)**

The following presents fundamental criteria that are intended to produce efficient and passenger-sensitive platforms.

- All platforms shall be designed to conform with the ADAAG, including detectable warning strips on platform edges.
- Platform length for both center and side platforms shall accommodate a four-car train and have a minimum length clear of approach ramps of 360 ft., unless approved otherwise by RTD.
- The nominal horizontal gap between the platform edge and the edge of vehicle floor shall be 6 inches. On tangent tracks, the platform edge is located 55 inches from track center line with a tolerance of +0.50 inches vertically and 0.0 inches horizontally.
- The platform height at the edge of platform face shall be 6 inches above the top-of-rail profile. When stations are located on or within streets or existing sidewalks, consider the crown of the street when calculating the platform height.
- Minimum platform width for side platforms shall be 12 feet with 21 feet preferred.
- Minimum width for center platforms shall be 16 feet with 21 feet preferred.
- Platforms must be located on tangent tracks.
- Cross slopes shall not exceed 2% with a minimum of 1% and the maximum longitudinal slope shall be no more than 1% unless approved by RTD in writing.
- Mechanical and electrical equipment shall be placed in vertical surfaces, rooms or underground to reduce obstructions. Consider maintenance implications for each piece of equipment prior to underground placement.
- Provide clear emergency exiting from platforms.

- Concentrate fixed objects such as furniture, signage, shelters, etc. within a furniture zone while maintaining adequate distance between elements for circulation. Keep as much of the platform clear of fixed elements as possible.
- The track area between platforms shall be covered or paved at designated pedestrian crossings only.
- Platforms and station exits shall be sized and located to accommodate the estimated or expected volume of passengers as defined by NFPA 130 Occupant Load.
- Exits shall provide safe exiting from trains and platforms under normal operational and emergency conditions. Platforms and exits shall be sized to allow passengers to completely clear the platform prior to the arrival of the next train.
- Secondary access or exit points should be provided, make them visible, inviting and safe.
- Barriers should not trap anyone between the LRV or vehicular traffic.
- Where possible, provide clear and unobstructed diagonal pedestrian access across platforms wherever modal interchange occurs.
- Platforms shall be provided with a source of water for cleaning and maintenance purposes.
- Any electronic passenger information systems such as variable message signs shall be located to maximize visibility to passengers while minimizing obstructions.

### **5.5.0 TRANSITION PLAZA**

The transition plaza is a space described as an area necessary to facilitate the movement of patrons from their multi-modal access to the platform. The transition plaza is where patrons can obtain tickets, view public information systems and wait to be picked up.

The following are basic design criteria;

- Design to conform to ADAAG standards and code requirements (see subsection 5.2.1)
- Provide easy access to Ticket Vending Machines (TVM), stand alone validating machines (SAV), information technology and public communication systems without impeding the flow of patrons to the platform.
- TVM, SAV and information systems and other furnishings must be located adjacent to the line of travel without impeding the pedestrian flow. All vending machines must be oriented away from direct sunlight.
- Preferably vertical circulation needed to reach the platform shall be constructed on the edge of the transition plaza and the platform. When ROW and site design constraints cause vertical circulation elements to be placed on the platform, the design should follow ADAAG requirements for minimum circulation space.

- Existing requirements from the plaza are the same as the platform; follow NFPA 130 2-5.2 and 2-5.3.

## **5.6.0 SHELTERS AND FURNITURE**

These criteria have been developed as a technical guide to safe and efficient station design while promoting community pride. Stations are the public focus of the rail system in that they are central to modal interchange and serve thousands of passengers on a daily basis. It is key to the operation of the entire transit system that station platforms are easily understood, friendly and efficient for passengers. Station design should not only consider the functional and operational efficiencies, but also integrate humanistic and community spirit into the design.

### **5.6.1 Passenger Shelters**

The following is a list of objectives that LRT, bus, and kiss-and-ride shelters should achieve:

- Provide passengers with comfort and protection from expected adverse weather conditions -- snow, rain, wind and summer sun.
- Provide identity for the station as well as the surrounding area.
- Provide a feeling of security and means of surveillance.
- Help provide adequate lighting.
- Utilize materials and construction practices that minimize maintenance requirements.
- Utilize materials and construction practices that minimize life cycle costs.
- Standardize materials and construction practices.
- Utilize materials and construction practices that are compatible with existing RTD facilities.
- Arrange and articulate shelters to create an enjoyable experience.
- Height of Shelter protective edge should be no greater than 10 feet 4 inches or eave height to match height of window head of passenger car.
- Minimum length of shelter to be 60 feet. Length of dual shelters to be determined by large ridership, local jurisdiction requirements and the potential for a shelter to tie into TOD.
- Width of shelters shall not infringe on the dynamic envelope for the rail cars. A minimum width is 12 feet.
- High block platforms shall be protected by canopy.

### 5.6.2 Windscreens

The following is a list of criteria for windscreens:

- Maximum height 6 feet 8 inches.
- 75% of the surface area must be translucent or transparent.
- Overall width depends on flow of pedestrians and location of the screen.
- Place where most effective in blocking prevailing winds.
- Provide a minimum of one bench on the lee side of the windscreen.
- Comply with ADAAG for access and circulation around the windscreen.

### 5.6.3 Furniture

The following is a list of furniture to be used at the stations:

- Newspaper racks by RAK systems or approved equal. Newspaper racks shall be placed according to security requirements outlined in section 14.15 Publicly Accessible Receptacles.
- Bicycle lockers/racks are not to be placed on the platform, only on the transition plaza or the park-n-ride. Bicycle lockers shall be placed according to security requirements outlined in section 14.15 Publicly Accessible Receptacles.
- Provide a minimum of 4 benches per station.
- Trash receptacles are not to be placed on the platform, only on the transition area away from locations where large groups may gather. Trash receptacles shall be placed according to security requirements outlined in section 14.15 Publicly Accessible Receptacles.
- Reference RTD Facilities Maintenance Design Manual for preferred manufacturer and style.

### 5.6.4 Service Buildings

Service buildings are defined as all structures not open to passengers, but which need to be accessible to RTD employees or contractors. Design of service buildings at stations shall comply with NFPA 130.

- Equipment Rooms - Signal, electrical and communication rooms shall be sized according to the requirement identified by RTD Systems Engineering. Location to be coordinated with Systems Engineering, Operations and the Station Design Team. Equipment rooms shall not be located on station platforms.
- Driver Relief Station - Driver relief stations (DRS) are to be provided at stations where they can be used by both bus and LRT operations. No access will be provided for public use. Generally, driver restrooms

will be located in association with larger park-n-rides or at the end of line stations.

#### **5.6.5 Materials and Finishes**

The quality and character of station materials utilizing simple, durable materials has a direct effect on maintenance requirements and the image of each facility. Simple, durable materials in minimal sizes with long-standing availability, installed to facilitate replacement can diminish damage and maintenance while balancing the character and visual quality of each station. Because vandalism tends to breed upon itself, materials should be used such that repair time is reduced and stations never appear underused or abandoned.

In specifying manufactured items or materials, preference shall be given to standard off-the-shelf items available from more than one supplier over custom-made or single-source items. In specifying finish, size, color, pattern or composition, slight variations in appearance should be allowed so less costly products or materials of equal quality can be utilized.

#### **5.6.6 Performance Standards**

##### **5.6.6.1 Durability**

Durable and cost-effective materials shall be used that have consistent wear, strength and weathering qualities. Materials shall be capable of good appearance throughout their useful life and shall be colorfast.

##### **5.6.6.2 Low Maintenance**

Life cycle maintenance costs should be considered in the evaluation of all materials and finishes.

##### **5.6.6.3 Quality of Appearance**

Materials should be appealing and harmonious in appearance and texture. They should reinforce system continuity while relating to the local context.

##### **5.6.6.4 Cleaning**

Materials that do not soil nor stain easily shall be used and shall have surfaces that are easily cleaned in a single operation. Minor soiling should not be apparent. Commonly used equipment and cleaning agents should be able to be utilized. All porous finishes subject to public contact shall be treated or finished in a manner that allows easy removal of "casual vandalism."

#### **5.6.6.5 Repair or Replacement**

To reduce inventory and maintenance costs, materials shall be standardized as much as possible for easy repair or replacement without undue cost or disruption of LRT operation. For example, hose bibs, electrical outlets, lighting fixtures and lamps, glass or plastic lights, information panels, signs, shelter materials, etc., shall be standardized on commonly available sizes and finishes for easy inventory stocking and installation.

#### **5.6.6.6 Nonslip**

Entrances, stairways, platforms, platform edge strips, and areas around equipment shall be high nonslip properties. Floor finishes shall be nonslip even when wet. This is particularly important at stairs, elevators and other areas near station entrances, as well as platform areas.

#### **5.6.6.7 Corrosion Resistance**

Because of moisture and the electrical currents involved in transit operation, special consideration must be given to prevention of corrosion. Non-corrosive metals shall be utilized when possible or required.

#### **5.6.6.8 Compatibility**

Selected materials shall be compatible with the Denver metropolitan area climate and consistent with existing materials within the station vicinity. Materials for structures should harmonize with existing facilities on a site-specific basis.

#### **5.6.6.9 Availability**

Selection of materials shall permit competitive bidding and emphasize regional products and processes over those not locally available.

#### **5.6.6.10 Fire resistance**

"Flame spread" ratings shall conform to the applicable building code definition for the material being used.

#### **5.6.6.11 Finish Materials**

Dense, hard, nonporous materials shall be used in all applications. Finish materials shall be corrosion, acid, and alkali resistant and shall be compatible with chemical compounds required for maintenance.

#### **5.6.6.12 Detailing**

Detailing of finishes shall avoid unnecessary surfaces which may collect dirt and complicate cleaning. Wall surfaces shall be vertical and flush allowing for texture. All edge and finish materials shall be detailed, incorporation joints and textures which reduce the requirements for true, visually perfect installation over long distances.

#### **5.6.6.13 Waterproofing**

All finish materials in underground spaces shall be selected and detailed with proper attention to waterproofing, cavity walls, drainage and venting. All drainage cavities shall be provisions for cleanout.

#### **5.6.6.14 Texture**

Materials within reach of passengers shall be easily cleaned, with a finish to prevent or conceal scratching, soiling, and to maintain desired illumination levels. Materials with homogeneous colors shall be selected. The use of paint, stains and coatings shall be minimized.

Graffiti resistant products shall be used to protect surfaces susceptible to graffiti. Graffiti resistant products shall allow for removal of graffiti without damage to the surface.

### **5.7.0 STATION EQUIPMENT**

This section includes all electromechanical equipment located at the stations other than communications equipment. The major items covered here include fare collection equipment.

#### **5.7.1 Fare Collection**

All platforms shall have provisions for either free standing or integrated fare vending machines.

RTD shall determine the number of initial machines and future provisions.

Weather protection shall be provided for each machine unless otherwise approved by RTD. At no time shall the front face of the vending machines be oriented to the south, west, or southwest, unless protection from the sun is provided.

See "Fare Collection Equipment" in Section 12 for more detailed information.

### **5.7.2 Equipment Location**

All equipment located at the station shall be coordinated through the station Design Team. This shall include but is not limited to all above and below grade equipment and structures such as water and electric in ground boxes and power stations.

## **5.8.0 COMMUNICATIONS**

This section includes all communications media and devices used to communicate with transit passengers.

### **5.8.1 Directional Signs**

Obvious, simple and clear signage between modes of transportation and throughout stations reduces confusion and frustration while increasing patron comfort. The less time spent searching for connections, the more time will be available for enjoying the convenience of transit. Signage shall conform to Section 4.30 of "Standards for Accessible Transportation Facilities," U.S. Department of Transportation, Denver Light Rail Systems Signage Standards dated 1-12-02, NFPA 130 3-1.3 Warning Signs and the MUTCD.

### **5.8.2 Platform Kiosk**

Free standing or integrated information kiosk shall be provided in all stations.

Kiosks shall be sized to accommodate standard RTD information materials, including LRT and bus system maps and schedules and to accommodate internal maintenance that may be required.

### **5.8.3 Platform Identification Blade Signs**

Free standing or integrated blade signs shall provide system, station and destination identification.

Two blade signs shall be provided on each platform to cover the areas that are not covered by the pylons.

### **5.8.4 Shelter Signage**

Provisions shall be made for station identification signs in passenger shelters and shall conform to current ADAAG standards.

### **5.8.5 Telephones**

Provisions for emergency telephones shall be provided as required in each station and shall conform to the requirements of Section 4.31 of "Standards for Accessible Transportation Facilities", U.S. Department of Transportation.

Public phones are not to be located on the platforms but shall be located at or near the edge between the platform and the transition plaza.

Public phones shall be easily visible from the station platforms, but located outside of circulation areas where the noise level is acceptable

#### **5.8.6 CCTV and VMS (Variable Message Signs) Displays**

Provisions shall be made for initial or future CCTV VMS displays; either free standing or integrated, as required by RTD.

#### **5.8.7 Security Equipment**

Refer to Section 14 System Safety and Security.

### **5.9.0 ELECTRICAL SYSTEMS**

This section establishes the design criteria for all electrical equipment for Light Rail stations.

These criteria include functional and design requirements for the supply, control, and protection of AC power electrical systems. All exposed conduit on platform structures shall be painted to match the structure. The electrical and mechanical equipment requiring power shall include the following:

- Lighting
- Fare Collection Equipment
- Communications and CCTV
- Emergency Lighting and Power Systems (if required)
- Transit Signal Equipment

#### **5.9.1 Standards and Codes**

AC power and electrical system design shall conform to the latest edition of the following standards and codes where applicable:

- National Electric Code (NEC), National Fire Protection Association (NFPA) No. 70
- National Electrical Safety Code (ANSI C.2)
- Electrical Codes of the local jurisdiction
- American National Standards Institute (ANSI)
- National Electrical and Electronic Engineers (IEEE)
- Life Safety Code (NFPA) - 101
- Insulated Power Cable (IPCEA)

**5.9.2 Station Power and Electrical System**

These criteria establish the basic design requirements for AC Station Power Systems.

**5.9.3 System Voltages**

Service Voltage: All stations shall have 240/120-V or 120/208 power supply. (Please reference Electrical Systems Design Criteria in this Manual)

Utilization Voltages:

- Lighting Fluorescent
- Lighting(Sodium/metal halide) ..... Use applicable voltage
- Lighting Incandescent ..... Use applicable voltage
- Fare Collection Equipment ..... Use applicable voltage
- Communication and Cable TV ..... Use applicable voltage
- Other loads ..... Use applicable voltage

Where single-phase power is taken from a 3-phase source, the loads shall be balanced among the three distribution phases.

**5.9.4 System Capacity**

Station power systems shall be structured from a single power distribution panel. The power distribution panel shall be of sufficient capacity to power all station loads plus a minimal spare capacity of 50%.

Demand Factors: In calculating system capacity, the following demand factors shall apply:

**TABLE 5A – DEMAND FACTORS**

Element Demand	Factor
Lighting (normal)	1.0
Heating (optional)	0.5
Fare Collection Equipment	0.5
Communications and Cable TV	1.0
Others	varies *

(\* per duty cycle and code requirements)

Convenience receptacles shall be 0.89 of branch rating or a demand load of 9.8 KVA per outlet.

### 5.9.5 Performance Standards

Illumination Engineering Society Lighting Handbook

Underwriters Laboratories, Inc.

### 5.9.6 Standard Elements

All luminaries and lamp types shall be standardized system wide to provide design and perceptual unity and simplify maintenance requirements.

### 5.9.7 Illumination Levels

Illumination levels shall define and differentiate between task areas, decision and transition points, and areas of potential hazard. In addition to quantity of light, it is essential that illumination be designed to minimize glare and provide uniform distribution. Luminaries shall be selected, located, and/or aimed to accomplish their primary purpose while producing a minimum of objectionable glare and/or interference with task accuracy, vehicular traffic and neighboring areas.

Minimum illumination levels are shown below:

**TABLE 5B – MINIMUM ILLUMINATION LEVELS**

Locations	Minimum Foot-candles
Station Platform and Plaza Areas	5 minimum
Fare Vending Area	8 minimum
Parking Lots & Accessways	(0.5 min at property line) 2 average
Tunnels & Pedestrian Accessways	5 minimum

### 5.9.9 Station Site Lighting

Station lighting includes internal site circulation and access to the station. The placement of luminaries shall not obstruct the movement of vehicles. Luminary placement shall be coordinated with the landscape and site plan to protect light standards which are located adjacent to roadways, and to ensure that plantings will not obscure the lighting distribution pattern.

### 5.9.10 Vehicular Access Lighting

Vehicular access lighting shall provide a natural lead-in to the bus area and Kiss and Rides. The illumination on all access and egress roads shall be graduated up or down to the illumination level of the adjacent street or highway.

### **5.9.11 Pedestrian Accessways Lighting**

Pedestrian accessways lighting shall define pedestrian walkways, crosswalks, ramps, stairs, tunnels and bridges.

### **5.9.12 Platform Lighting**

Platform area lighting shall be in any area that is used to load and unload a train. The lighting elements shall extend the entire length of the platform and shall demarcate the platform and emphasize the platform edge and vertical vehicle surfaces. Care shall be taken to avoid "blinding" LRT operators or other vehicle drivers with excessive or misdirected lighting.

### **5.9.13 Control of Lighting Systems**

Lighting control shall be designed to use energy efficiently. Automatic and manual control arrangements shall ensure efficient utilization of energy and maintenance procedures. All exterior site areas shall be illuminated by a photocell with time clock or manual override.

## LIST OF FIGURES

FIGURE 5.1 .....PLATFORM AT ROADWAY

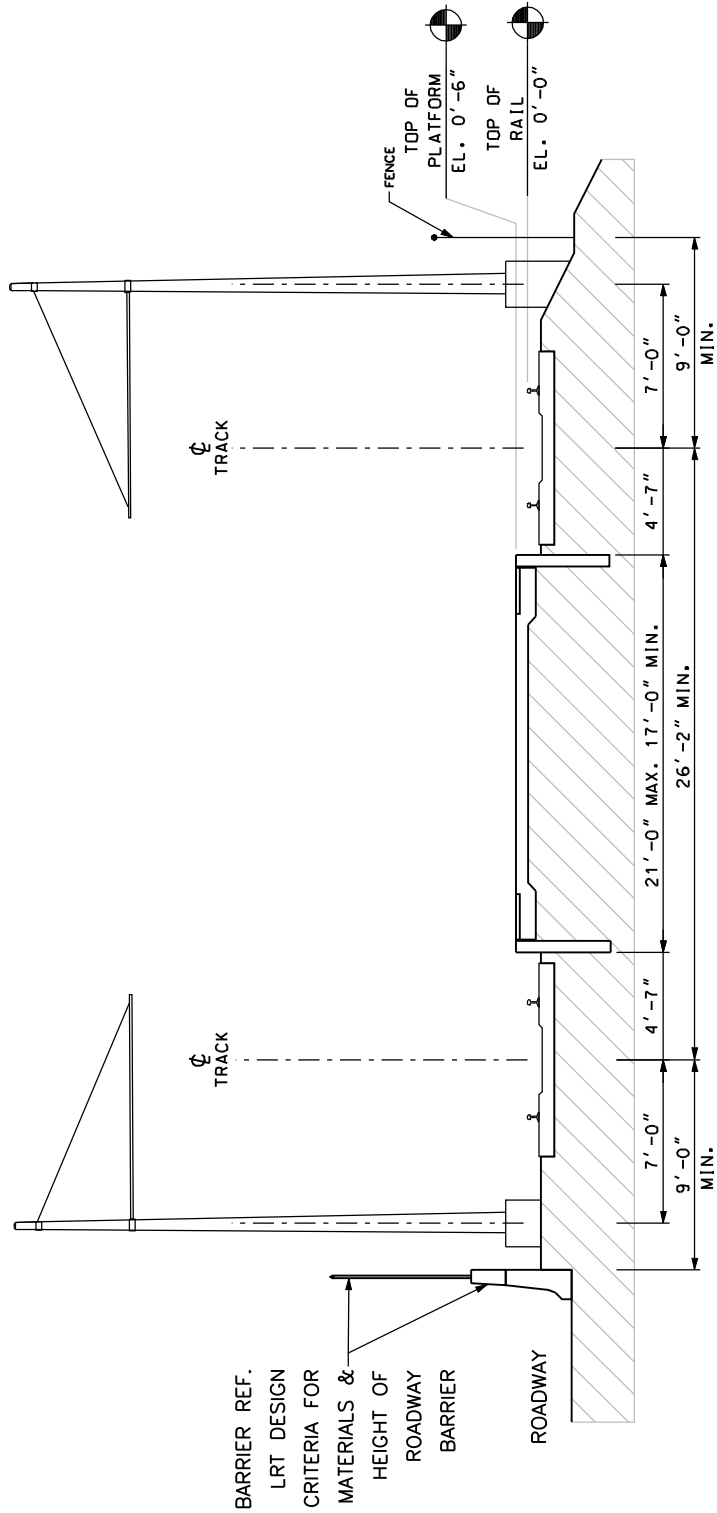
FIGURE 5.2 .....PASSENGER THROUGH ZONE

FIGURE 5.3 .....CENTER PLATFORM

FIGURE 5.4 .....SIDE-SIDE PLATFORM

FIGURE 5.5 .....CENTER-SIDE PLATFORM

CLEARANCE  
TO STRUCTURE  
EL. 24'-0"



PLATFORM @ ROADWAY SCALE 1/8"=1'-0"



DESIGN CRITERIA

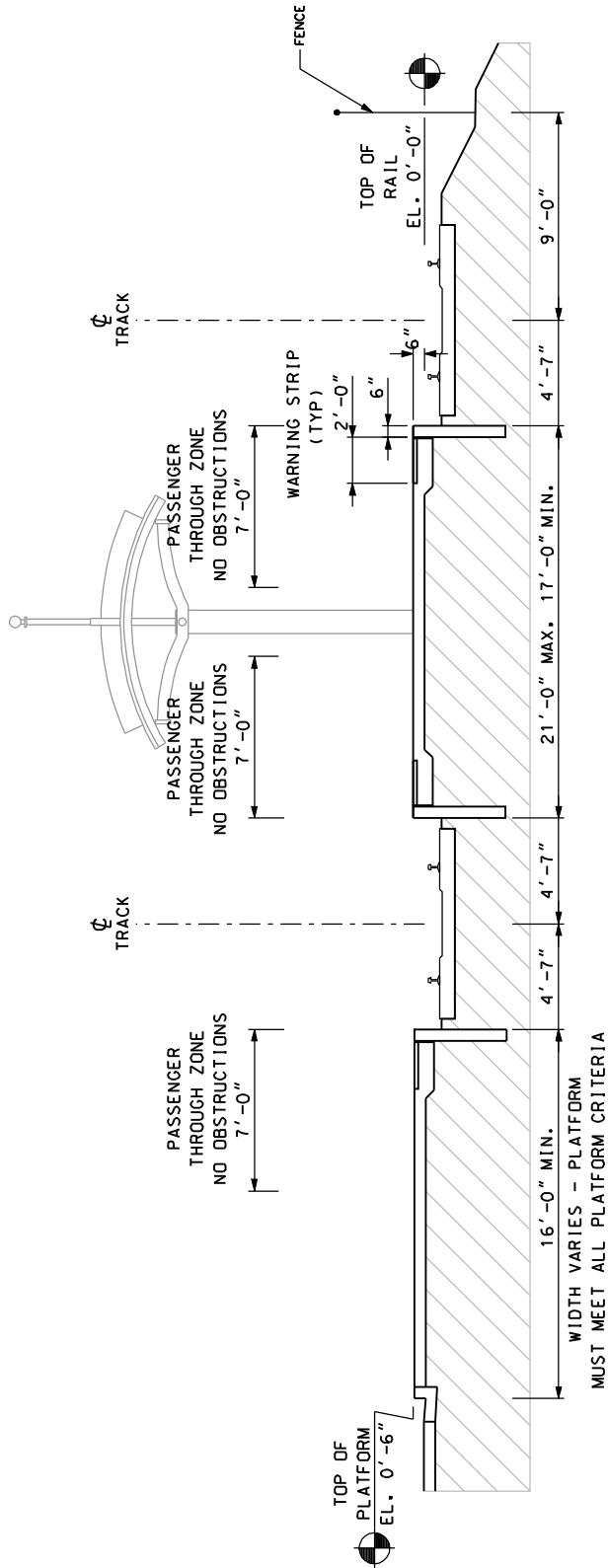
TITLE:

PLATFORM @ ROADWAY

FIGURE:

5.1

CLEARANCE  
TO STRUCTURE  
EL. 24'-0"



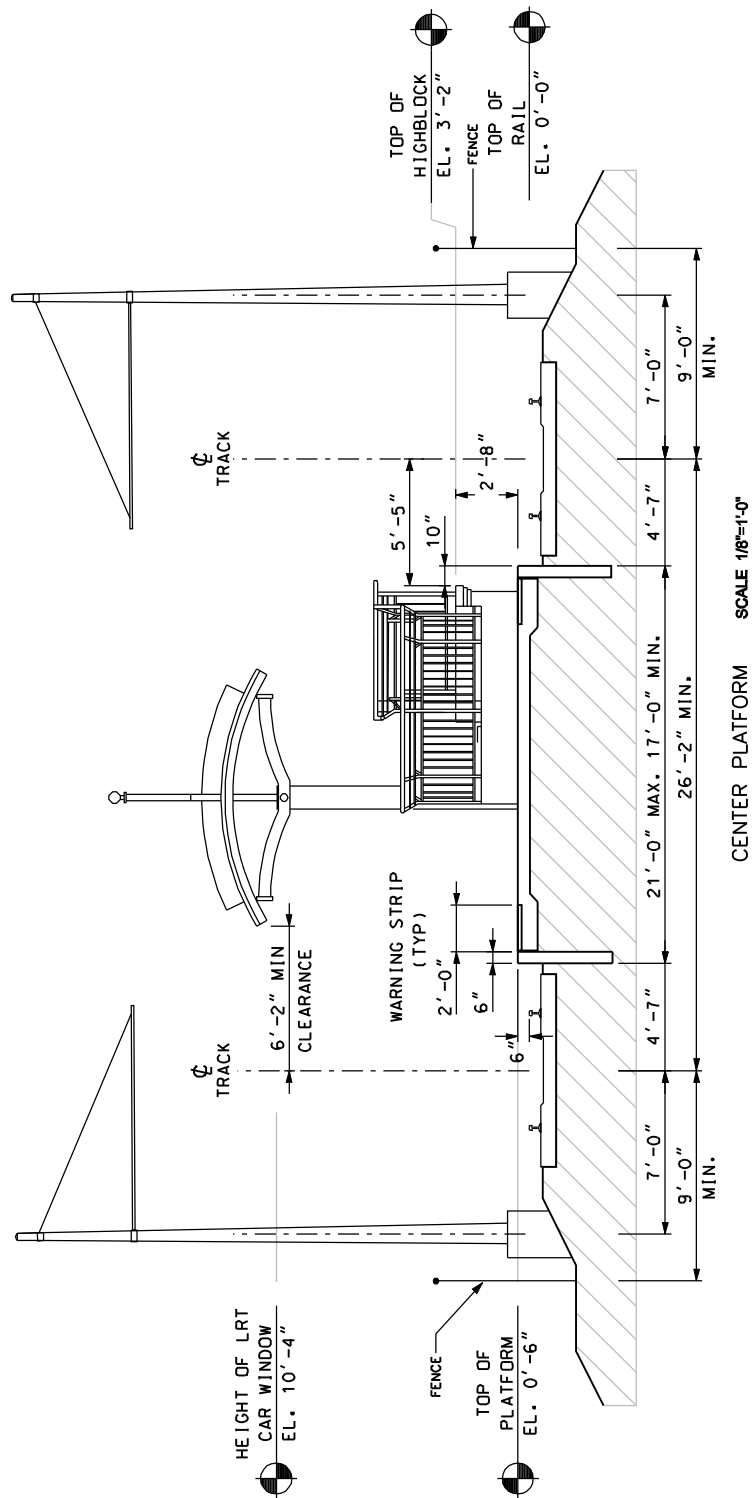
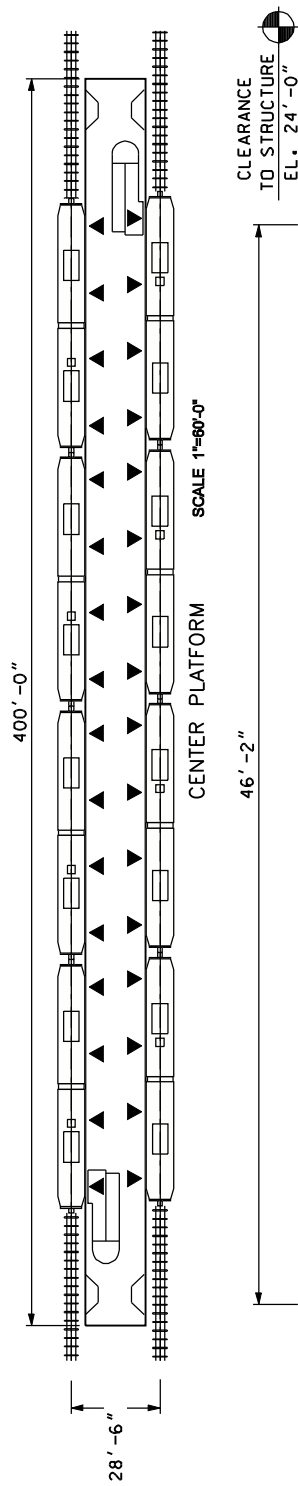
CENTER - SIDE PLATFORM, PASSENGER THROUGH ZONE SCALE 1/8"=1'-0"



DESIGN CRITERIA

TITLE: PASSENGER THROUGH ZONE

FIGURE: 5.2

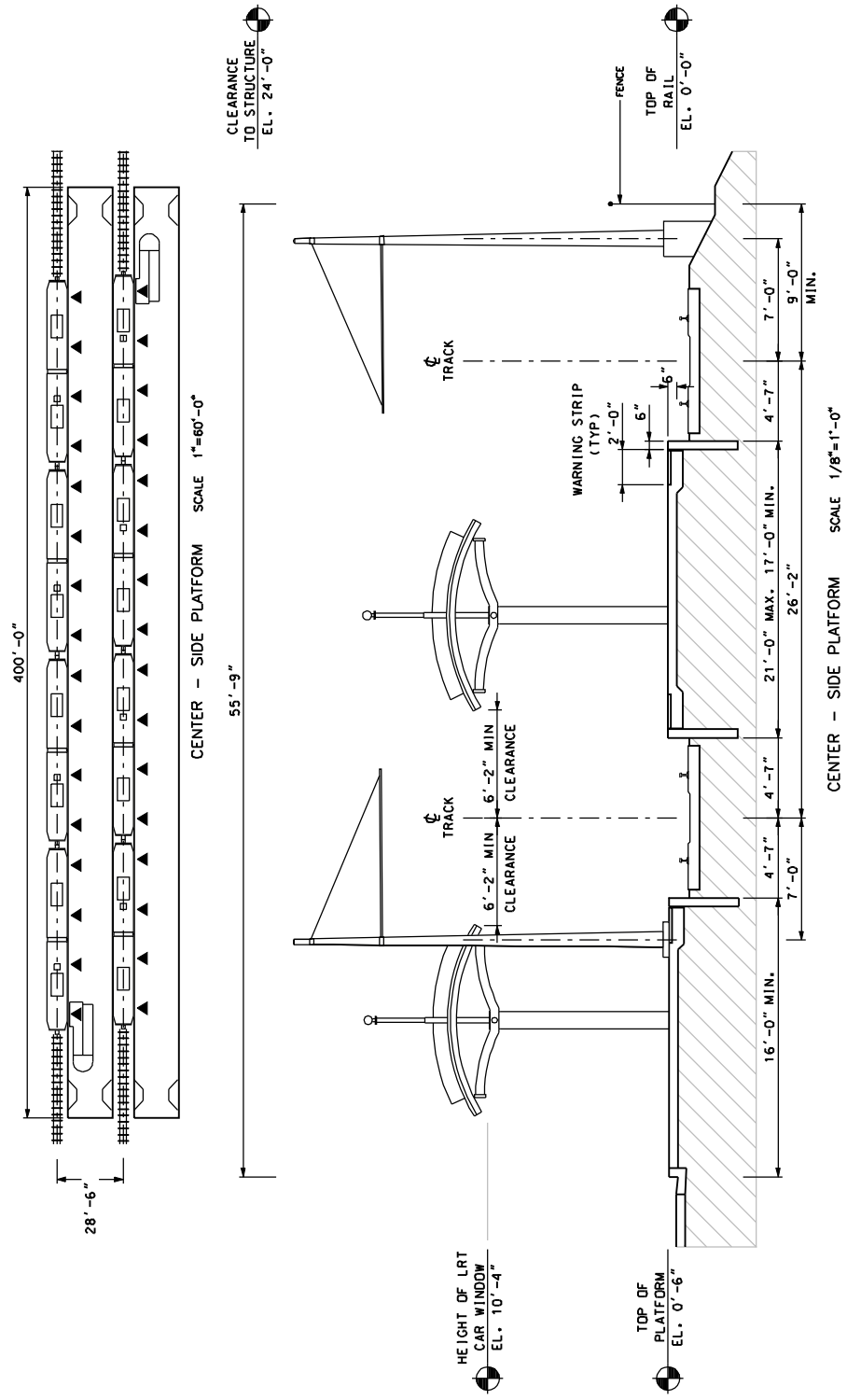


DESIGN CRITERIA

TITLE: CENTER PLATFORM

FIGURE: 5.3





DESIGN CRITERIA

TITLE: CENTER - SIDE PLATFORM

FIGURE: 5.5