SCRTD
METRO RAIL PROJECT

Revision 1
January 8, 1982

Project Definition and Objectives

DECEMBER 1981

Southern California Rapid Transit District

PREFACE

DOCUMENT PURPOSE AND SCOPE

This Project Definition and Objectives Document establishes the definition and objectives for the SCRTD Metro Rail Project. It is a source document to provide guidance to SCRTD staff and design team contractors at the start of the design effort. It documents the "top-down" approach that has been established for the project, defining:

- The transportation needs of the region toward which the Metro Rail System is directed
- The objectives to be achieved in planning and designing the system, so that these regional needs will be satisfied
- The means by which these objectives will be achieved (project requirements).

By providing a common understanding of project definition as well as the basis for a common language and a consistent planning and design logic, this top-level document provides a means of coordinating the efforts of the Metro Rail Project staff and the several design teams. Companion documents--Design Criteria, Design Configuration Drawings and Design Specifications--define the functions and specific characteristics of system elements and components.

DOCUMENT STRUCTURE AND CONTENT

This document has been structured to logically and progressively follow a hierarchy of objectives and requirements that has been established for the Metro Rail Project. The hierarchical structure begins following a brief system description and background discussion in Chapter 1.

Chapter 2 presents the overall rapid transit system goals established for the Los Angeles Regional Core. These goals formed the basis for selection of a rail rapid transit system as the preferred alternative for meeting

the transportation, environmental and developmental needs of the area in the alternatives analysis for transit system improvements in the Regional Core.*

Chapter 3 presents the objectives of the Metro Rail Project itself. These objectives reflect the top-level design and integration aims of the Metro Rail Project. These are designed to guide development of the rail system. Chapter 3 also defines Metro Rail Project requirements. These provide the technical interpretation of project objectives. Project requirements are prescriptive statements of systemwide needs; they are the basic rules to be followed in the planning and design of the system.

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* Final Alternatives Analysis/Environmental Impact Statement/Report on Transit System Improvements in the Los Angeles Regional Core, April 1980.

1. INTRODUCTION

in April 1980. When placed into revenue operation in approximately 1990, the project will form the backbone of SCRTD's integrated bus/rail Metro System serving Los Angeles County. Some bus service will be supplemented by the rail line and many bus routes in the core area of the region will be realigned and scheduled to serve as an efficient and economical feeder network for the rail transit line. A map of the proposed system is shown in Figure 1-1.

Physical features that have been tentatively identified prior to Preliminary Engineering are described as follows:

- Corridor - A 55-square-mile area covering Downtown Los Angeles, Wilshire, Fairfax, Hollywood and North Hollywood Districts.

- Technology - Standard gauge conventional rail rapid transit.

- Horizontal Alignment - Passes through or near the following areas: Union Station, Civic Center, Downtown, Wilshire Boulevard, Hollywood Boulevard, Cahuenga Pass, Vineland Avenue, Chandler and Lankershim.

- Vertical Alignment - All in-bored subway, if possible, 40-200 feet underground.

- Grade Separation - Totally grade-separated.

- Stations - Will be "mined" or "cut-and-cover" construction, depending on local conditions. A total of 16 stations along the route are presently being considered at the approximate locations set forth below. Additions to or deletions from this list may be recommended as a result of Preliminary Engineering.

  - Union Station
  - First and Broadway (Civic Center)
  - Fifth and Broadway
  - Seventh and Flower
  - Wilshire and Alvarado
  - Wilshire and Vermont
  - Wilshire and Normandie
  - Wilshire and Western
  - Wilshire and La Brea
  - Wilshire and Fairfax
  - Fairfax and Beverly
  - Fairfax and Santa Monica

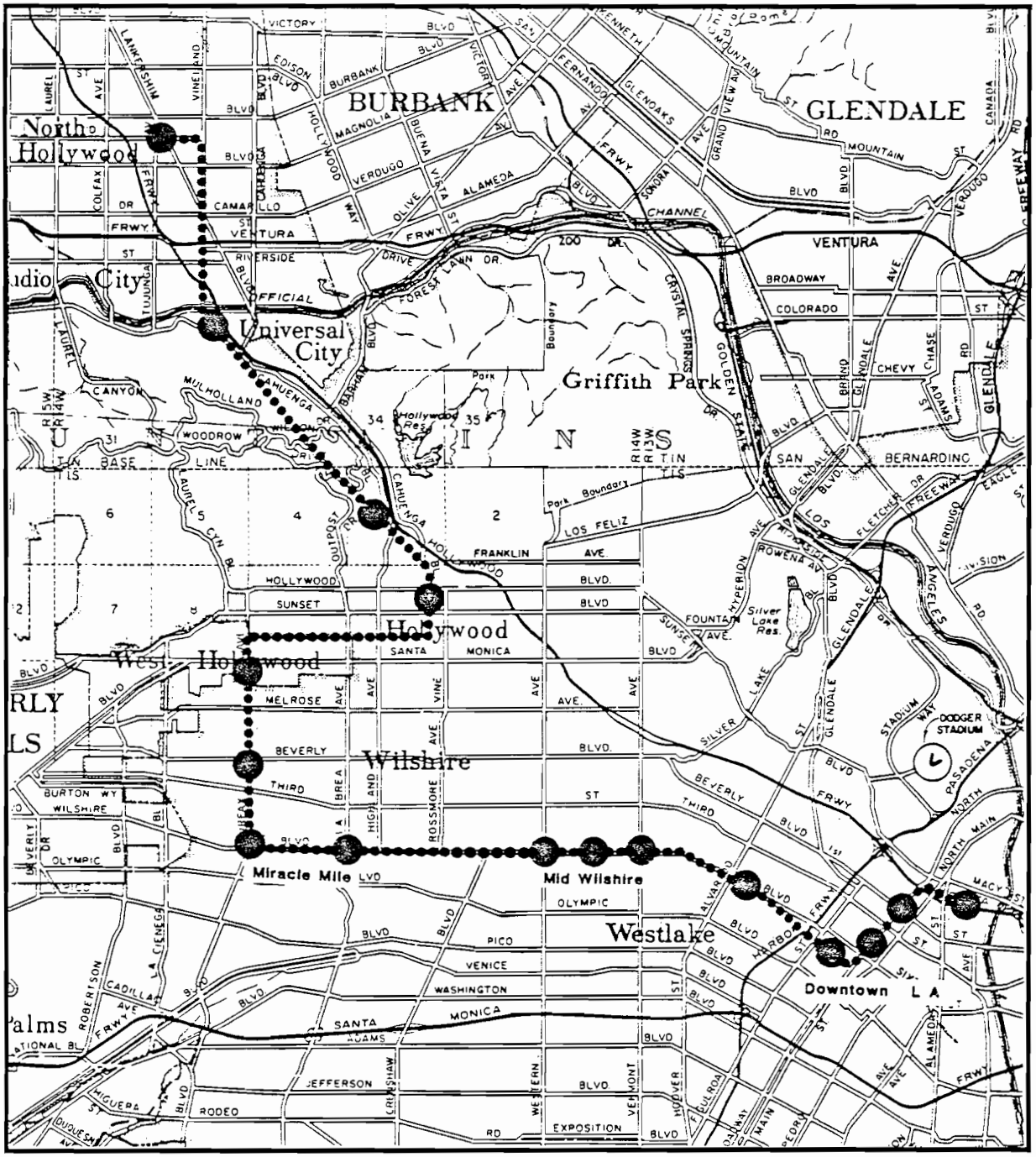

FIGURE 1-1
Map of Proposed Metro Rail System

The Preliminary Engineering cost estimates must be of such accuracy that the District and other government agencies can use them to make fiscal commitments for funding and construction of the project.

Once these cost estimates have been evaluated and a decision to proceed with the project has been made, the Final Design phase will commence. Final Design will bring system design to completion with the issuance of final design, construction and equipment procurement specifications and drawings.

The construction phase will involve the building of stations, ways and structures, and the procurement and installation of equipment and vehicles. Prior to beginning operations, the system will undergo system and subsystem quality assurance testing.

4. PROJECT DEFINITION

A "top-down" approach was utilized to define the project and its principal output, the Metro Rail System. Examined in descending order were:

- The transportation needs of the Regional Core
- The planning and design objectives to satisfy these regional needs
- The means by which these objectives will be achieved.

In following this approach, a project definition hierarchy was developed, including:

- Regional Core Rapid Transit Goals
- Metro Rail Project Objectives and Requirements.

(1) Regional Core Rapid Transit Goals

Rapid Transit Goals relate to the long-term transportation, environmental and developmental needs of the region. They were derived from policy statements by responsible local and state agencies and formed the basis for selection of a rail rapid transit system as the preferred alternative for meeting these needs.

(2) Metro Rail Project Objectives and Requirements

Project objectives and requirements provide direction for the project. They are the basic rules to be followed in planning and designing the Metro Rail System. Whereas Rapid Transit Goals reflect regional transportation needs, Project Objectives and Requirements are specifically related to the design of the Metro Rail System. They provide the essential link between the needs of the region and the manner in which the rail system will meet those needs.

Metro Rail Project Objectives and Requirements are established by the Metro Rail Project Manager/Chief Engineer and endorsed by the General Manager and SCTRD Board.

5. SCRTD BOARD POLICY

Metro Rail Project Policies are adopted at the discretion of the SCRTD Board of Directors and may vary in their scope from broad project objectives to specific design requirements. They provide guidance and direction to the Metro Rail Project design effort. Policy will be recommended for board adoption if a decision or action will:

- Substantially affect or alter Metro Rail's major plans or programs or the way they are carried out
- Define priorities and acceptable tradeoffs among design objectives
- Result in a major commitment or shift of District funds
- Define the means by which the Metro Rail System is to be integrated into the existing SCRTD system.

Four Metro Rail Project policies that have been set by the Board are:

- Each train shall be operated by one man supported by automatic devices and modern technology to ensure safe operation.
- Each station shall be designed to be fully automated, but also designed so that it could be manned or attended.

- Each station shall provide male and female restrooms, locked to the public except in emergencies.

- A 75-foot rail car similar in design to that defined in "Transit Industry Core Technical Specifications for the Procurement of Rapid Rail Cars" will be used.

2. LOS ANGELES REGIONAL CORE RAPID TRANSIT GOALS

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Goals for transit improvements in the Regional Core of Los Angeles were stated in the alternatives analysis report which recommended the preferred alternative, the Metro Rail System.* These goals were prepared to assist in the development and evaluation of several transit alternatives and reflect the overall transit needs of the study area. The Metro Rail System was selected as the preferred alternative because it was shown to be the most effective means of achieving these goals, which are:

- Mobility
  - To provide a very necessary improvement in the level of mobility in the Los Angeles CBD-Wilshire-Hollywood-North Hollywood Regional Core Area
  - To integrate the corridor transit system with the other three elements of the RTDP, so that convenient regional access is provided for all corridor residents**
  - To maintain and improve transportation system safety and dependability for both users and non-users
- Cost-Effectiveness
  - To maximize system capital and operation cost-effectiveness in the Regional Core in terms of passengers and passenger miles, over a foreseeable range of passenger volumes

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* Final Alternatives Analysis/Environmental Impact Statement/Report on Transit System Improvements in the Los Angeles Regional Core, April 1980.

** As mentioned in Chapter 1, two elements requiring new construction--Freeway Transit and the Downtown People Mover--may not be built.

- Land Development

  - To be complementary to and compatible with regional and local transportation and urban land development goals

  - To support city and county plans for land development along Wilshire Boulevard and for the revitalization of Downtown Hollywood and North Hollywood

- Environment

  - To complement and support regional energy conservation and air quality goals

  - To minimize displacement, disruption, disturbance and noise exposure to residential and employment areas in the Regional Core

  - To reduce vehicle miles traveled on Regional Core surface streets to the extent that this can be accomplished without arbitrary restraints and delays

  - To make the most efficient use of existing transportation energy resources and to improve the ability of the transportation system to use alternative energy sources in the future.

3. METRO RAIL PROJECT OBJECTIVES AND REQUIREMENTS

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The Metro Rail Project objectives and requirements are presented in this chapter. They are top-level project statements of direction to guide the design of the Preferred Rapid Transit Alternative.

The project objectives are expressed by the fundamental objective constrained by five additional project objectives.

The fundamental objective of the SCRTD Metro Rail Project is to provide a fixed-guideway rail rapid transit system, which satisfies the transportation needs of the Los Angeles Regional Core, while adhering to the following additional objectives:

- Safety and Security
  - Safety will be the foremost concern in the design, construction and operation of the Metro Rail System.
  - Hazards to patrons, employees, the general public and equipment will be either eliminated or satisfactorily controlled by methods consistent with operational effectiveness.
  - Real and perceived security will be established to provide a favorable environment for travel and work, and to protect system integrity.
- System Assurance
  - The system will be planned, designed and constructed to provide sufficient capacity to meet anticipated demand without undue crowding.
  - The system will be designed for reliability and maintainability to ensure that the service provided will be perceived by the public as dependable.

- The system shall incorporate such features as are required to control the impact of a service failure or anomaly and to recover promptly from such events.

. Comfort and Convenience

- The environment provided patrons of the system will be designed for comfort with surroundings acceptable to the human senses.

- The system will be accessible and easy to use so as to provide an attractive alternative to other modes of transportation in the regional core.

. Urban Environment

- The system shall be designed to enhance or be compatible with the urban environment in which it is to operate, so as to have a positive effect on the regional economy and local revitalization.

- System design will minimize, to the extent possible, disruptions or inconveniences that may result during construction.

. Cost-Effectiveness

- The system and its elements will be designed to minimize total life-cycle cost, without compromising other requirements.

The project requirements express the technical needs which are necessary to achieve successful implementation by satisfying the project objectives. They are a technical interpretation of the above project objectives.

1. SAFETY AND SECURITY

Safety shall be the foremost concern in the design, construction and operation of the Metro Rail System. No user, employee or non-user shall be exposed to recognized hazards of unacceptable levels of severity or occurrence probability.

The Metro Rail System shall conform to all applicable codes and regulations. System safety engineering technology, augmented by those standards and guidelines developed by industry advisory agencies, shall be utilized to ensure that the Metro Rail System achieves a level of safety and security--both real and perceived--that equals

or betters those levels attained by other rail transit systems operating in the United States and Canada. Safety and security project requirements shall comprise:

- Hazards control
- Emergency provisions
- Security.

These are described below.

(1) Hazards Control

The Metro Rail System shall achieve an acceptable level of design safety by the processes of eliminating, minimizing or controlling hazards through analyses, review and design selection. A System Safety Program Plan shall be developed and implemented for the purpose of ensuring that hazards are identified and evaluated for the actions to be taken for elimination or control.

1. Single-Point Failures

All single-point hardware and software failures resulting in critical or catastrophic hazards shall be avoided or eliminated. Those with the potential for resulting in marginal hazards shall be controlled to an acceptable level of risk. Measures for the control of hazards shall include redundancy of critical components, judicious use of safety margins and factors, selection of reliable time-proven components and designs, and use of safety and warning devices and special procedures.

2. Dynamic Failures

Fail-safe principles shall be incorporated into dynamic system elements under all potential operating conditions, including those circumstances where operations continue in the presence of component or subsystem failure.

3. Facility Safety

Facilities and other structural elements of the Metro Rail System shall be free of design features which pose a danger to the life or safety of patrons, personnel and the general public. Design of these facilities shall incorporate accepted safety margins for all

load-bearing members, accounting for the anticipated stresses under which they are to be placed over the life of the system. Obstacles that may prove hazardous to passenger movement under any anticipated circumstances shall be either avoided or controlled to an acceptable level of risk; facilities must be designed for safety through provision of adequate movement and queuing capacities. Materials must not pose a danger to movement, nor pose a health- or life-threatening hazard when exposed to fire, extreme heat, light, electric current or moisture, or when in contact with other building materials.

4. Fire Safety

Strict attention to applicable fire codes and use of fire-resistant materials and construction shall promote fire safety in the system. Stringent controls of combustible fuel loads shall also be developed.

5. Occupational Safety

Occupational safety shall be provided by a combination of design and procedures that will control the risk of injury to system personnel during their normal operations, maintenance and repair activities. These provisions shall include protection from:

- Electric shock
- Toxic, corrosive or explosive substances
- Improper operation of vehicles
- Tripping, slipping or falling
- Fire and flame.

(2) Emergency Provisions

The system shall be designed to permit the implementation of special operating procedures for the safe and efficient handling of any foreseeable emergencies.

1. Emergency Evacuation

The system shall be designed to permit the safe and timely evacuation of patrons and personnel from all fixed structures and facilities.

Vehicle evacuation shall be accomplished under direct supervision of system personnel, except under those circumstances when an immediate threat to the health, safety or security of passengers or system personnel exists. Provisions for unsupervised self-evacuation--design features, equipment and instructions--shall be made for these circumstances; these provisions, however, shall be such that their use is discouraged except in extreme emergencies when immediate evacuation is essential.

Procedures and facilities shall provide for the supervising of safe, timely and orderly evacuation of passengers from vehicles located anywhere in the system. As a minimum, provisions shall be included to safeguard patrons, system personnel and emergency forces anywhere on an evacuation or access route from hazards created by the following:

- Power distribution system
- Moving vehicles
- Potential for falling or tripping.

2. Emergency Detection

Fire and smoke detection systems, alarm systems, and provisions for emergency monitoring and control procedures shall be incorporated as appropriate to minimize the potential for fire losses and associated service disruptions.

3. Emergency Equipment

Design of facilities and subsystems shall provide for availability of necessary on-site emergency equipment and ease of access by emergency forces.

(3) Security

The Metro Rail System shall ensure a real and perceived high level of security for patrons and personnel. Facility design and operating procedures shall promote a sense of well-being among patrons and personnel, discouraging acts of crime, violence and abuse. Security provisions shall also maintain system integrity by discouraging acts of vandalism, theft and fraud.

A System Security Program shall be developed for the purpose of identifying and responding to potential security risks. It shall integrate security considerations with the activities of design engineering to achieve an optimum relationship between security features, functional design, architectural concept, system operation, and cost-effectiveness. The security program shall address three issues:

- Patron and personnel security
- System equipment and facilities security
- Revenue security.

1. Patron and Personnel Security

The Metro Rail System shall be planned and designed with a means of surveillance and communication to detect patron and personnel problems, to provide patron assistance, and to deter and control crime, vandalism and violence.

Patron security shall be further enhanced by architectural designs that minimize obstructions, blind corners and dead-end passageways, and that provide proper lighting and maximum visibility of major entrances, elevators, escalators, stairways, mezzanines and platform areas.

2. System Equipment and Facility Security

System security shall be provided by discouraging unauthorized use or entry of non-public equipment or facilities. In addition to surveillance provisions, this shall be achieved by appropriate graphics, door locks, barriers, and alarm systems. Equipment and facilities shall incorporate the use of vandal-resistant materials and design, where practical. Consideration shall be given to prevention of theft of material by both the general public and system personnel.

3. Revenue Security

Revenue security shall be achieved by design and procedures associated with the fare collection system. The system shall ensure that the risk of fare evasion and fraud by patrons and of theft by system personnel or other persons is minimized.

2. SYSTEM ASSURANCE

The planning and design of the Metro Rail System shall enable it to provide sufficient levels of service to meet projected demand and to operate this service in a dependable manner. System assurance requirements are divided into three subsections:

- System capacity
- Dependability
- Failure management.

(1) System Capacity

The Metro Rail System shall be planned and designed to accommodate passenger demand and flows through 1995 without any modification to its fixed facilities. This capacity requirement should be defined in a manner that addresses those conditions that can reasonably be projected to occur, including normal day-to-day routine, special events and service irregularities.

The system design shall be such that anticipated future increases in service levels (due to patronage growth) and line extensions and branches can be accomplished without major structural changes or major service interruption on the starter line itself. Each system component required to operate the service and accommodate the interactive needs of the patrons (such as the passenger assistance communications system, escalators or the fare collection system) shall also meet these requirements. Furthermore, support equipment and facilities shall be in sufficient numbers and of sufficient capacity to ensure the continued achievement of system and subsystem availability criteria.

(2) Dependability

The Metro Rail System shall be designed with a high degree of reliability, availability and maintainability to provide dependable service that is also safe and cost-effective. Service dependability shall be a design consideration for all system elements on which patrons will rely while using the rail system; this shall extend both to those elements involved in train movement and those station-located elements--including communications, fare collection, and elevators/escalators--encountered during access/egress.

System dependability shall be achieved through system engineering, and through the establishment of appropriate operating procedures to maximize the likelihood of operating service without degradation or stoppage and to minimize the degree of degradation in the event of a component failure. Goals for system dependability shall be set and their achievement measured.

A key product of the system design effort will be the establishment of standards for component and subsystem reliability and maintainability so that the dependability goals may be met. Reliability shall be measured in terms of MTBF and MTBSF (i.e., mean time between failures and mean time between service failures). Maintainability, measured as MTTR (mean time to repair), shall be designed into system elements to limit downtime and resultant service delays or stoppages.

A System Reliability, Availability, Maintainability and Dependability (RAMD) Program will establish system dependability and availability goals and the reliability and maintainability levels that must be achieved to reach these goals. Requirements established for system elements and components shall take service requirements into account and shall minimize life-cycle costs. A Quality Assurance Plan, also to be developed during Preliminary Engineering, shall ensure that parts, components and subsystems to be procured meet functional and performance requirements.

Reliability design features shall reduce the probability of system failure and the associated impact on patron service through the use of the following techniques:

- Application of selected redundancy
- Use of components with proven reliability that are compatible with other interacting components
- Minimization of single-point failures which interrupt service
- Minimization of equipment operation stresses
- Provision of "operate-around-failure" capabilities.

Features for minimizing downtime shall be incorporated into the system, including those for:

- Rapid and positive detection and localization of failures and anomalies
- Rapid access to critical functional components
- Rapid correction of faults and verification of system operation.

Downtime shall be further reduced through the establishment and enforcement of an effective preventive maintenance program, and provisions for on-line maintenance.

(3) Failure Management

The system shall be capable of identifying and responding to system disruptions and irregularities in a manner that minimizes their impact on system service. Full service shall be maintained on as much of the system as possible. When operational or safety considerations require, service shall be degraded; service stoppage shall be a last resort.

In response to system disruptions or irregularities, the system shall be adaptable:

- To limit the number of users that are affected
- To limit the inconvenience of these users
- To minimize the time required to restore the system to full service operation, with consideration given to long-term effects.

System responses may include either automatically or manually initiated changes in system configuration, modifications of system operating strategies, and recovery operations. Any automatically initiated failure management strategy shall be capable of being manually overridden or modified by system personnel. Means and procedures for communicating service disruptions to patrons shall be an integral part of failure management.

3. COMFORT AND CONVENIENCE

The elements of the Metro Rail System shall be designed for patron comfort and convenience to provide an attractive alternative to other modes of transportation in the Los Angeles Regional Core. Comfort and convenience requirements are classified by:

- Comfort
  - Environmental control
  - Aesthetics
  - Noise control and acoustics
  - Lighting
  - Ride quality and comfort
- Convenience
  - General accessibility and ease of use
  - Design for elderly and handicapped access.

(1) Comfort

Comfort refers to the effect of system design and operation on the human senses. The environment provided the patron will address the following requirements.

1. Environmental Control

Passengers will be completely protected from all types of weather and climatic conditions (rain, wind, dust, heat) while inside rapid transit vehicles. Careful attention will be given to station elements exposed to climatic conditions to provide appropriate protection for patrons.

The rapid transit system will be designed to provide control of air flow, temperature and humidity conditions and ventilation within vehicles and in covered and enclosed public facilities.

2. Aesthetics

Stations and vehicles shall be visibly pleasing, the style of each in keeping with modern, contemporary practices. Stations shall be designed to provide feelings of openness and proportion.

3. Noise Control and Acoustics

The Metro Rail System shall be designed so that normal human speech between two persons located reasonably close to one another in any public area of the stations or vehicle will not be interrupted by unwanted sound generated by the normal functioning of any system facility or equipment.

Design of stations, vehicles and PA systems shall provide for good intelligibility of public announcements throughout the public area.

4. Lighting

All system facilities will be lighted to provide the levels of illumination required for the various area activities and usage in accordance with accepted contemporary industry standards. Lighting levels will also provide for the comfort, safety, security and amenity of patrons. They will promote passenger circulation and assure no sudden transitions from light to dark areas.

Emergency lighting will be provided to allow persons to exit vehicles and facilities under primary power outage conditions.

5. Ride Quality and Comfort

The Metro Rail System shall provide a ride quality that equals or exceeds that of other modern rapid transit systems in the United States. Vehicle interiors shall include comfortable seats in a configuration that permits efficient use and rapid loading and unloading. Standing passengers shall be provided suitable handholds for steadying during acceleration and braking. Ride comfort shall be provided by setting and designing to appropriate goals for the following:

- Maximum passenger loading densities
- Average and maximum standing times
- Maximum accelerations: longitudinal, lateral, vertical

- Maximum rotational rates: roll, pitch, yaw

- Maximum vibration limits.

(2) Convenience

Convenience refers to the degree to which the patron may move through the system without encountering confusion, disorientation or obstacles. The system must be accessible and easy to use and understand.

1. General Accessibility and Ease of Use

Design of the Metro Rail System shall incorporate human factors engineering to accommodate patrons, including infrequent, occasional and regular users. To provide general accessibility and ease of use, attention shall be paid to patron orientation, minimization of access/egress travel distances between interfacing modes, and to level changes within the system. Station entry points shall be easily identifiable and clear of obstacles and circulatory conflicts.

Use of the system shall not be complicated, confusing, intimidating or imposing to the general public. Informational graphics shall be simple to understand.

The planning and design of the Metro Rail System shall also seek to provide a safe, convenient and secure working environment for system personnel, to ensure their continued health, morale, productivity and quality of work.

Accepted engineering standards and techniques will be utilized in the design of critical interfaces between system and users, and system and system personnel.

2. Design for Elderly and Handicapped Access

The planning and design of Metro Rail System facilities and vehicles shall safely provide for accessibility, mobility and effective usability by the elderly and handicapped, without loss of operating capability for the general patron. It shall be possible for the elderly and handicapped to

travel between and into or out of stations on the Metro Rail System without encountering formidable barriers to their movement. Travel and informational aids shall be provided to mitigate inconveniences caused by their physical disabilities. System design shall address accessibility issues including horizontal distances, level changes, orientation, and use of necessary passenger-oriented equipment such as informational graphics, fare collection equipment, and assistance phones.

Metro Rail System facilities shall also be designed to provide full access for the physically handicapped to System employment opportunities for which they are qualified.

4. URBAN ENVIRONMENT

The design of the Metro Rail System shall seek to minimize, during both Construction and Operation phases, any adverse impact to the neighboring communities as it strives to strengthen the economic vitality of the Regional Core as a whole and the neighboring communities in particular. Urban environment requirements are divided into Construction and Operation phases.

(1) Construction Phase

The design of the fixed facilities shall seek to minimize modification or relocation of existing structures. Any modification that is required shall conform to current codes and standards. Furthermore, every effort shall be made to provide for the continued operation of businesses and services during the construction period, and to accommodate traffic and pedestrian circulation into and around these businesses and services. Utility operations shall not be disrupted to the extent that a hardship is placed on the public.

(2) Operation Phase

The strategic location of a modern transit line and, particularly, of a transit station in a neighborhood, frequently provides a magnet for economic development as the relative accessibility to and from that area is improved. Every effort shall be made to attain maximum benefit to the Regional Core and its corridor by designing in a manner that avoids undesirable features.

Stations and other structures, whether above or below ground, shall be designed to be aesthetically pleasing, in concert with the existing or desired architecture of the surrounding community. Adverse impacts on pedestrian and vehicular circulation within the neighborhood by station access requirements shall be minimized, while providing convenient community access to these stations.

Impacts from noise and vibration shall be minimized by employing appropriate methods in acoustical design for ways and structures, vehicles, stations, and station-located equipment. Maintenance of track, facilities, equipment and vehicles shall have as one objective the continued control of generated noise.

The Metro Rail System, through the quality, aesthetics and openness of its architecture, and through its security procedures, shall not detract from the security of community residents.

5. COST-EFFECTIVENESS

The design and construction of the Metro Rail System must result in a system that is both effective in the attainment of the System objectives and efficient in the means of this achievement. Any evaluation of cost-effectiveness shall consider both the effectiveness and the efficiency of achieving a specified objective; that is, design of system elements must consider both the level and costs of objectives achievement. Alternatives to meeting a specified objective or objectives shall be evaluated utilizing an analysis of life-cycle costs; both capital and annually recurring (operating and maintenance) costs shall be examined as well as the service life of affected components.

Efforts shall be taken to utilize automation to reduce labor costs, but not at the expense of reliability or maintainability. System components shall be designed and specified for high reliability and maintainability.