



American Railway Engineering and
Maintenance-of-Way Association

CHAPTER 12

RAIL TRANSIT¹

Current until revision of next edition

FOREWORD

Chapter 12, [Rail Transit](#) is intended to serve as a guide and offer insight for planning, design and maintenance of a rail transit system. Recognizing the importance of the technical considerations required in the design, construction and maintenance of a rail transit system, the well informed choices of the engineering professional are of utmost importance. The available methods, components and applications are many and varied, therefore concise and clearly defined criteria are essential when developing goals and objectives. This chapter endorses the AREMA recommended practices from other chapters when possible, and recognizes that many of the topics within require extensive coordination with other chapters in the manual. Various techniques, components and methodologies for construction and maintenance must be evaluated fairly and accurately in order to consider alternative concepts on an equal basis. The reader is encouraged to evaluate the methods and effective practices utilized by the many operating rail transit systems in North America, and to utilize this manual and chapter as a basis for the work.

NOTE: This chapter is being developed by Committee 12, which was formed in 1986. Additional material will appear in future Manual Revisions.

¹ The material in this and other chapters in the *AREMA Manual for Railway Engineering* is published as recommended practice to railroads and others concerned with the engineering, design and construction of railroad fixed properties (except signals and communications), and allied services and facilities. For the purpose of this Manual, RECOMMENDED PRACTICE is defined as a material, device, design, plan, specification, principle or practice recommended to the railways for use as required, either exactly as presented or with such modifications as may be necessary or desirable to meet the needs of individual railways, but in either event, with a view to promoting efficiency and economy in the location, construction, operation or maintenance of railways. It is not intended to imply that other practices may not be equally acceptable.

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INTRODUCTION

The chapters of the AREMA Manual are divided into numbered Parts, each comprised of related documents (specifications, recommended practices, plans, etc.). Individual Parts are divided into Sections by centered headings set in capital letters and identified by a Section number. These Sections are subdivided into Articles designated by numbered side headings.



Page Numbers – In the page numbering of the Manual (12-2-1, for example) the first numeral designates the Chapter number, the second denotes the Part number in the Chapter, and the third numeral designates the page number in the Part. Thus, 12-2-1 means Chapter 12, Part 2, page 1.



In the Glossary and Bibliography, the Part number is replaced by either a “G” for Glossary or “B” for Bibliography.

Document Dates – The bold type date (Document Date) at the beginning of each document (Part) applies to the document as a whole and designates the year in which revisions were last made somewhere in the document, unless an attached footnote indicates that the document was adopted, reapproved, or rewritten in that year.

Article Dates – Each Article shows the date (in parenthesis) of the last time that Article was modified.



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Proceedings Footnote – The Proceedings footnote on the first page of each document gives references to all Association action with respect to the document.



Annual Updates – New Manuals will be reprinted and issued yearly, in their entirety.

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American Railway Engineering and
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Part 1

General Information



— 1996 —



FOREWORD

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SECTION 1.1 DESCRIPTION OF RAIL TRANSIT SYSTEMS (1996)

Material being developed.



SECTION 1.2 ROLE OF THE SPONSORING AGENCIES IN TRANSIT ACTIVITIES (1996)

Material being developed.



SECTION 1.3 INTERFACES WITH OTHER AREMA CHAPTERS (1996)

Material being developed.





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Corridor Planning¹

— 1992 —

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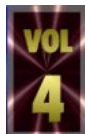
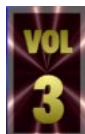
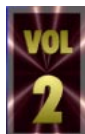
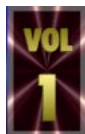


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SECTION 2.1 INTRODUCTION

2.1.1 GENERAL (1992)



- a. This section covers an area best described as conceptual engineering. It describes the steps and considerations which are normally addressed when identifying and analyzing rail transit corridors. A general synopsis of the planning considerations is included to familiarize the engineer with the overall concepts for studying a potential corridor.
- b. A rail transit corridor evaluation study is typically performed by a multi-disciplined team. It is important that engineers be included on this team so that practical engineering considerations are recognized from the earliest stages of project development. This team must work closely with the agency sponsoring the study, as well as the different levels of government and agencies involved in the area to be studied. The study team staffing plan should include environmental impact specialists, financial analysts, and government representatives. In an area with an existing transit system, representatives of the operating authority should also be included.
- c. The first step when starting an analysis is to define clear project goals. Some goals will be set by the sponsor and some will be self-evident. Other goals need to be defined by the project team before an effective study can proceed. Included in this section is a discussion of what the most common goals are and how to achieve them. Once the goals are set, the gathering of data and projections can begin.
- d. Some types of planning data will be readily available. Other data must be specifically developed for the project, and will take a period of time to produce. Ridership projections and economic analyses, in particular, can take long periods of time to obtain, especially if they are to be accurate. Ridership estimates must ensure reasonable conclusions and supportable projections.
- e. The corridors to be analyzed should be identified early in the process, so that data collection can proceed effectively without wasting time and effort on nonviable corridors. Corridor studies are often broken down into conceptual and preliminary phases. The conceptual study phase attempts to look at all choices, but this is done only with the amount of detail necessary to eliminate the worst choices. The preliminary study phase then proceeds with a more in-depth analyses to arrive at the evaluation team's recommendations.
- f. The criteria for evaluating the potential corridors and routes need to be set by the entire study team, with due regard for the sponsoring agency goals. In the case of an initial line in a location with no previous transit experience, local decision makers may be unfamiliar with rail transit planning issues. In these circumstances, the responsibility of the planning team is increased and the assignment of the best qualified people is essential.
- g. The decision to build a rail transit corridor will have extensive long-term impacts on the region. Due to these long-term effects, the choice of rail transit technology must be closely related to the potential ridership and the perceptions of the public. The proposed rail transit system must be perceived as a socioeconomic benefit. It must also interface with and improve the existing regional transportation system. Finally, it must serve the future transportation needs of the area.
- h. Major areas to be addressed in identifying rail corridors go beyond engineering and include:

• Planning	• Finances
• Urban Land Economics	• Operations
• Environmental Issues	• Politics

- i. Engineers working on corridor studies need to have familiarity with the above disciplines, and recognize that they will have strong effects on the eventual conclusions and recommendations. Likewise, the choice of corridor/route and vehicle technologies often affect each other.
- j. The corridor evaluation section includes a discussion of some of the factors important when selecting a vehicle technology. Alignment, station locations, passenger loadings and travel time are obvious factors. However, technology changes, such as those in car design, control and power systems, can cause a cascade effect in other areas.
- k. Lastly, the strategy for the implementation of the corridor study needs to be developed. This includes phasing, land purchases, financing, approvals, public relations and design/construction planning.



SECTION 2.2 CORRIDOR PLANNING GOALS

2.2.1 GENERAL (1992)

In the planning for rail transit corridors, it must always be kept in mind that the central purpose is to move people. More particularly, to move people efficiently and safely with an appropriate degree of comfort. In defining a rail transit project, practical trade-offs must be made between ideal planning objectives and adherence to rigid design criteria. Many other sub-goals and criteria must also be considered, but their relationship to the central goal of effectively moving people must always be kept in mind. Examples of major criteria include the following.

2.2.1.1 Capacity

- a. The characteristic of rail transit that gives it special significance in corridors is its ability to handle large volumes of people on minimal rights-of-way. There are systems operating that move as many as 60,000 persons per hour per track in the peak travel direction. Utilizations of 500-700 persons per track per minute may be more reasonable to avoid unfavorable public reaction to crush loading. However, the 1,000 person per minute capability can be obtained.
- b. Rail transit's high volume capabilities suggest that its primary goal is to move large volumes of people, particularly during peak travel hours. Various operating patterns (local, express service, zone service, skip-stop service) may be considered to tailor the system to passenger demand. Capacity to handle future demand increases requiring additional tracks and ability to bypass stations (e.g. express or zone service) should be considered in the planning process.

2.2.1.2 Land Usage

- a. Due to rail transit's high volume capability, it is particularly well suited to service points of high density land utilization. In these situations, other vehicles move about only with difficulty and large amounts of land and structures are necessarily devoted to streets, highway structures and parking.
- b. A central goal for rail transit corridors is to feed or link these areas of high density land usage, or to act as a catalyst for high density development. Rail transit allows much more dense commercial, business, and residential development than is possible with other transportation technologies. As such, rail transit can be an asset in planning and stimulating real estate development in accordance with community land use goals.

2.2.1.3 Energy



High capacity rail transit uses much less energy per passenger-mile produced than the single occupant automobile. Therefore, an important goal is to couple highway systems to rail corridor systems using fringe or suburban parking developments. In this manner the energy-inefficient automobile portion of the trip can be shortened, and lower cost land can be utilized for parking.



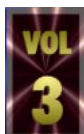
2.2.2 USER NEEDS (1992)

The success of any rail transit corridor will be dependent on its ability to attract riders. The service must be convenient, predictable, pleasant, and economical to the user. Both the infrastructure and the rolling stock must support these needs. Categorized below are various attributes that may be considered important to the attractiveness of service.



2.2.2.1 Convenience

- a. Rail corridor stations must be convenient to destination points and facilities such as station parking lots. Pedestrian mobility to and around stations must be direct and without obstruction. The practical pedestrian radius will be influenced by length of walk, surroundings, climate, and local preferences.
- b. For destinations beyond walking distance, convenient interface facilities with connecting transportation systems are a must. Timing of connections at interface points is particularly important.
- c. Frequency of service and perceived speed are other important characteristics affecting convenience. High density systems commonly operate on as little as 90 second headways. Moderate ridership densities can use 10-15 minute headways, while longer headways are often used in commuter rail service. Various types of operating patterns (express, zone, skip-stop, etc.) may be used to reduce travel times.



2.2.2.2 Reliability

- a. Of all the characteristics that will make the rail transit corridor attractive, reliability of service may be the most important. Transit riders do not have a sense of control. The system must not frustrate them or make them want to regain control (i.e., return to a private auto). Significant variations from expected performance cannot be tolerated.
- b. Reliability starts with dependable, maintainable mechanical equipment, electrical facilities, and infrastructure. To the extent possible, maintenance must be accomplished without disrupting or altering service. The system must also be resistant to adverse weather conditions such as snow, heavy rain, or fog.
- c. Another aspect of reliability occurs at connections. Undependable or overly long connections are annoying, fare machines or turnstiles that don't work are frustrating, and inadequate parking facilities make the trip difficult. Techniques such as timed transfers, dependable machines, and user-friendly designs that promote the sense of reliability must be included in system goals.

2.2.2.3 Ambiance

- a. The ride quality, rail vehicles, stations, and station access must be pleasant. Station designs should provide shelter from wind and weather, and provide a feeling of security. Stations (and their neighborhoods) must be "pedestrian friendly." Activity centers such as small shops can be integrated into station designs to improve the appearance and vitality of the station environment.

- b. While there is a necessary level of reliability and attractiveness to generate the volume of passengers required for support of the rail corridor, overspending on details that add little to convenience, reliability, general ambiance, utility of construction or efficiency of operation and maintenance should be avoided.
- c. Reasonable Fare Structure – Studies are required to suggest an appropriate fare structure and to designate the sources of additional funding. This additional funding typically carries from 15 to 65% of the cost of operations. The additional funding must be derived from a long-term, dependable source.

2.2.3 ECONOMIC ACCEPTANCE (1992)

Only a portion of the population will ride the rail transit corridor. Yet, the presence of the rail transit corridor will affect the whole community through its influence on highway traffic volumes and density of land usage. It is important that the rail transit corridor be understood and accepted by the community as a whole, because of the rail line's impact on the surroundings and its need for some form of public subsidy. A definite effort should be made to quantify the costs and benefits of all transportation modes in the community, including rail transit.

2.2.4 ENVIRONMENTAL ACCEPTANCE (1992)

Environmental acceptance goes well beyond the common restrictions on air and water pollution. It encompasses the question "is the proposed rail corridor compatible with the character and feelings of this community?" A goal of the rail corridor development is to pass this community test. A number of factors must be considered, including air quality, noise, vibration, visual appearance, travel time, traffic congestion, blocking of streets, taking of property, dislocation of neighborhoods, blocking of views, construction disruptions, etc.

2.2.5 SOCIAL ACCEPTANCE (1992)

Modern day society requires that certain social goals be met when providing transit services. These generally require an equality of mobility for all persons in the community. Communities are unique and the relationship of their social goals to the rail transit corridor must be aired and decided.

2.2.6 SAFETY (1992)

The corridor safety goal is that it must be, on a per trip basis, at least as safe as the existing alternatives. A number of particular details for attention are categorized below.

2.2.6.1 Train Movement

By far the most important safety matters in rail corridor operations are speed and control of train movement. The irrevocable goal is that safe separation distances be maintained at all times and that there be no collision or hazard of accident between trains.

2.2.6.2 Infrastructure

Design and engineering of tracks, bridges, and tunnels utilize well-developed safe practices and codes. The goal for infrastructure is that it be safe, maintainable and in accordance with all applicable codes.

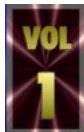


2.2.6.3 Electrical Hazards



Systems employing overhead or third-rail power distribution must include protective designs for both the public and their own employees. Access to overhead wires must be denied at bridges; third-rail should employ covers, and be located on secure right-of-way.

2.2.6.4 Vehicular Conflicts



Grade crossings accidents are the principal cause of human injury due to railroad operations. Collisions between highway vehicles and rail vehicles must be prevented. Systems employing automatic train operation must be isolated from all uncontrolled activity such as vehicles and pedestrians at grade. This isolation includes the system's own maintenance activities.

2.2.6.5 Pedestrian Safety



- a. Stations, station platforms, stairways, and escalators must include safety considerations in their design. Problems of car door safety and platform gap awareness are important focuses for safety on high density systems. Designs must also recognize the safety considerations posed by persons with physical disabilities. The goal is to avoid personal injuries from stumbling, slipping, falling, running into objects, or being pushed into a dangerous situation.



- b. Trespassers form a second consideration for pedestrian safety. Rail rights-of-way should be designed to be relatively inaccessible and warning signs should be used.

2.2.6.6 Security



Along with general pedestrian safety, security of individuals must also be considered. The problem is as much perceived security as it is any actual threat to persons using the transit system. Designs should attempt to keep persons in full view of others and avoid solitary paths of movement in and around stations. The goal is to avoid security problems by keeping people together and within sight of one another. Proper use of CCTV systems with centralized security and communications bears consideration.

2.2.6.7 Fire

The primary source of transit fires is electrical systems, both in trackside power systems and onboard the cars themselves. The infrastructure must be able to evacuate trapped passengers quickly and safely and must allow access and safety for fire fighters. Designers are well advised to know their local fire safety codes and, in particular, NFPA 130, "Standard For Fixed Guideway Transit Systems." The goal is to avoid injury or loss of life due to fires occurring on the rail transit system.

SECTION 2.3 DATA COLLECTION

2.3.1 GENERAL (1992)

A complete set of data and information is needed early in the rail corridor planning process. This data ranges from the demography of the human populations to be served to the physical characteristics that will govern engineering and design of the system. This section suggests the variety and scope of data to be collected and considered.

2.3.2 DEMOGRAPHIC DATA (1992)

- a. Demography is “the statistical study of human populations, particularly with respect to size, density, distribution, and vital statistics.” The beginning of the corridor analysis is to determine if there are enough people who are likely to utilize the corridor to justify an investment in rail transit. The study will seek to identify existing demand, and may be conducted as part of a larger effort to use rail transit as a tool to guide future development and to implement community land use policies. Sound data concerning the distribution, characteristics, and density of potential service populations are essential to estimating corridor demand.
- b. The statistics must include where people live and where people work, as in most instances, the rail corridor will be connecting people to their workplaces. Trip origins may be generated by close-by high density housing, or by a more distant and dispersed market which arrives via park-and-ride facilities or on feeder bus systems.
- c. Demographic data is also needed at the destination. For rail corridors, it is thought that most destinations will be defined by high density, temporary populations such as offices, commercial facilities, retail facilities, production facilities, transportation hubs, shopping areas, entertainment centers, recreational facilities, etc. People visiting these activities may be either workers or customers. For example, the temporary daily working population of New York’s JFK Airport is 50,000 people, a substantial market in itself without considering customers.
- d. The time of day that these populations congregate and disperse is critical to the corridor data. The primary task of the rail corridor will be the handling of the peak period passenger flows. The off-peak and reverse commute movements must also be estimated, since these supplemental markets are important to the overall economics of the corridor.
- e. Vital statistics of the population are also important. The working population will have a different demand than the leisure population. Age distribution will affect demand and particularly future demand. Economic distribution will also affect demand.

2.3.3 ATTITUDE SURVEYS (1992)

- a. The attitudes of the current land owners and the residents of the communities through which the corridor passes will have a strong influence on the feasibility of a rail corridor. Survey data about these attitudes are important because they imply whether the project is a community effort, a development effort, or an unsupported engineering concept. Projects often fail to materialize due to the inability to resolve political differences.
- b. The attitude surveys and observations must answer a number of questions:
 - Is the rail corridor seen as improving mobility by local residents and businesses?
 - Are there resistances to transportation system changes? If so, what are they?





- What are the perceived problems with the proposed transportation system?
- Will the political system support the changes called for by adoption of a rail transit corridor?
- How do attitudes vary between absentee owners, resident owners, and resident users?

c. A second set of objective data should be collected. This data supplements the community surveys and should include:

- Recent trends in land use density and land use classification.
- Apparent reasons for change.
- Probable life cycles of present and future land use developments.

d. Opinion surveys must be interpreted with caution. What people say, how they feel, and what they eventually do to support or block a project are not always consistent. Taking surveys does serve the function of coupling the project and its planning team with the community. But objective data should always be utilized to assess the validity of subjective survey data.

2.3.4 ZONING DATA (1992)

- a. Land use zoning must be compatible with rail corridor development. The suitability of rail corridors is highly dependent on the timing and density of population movements and the presence of high density land occupancy.
- b. Zoning maps and zoning levels help project future land use densities and weaknesses in the existing zoning plan. The zoning data must be evaluated from the standpoint of “what’s practical.” That is, how will zoning requirements change and will the market really support either the projected land use or the present zoning on the books?

2.3.5 ENVIRONMENTAL DATA (1992)

- a. Various governmental requirements exist to control activities that may disrupt the environment. If the rail project will utilize Federal funds for its construction, the requirements for an Environmental Impact Statement (EIS) must be met. A project cannot be artificially divided into parts to avoid this requirement.
- b. If federal funding is not used, state or local requirements must be met. Local requirements are often more stringent than the federal requirements.
- c. The range of environmental investigation can include:
 - Wetlands.
 - Endangered species.
 - Water quality.
 - Wildlife.
 - Air quality.

- Hazardous substances (site cleanup).
- Public safety.
- Public nuisances (noise, lighting, odor, vibration).
- Public convenience (transit times, detours, delays, accessibility).
- Rerouting of utilities and traffic.
- Taking of property.
- Archeology of historic sites.
- Construction limits (duration, time of day, work sites).
- Construction nuisance.
- Impact on commercial establishments.
- Impact on property values.

2.3.6 GEOGRAPHIC AND PHYSICAL DATA (1992)

- a. Geographic and physical data are often available from previous surveys. Data sources include:
 - Topographic maps.
 - Development maps.
 - Geologic data.
 - Climatic records.
 - Hydrological records.
 - Utility maps and records.
 - Railroad right-of-way maps.
 - Track and signal diagrams.
 - Other right-of-way maps.
- b. The physical characteristic data must be combined with demographic and transportation data to identify the physical obstructions and preferable routes for the natural flow of the transportation system. From this process, a set of possible corridor routes will emerge to be evaluated.



2.3.7 PROJECTION DATA (1992)



- a. The beginning of a rail corridor investigation should be a literature search of published population and economic growth projections. Public records and utility records are good sources of growth information.
- b. The following points should be considered to assess the validity of the growth projections:
 - What are the underlying assumptions?
 - What assumptions are missing?
 - What are the sources of the base data?
 - Are the assumptions and base data adequate?
 - Do the projections make sense?
- c. Next, evaluate the projections themselves. Are they relevant to the rail corridor? What will be their effects?
- d. Missing projection data must be developed. It is important that the corridor agency participate in development of projections so that other agencies' observations and knowledge are incorporated. A consensus is important; all parties should formally agree on the population and employment forecasts. Also, these forecasts should indicate a range of results (low, medium, and high) using appropriate statistical measures, such as means and standard deviations.

2.3.8 CURRENT AND PROJECTED TRANSPORTATION DEMAND (1992)

- a. Accurate knowledge of current transportation patterns is indispensable to any rail corridor plan. The data desired is accurate origin-destination pairs by mode and by time of day.
- b. Once the current transportation patterns are known, population, employment, and activity projections can be considered and the range of future demand forecast. The first transportation forecast assumes no changes in transportation infrastructure and forecasts the impacts of future increases in transportation demand.
- c. If high density land use is present or projected, rail transit corridors should be considered. It is very important that once a rail corridor has been defined, it must be integrated into an overall regional or local area transportation plan. This plan must include highways, local roads, parking, and public transit.

SECTION 2.4 CORRIDOR IDENTIFICATION

2.4.1 RAIL CORRIDOR CRITERIA (1992)

Within each given study area, specific corridors of transportation demand will exist. These corridors are defined by the transportation demand which arises from centers of economic and social activity such as business districts and their associated residential communities, schools, hospitals, and shopping and recreational areas. Transportation demand manifests itself as major traffic flows along the corridor between activity centers. The key point is to identify those corridors having sufficient ridership potential to justify consideration of the rail mode.

2.4.2 TRANSPORTATION DEMAND (1992)

- a. Corridor transportation needs should be considered within the context of both existing and projected demand. Existing demand will be evident from the current level of traffic on highways and transit routes within the corridor. Traffic congestion and/or heavy transit ridership point out areas where additional capacity is needed and where rail development may be feasible.
- b. The forecasts produced by a metropolitan planning organization (MPO) and similar bodies should be considered in projecting future demand. These forecasts will provide an overall view of the area's anticipated transit demands. Corridor-specific studies should be conducted to accurately assess demand within each corridor. Study results must recognize and attempt to correct for the effects of data limitations, "built-in" software assumptions, and other circumstances which may be present.
- c. Origin-destination studies can be undertaken to estimate future transportation demand in the identified corridors within an appropriate planning horizon.

2.4.3 TRAFFIC SOURCES AND CORRIDOR DEFINITION (1992)

A corridor will be generally defined by its major traffic flows. Key elements in refining the characteristics of a corridor are the identification and characterization of its major traffic sources. These passenger generators must be identified so that logical corridor end points and intermediate nodes can be determined, together with their connecting transportation links. Traffic flows can then be analyzed within the framework of this skeletal corridor defined by links and nodes.

2.4.4 ROUTE IDENTIFICATION (1992)

- a. Once identified, a corridor will broadly define the location of a proposed rail transit line within its boundaries. As corridor characteristics are analyzed, the rail line location will be further defined in terms of a general route or alignment. Characteristics defining a route may be the traffic demand pattern, existing transport facilities (rail lines, highways, power lines), or the natural topography. In some cases where a candidate route is delineated by existing or projected travel demand, there may not be an obvious physical route available.
- b. These situations should be evaluated at an early stage so that their impact on project cost and feasibility may be determined.
- c. In some situations, there will be two or more alternate (parallel) routes possible through all or part of the corridor. In these cases, an analysis must be conducted to rank candidate routes.



2.4.5 CONSTRAINTS (1992)

Even at the earliest stages of a corridor study, certain constraints will be readily apparent. The initial feasibility survey of a rail corridor should attempt to identify as many of these constraints as possible. The available routes within a corridor may be constrained by both natural topography (hills, watercourses, wetlands, etc.) and the adjacent infrastructure (highways, urban development, etc.) In particular, constraints should be reviewed to identify “fatal flaws” as early as possible so that the list of feasible route alternatives may be initially ranked for later evaluation.

2.4.6 LAND AVAILABILITY (1992)

- a. The availability of land suitable for rail transit development within a selected corridor may be limited. Often, land and right-of-way availability become the crucial issues in rail corridor development. The planning process should explore creative use of existing public and private rights-of-way to mitigate these problems.
- b. The purchase of land to create a new transportation corridor where none exists is an expensive, time-consuming activity. It is a highly public endeavor requiring multiple review processes. As an alternative, it may be desirable to analyze the rail transit potential of existing transportation corridors, such as railroads, highway medians, utility rights-of-way, etc. The presence of a relatively inexpensive, existing right-of-way may make a rail project practical and economically justified, even if it is not among a region’s most densely travelled corridors.
- c. The use of existing rights-of-way is subject to two caveats: The conversion cost to rail transit use must be reasonable, and the project must service a meaningful level of transit demand.
- d. Public agencies may also wish to preserve existing unused rights-of-way or actively assemble individual parcels into new corridors for future transportation use. Otherwise, these opportunities may be lost through uncoordinated land development.

SECTION 2.5 CORRIDOR EVALUATION

2.5.1 SELECTION OF ROUTE WITHIN A GIVEN CORRIDOR (1992)

- a. Following the determination that a particular corridor justifies rail transit, the selection of the route to be utilized within the corridor is undertaken. The route selection process must recognize the differing characteristics of the various rail modes to some degree. If it has been determined that this corridor will be served as an extension of an existing system, then many of the design standards will be known at this point.
- b. If the decision of which rail mode to use has not been made, the physical attributes of the corridor (such as right-of-way width, curvature, grades, street alignment vs. dedicated right-of-way, etc.) will influence the decision on the rail transit type to be used.
- c. Another important activity early in the evaluation process, when federal (or other government) funds are used, is development of an Environmental Impact Statement (EIS). The EIS is a comprehensive and detailed study of the impacts of the rail corridor and alternatives to the route and mode chosen. The EIS process must be started early in project planning if implementation delays are to be avoided.

2.5.2 CONVENIENCE FOR PASSENGERS (1992)

- a. The most heavily weighted factor in the selection of a particular route within a corridor should be how well the line serves its potential passengers.
- b. Passenger ridership studies and modal split analyses help determine how many passengers will ride a particular rail line. A route selection that maximizes the number of passengers attracted to the facility indicates how well the public is served by the proposed route. One must also look at future growth tied to the zoning, future developments, regional planning, and other factors which affect where people work, where they live, and how they will travel.
- c. Design criteria for rail transit projects differ from most railway engineering projects. Criteria such as shortest distance, least grade, minimum curvature, ease of operation, and other factors are given far less weight in the design of an urban passenger line.

2.5.3 LAND AVAILABILITY (1992)

- a. As development of urban and suburban areas continues, the identification of usable rights-of-way is a key item in the planning process. If the line is to serve any portion of suburban development, not only must land be available for the line itself, but equally important land must be available for the following:
 - Station facilities.
 - Parking lots.
 - Pick-up and drop-off areas.
 - Shop facilities.
 - Substations and support facilities.
- b. The changing character of the work force over the past few decades has dramatically increased the proportion of rail riders requiring automobile parking space at the railhead.

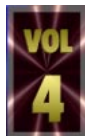
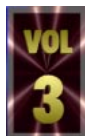
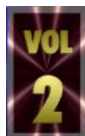
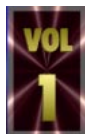
2.5.4 RELATIONSHIP TO HIGHWAY AND STREET NETWORK (1992)

- a. The relationship of the location of stations to the highway network, and in particular, the freeway system and arterial road network, must be considered. If the purpose of the line is to serve a large area beyond the corridor itself, then the design of the station/highway interface may include modifications of the freeway interchanges to facilitate intermodal coordination.
- b. The total travel time of the passenger is a very important consideration in route selection. However, this factor should not be calculated simply from one rail station to another; rather it must be calculated from the passenger's origin (home) to his/her destination (work, school, entertainment). Total travel time includes walking or driving, waiting, transfer, travel on bus and/or rail transit, walking, and elevators to final destination.

2.5.5 CENTRAL BUSINESS DISTRICT CONSIDERATIONS (1992)

- a. In the Central Business District (CBD) there are many factors that must be considered. An extremely important factor is how well the route is integrated with the passenger distribution system in the CBD. The alignment of the new system must also mesh with existing and proposed high rise development.





- b. If there are other rail transit lines in the area, new stations should be located in a manner to allow ease of passenger transfer between systems. New stations should be directly connected to old stations if at all possible. If the CBD is, or will be, served by a local guided transport system it should complement the rail line – and they should not duplicate each other.
- c. If buses and taxis are the prime means of distribution within the CBD, then the location and design of stations must be selected to facilitate transfer to these systems.

2.5.6 URBAN AREA – INTERFACE WITH LOCAL NEIGHBORHOODS (1992)

- a. In the urban area, the route, type of construction (at-grade, aerial, underground), and selection of sites for stations, storage yards, and maintenance shops must conform with the nature and character of each neighborhood that the line serves.
- b. Station design should be integrated into the fabric of the individual neighborhood being served. From the engineering and operation standpoints, stations may be standardized but from aesthetic standpoint they should be assets and an integral part of the area. Properly done, the new stations will become the hubs in their local area and will attract development around them.

2.5.7 JOINT DEVELOPMENT OF TRANSIT STATIONS AND FACILITIES (1992)

- a. The location of a new transit station may attract private-sector development of stores, offices, and housing. The possibility of joint public-sector/private-sector investment should be considered when decisions concerning station location are being made. Such investments would offset portions of project construction costs and may be made through joint development of station/commercial complexes, establishment of benefit assessment districts, or other means negotiated between the parties.
- b. Similarly, the use of air rights over rail storage yards and maintenance shops for commercial and residential use should be part of the basic planning of the line. Such basic considerations as additional spacing between yard tracks to allow later placement of columns for future construction allows such development much later, even though the precise nature of the development may not be predicted when the line is being built.

2.5.8 PROTECTION OF PROPERTY VALUES (1992)

- a. In the suburban zone, the goal should be to locate the line in such a manner as to maintain property values – not reduce them. Stations must be located where large tracts of land are available for parking facilities. Both immediate and future parking needs should be thoroughly considered when site selection is being made.
- b. In the urban zone, proper integration with existing distributor systems will reduce the need for large parking areas.
- c. Location of traction power substations required by electrified lines must be handled carefully. If they cannot be located in industrial areas, careful attention must be given to the architecture of the structures in order that they appear to be part of the existing environment. They should blend with the appearance of adjacent buildings and maintain the property values of neighboring structures.
- d. Where possible, substations may be integrated with passenger stations, shop facilities, or other project-related structures.

2.5.9 FACTORS RELATING TO CHOICE OF EQUIPMENT (1992)

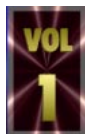
- a. The type of equipment to be used must be determined before route evaluation is completed. In order to successfully achieve the mission of attracting passengers from automobiles to rail transit, the transit vehicle chosen must be fast, safe, and include a comfortable passenger environment. The cost of the vehicles is a major element in the economic evaluation of routes on a proposed new system.
- b. The number of vehicles required on a system will depend not only on the length of a line but also on the actual operating speed, station dwell times, and other factors such as location of turnback facilities. When all of these factors have been considered, then a determination can be made of the type of equipment to be used within the corridor.
- c. In the case of electrified lines, factors peculiar to this form of propulsion must be considered, such as the availability of electric power in the area. Depending on the type of electrification chosen (third-rail or overhead wire) appropriate measures must be included to provide a safe environment.
- d. In the case of internal combustion propulsion, factors such as fuel storage and handling, and the ventilation of tunnels and stations must be considered. Noise and fumes from idling equipment both during daytime layover in the vicinity of the CBD and during night hours at the urban or suburban terminals must be considered in terminal designs.
- e. The equipment decision, the civil engineering standards for the route, and the service level to be achieved are all closely related. The following discussion gives a broad range of possibilities that can be considered.

2.5.9.1 Commuter Rail

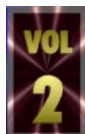
- a. Commuter rail services operate over trackage which is part of the general railroad system of transportation. As such, the rolling stock, signal equipment, and operating practices must be in accordance with all applicable government (e.g., state regulations, Federal Railroad Administration) and Association of American Railroad standards. Commuter railroad operations, including associated terminals and shop facilities, will therefore require railroad-type rolling stock, large curve radii, low grades, and signaling systems compatible with main line railroad practice.
- b. Passenger cars may utilize the single-level, bi-level or gallery configurations. Generally, multilevel cars will offer increased passenger capacity over single-level designs. Seating pitch and type (four-across vs. five-across) will also influence capacity.
- c. Consideration should be given to use of as large a car as possible, consistent with capacity requirements, available physical clearances, and community preferences. Use of larger cars will keep the fleet size down and reduce many factors, such as:
 - Cost of maintenance.
 - Length of station platforms.
 - Storage track requirements.
- d. If a desired extension requires tunneling (e.g. into the CBD), there is an immediate trade-off between the additional costs for tunneling for a larger car, versus the factors involved in a larger fleet. A limited area for a terminal station, on the other hand, may require use of high capacity cars to minimize required platform lengths. The trade-offs are unique for each situation, and should be evaluated to identify the most economic approach.



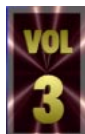
2.5.9.2 Rapid Transit



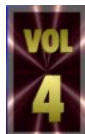
- a. If the designated corridor has characteristics suggesting the need for a trunk line rapid transit system, the selection of such factors as car length, platform height, and door pattern affect the length of stations, the required running and station dwell time, and the number of cars in the fleet.
- b. In turn, the selection of the route alignment may require cars that can negotiate small radius curves and steep grades. The height of the car becomes a factor in the cost of construction if extensive tunneling is involved. The weight of the car becomes a factor if extensive aerial structures are required.
- c. The capacity of the cars, the size of the door openings, and the minimum spacing between trains strongly affects the design of the station platforms, staircases, escalators, and other station design elements relating to capacity.



2.5.9.3 Light Rail Transit (LRT)



- a. Vehicles designed for use on lines which will include a combination private rights-of-way, aerial structures, tunnel, and running in public streets with automotive traffic must be designed to accommodate an additional series of criteria.
- b. In order to negotiate curves required when turning corners in an existing street pattern, vehicles must be capable of negotiating extremely short radius curves. If the route under consideration has steep grades, these must also be accommodated.
- c. Street running with automotive traffic requires that the braking rates and systems for vehicles in such service be capable of much shorter stops than other rail systems.



- d. In order to obtain high productivity, many LRT lines utilize trains of several cars under control of one operator. The total train length must be determined such that the rear of a train stopping for a traffic light at one intersection will not interfere with traffic flow at adjacent intersections.
- e. The design of stations within the city streets will be affected by, and will affect, the design of the car.

Basic route selection of all transportation facilities includes the factors of travel time, initial cost of construction, initial cost of locomotives and vehicles, operating costs over the life the system (life cycle cost of system), feasibility of construction and political acceptability. All of the factors enumerated above must be considered before the final evaluation is made.

SECTION 2.6 SELECTION OF RAIL TRANSIT TECHNOLOGY

2.6.1 GENERAL (1992)

- a. The central issue in the selection of the best-suited rail transit technology is the selection of the vehicle technology or type.
- b. The functions of service goals and vehicle type/technology are closely interrelated. Service goals set the level of service frequency, transit time, station spacing, comfort levels, and amenities, as well as the nodes to be served. These, in turn, determine the power and propulsion requirements, station size, and vehicle configuration for expected loadings. Finally, the requirements for the vehicle type are reflected in the infrastructure (curvature, grade, speed capabilities), need for grade separation, and other design characteristics of the track and structure.



2.6.2 VEHICLE TECHNOLOGY TYPES (1992)

- a. There are four general types of rail transit technology that can be considered:
 - Commuter Rail.
 - Heavy Rail.
 - Light Rail.
 - Automated People Movers.
- b. While each type has some flexibility in application, the technology must be compatible with the selected route alignment. As a result, from a technical standpoint, the selection of transit technology is interdependent with the choice and design of the route alignment.

2.6.3 ROUTE TECHNICAL CONSTRAINTS (1992)

The following route characteristics form the constraints that will influence the selection of the transit technology.

2.6.3.1 Exclusive Grade-Separated Right-of-Way

This alignment represents an ideal situation for any rail technology. It is generally utilized when third-rail power collection is used and is a requirement when automated rail systems are employed, due to safety considerations. In addition, automated systems require fencing and should consider intrusion detection protection. Exclusive rights-of-way are desirable for higher operating speeds, regardless of the power supply or control systems.

2.6.3.2 Dedicated Grade-Level Right-of-Way

Rail operators have often been located on dedicated rights-of-way with periodic crossings at grade for highways and pedestrians. This arrangement is typical of most of the U.S. railroad network and many transit operations. This configuration allows economy of development but incurs safety problems at street crossings and with trespassers.

2.6.3.3 Street Running or Non-Dedicated Right-of-Way

Alignments which intermix rail vehicles with street traffic will generally prohibit commuter rail equipment due to size and braking distance requirements. Automatic systems are not suitable for street running due to the inability of their control systems to react to unsafe movement by automotive vehicles or pedestrians. Street running is well suited for light rail operations, and can offer advantages with respect to alignment flexibility and cost economies.

2.6.3.4 Curvature

Commuter rail systems are typically limited to approximately 10 degrees of curvature, except in terminal areas. The other rail technologies can accommodate curvatures to 46 degrees (125-foot radius) and sharper; however, it is recommended that new construction limit curvature to approximately 23 degrees (250-foot radius) for light rail and 19 degrees (300-foot radius) for heavy rail. People mover systems can accommodate sharper curvature when short cars are utilized. Note that various features of car construction can materially influence the minimum radius curvature allowable. [Table 2-1](#) illustrates typical minimum radius curvatures utilized on existing systems.

Table 2-1. Typical Minimum Curvature Examples

Category	Mainline	Yards and Terminals
Commuter Rail	570 feet (10° maximum curvature)	300 feet (19° maximum curvature)
Heavy Rail	85-750 feet	85-300 feet
Light Rail (Note 1)	82-100 feet	82-100 feet
People Mover	230-328 feet	100 feet
Note 1: Radii as short as 35 ft are used on light rail systems that have evolved from historic trolley car systems. However, choice of these shorter radii limits the procurement and operation of equipment as the more common modern day light-rail car designs are designed for 82 ft (25 meter) radius.		

2.6.3.5 Grade

Commuter rail, while using existing roadbeds in most cases, should utilize desirable grades of under 2% for mainline operations. Desirable maximum grades for heavy rail construction are approximately 3%. Light rail vehicles usually possess the ability to climb steeper grades than heavy rail equipment. New construction should reference existing operating properties to establish desirable grades. Care must be taken in considering propulsion methods and weather considerations in planning for gradients. A major criterion is vehicle braking performance on descending grades; systems utilizing automatic controls usually require that grades within 1,000 feet of stations be limited to 3% or less. See [Table 2-2](#) for examples of existing systems.

Table 2-2. Typical Maximum Gradient Examples

Category	Mainline	Exceptions
Commuter Rail	3%	—
Heavy Rail	6%	7%
Light Rail	5-6%	7%
People Mover	6%	8%

2.6.3.6 Speed

Typical design running speeds are 50 to 80 miles per hour. Commuter rail, if operating on joint use trackage, should be designed for speeds up to 79 miles per hour in wayside signal territory. It may be designed for higher speeds in cab signal or automatic train stop territory, as governed by FRA rules. Heavy rail vehicles, for the most part, are designed for fast acceleration/deceleration for throughput and frequent stops. Running speeds up to 65 mph are generally adequate. Light rail vehicles are also designed for fast acceleration/deceleration and may also be operated in non-exclusive rights-of-way or in street running with other vehicles. Typical light rail vehicles are designed for maximum speeds in the 50 to 65 miles per hour range. Automated systems for dense patronage in an urban environment have been designed for speeds up to 70 mph. Automated people movers also serve dense patronage (such as at airports), but are designed for somewhat slower speeds, in the range of 25 mph to 50 mph. For each technology, desired speeds must be determined from station spacing, line geometry, braking capabilities, and the ability to attain and maintain vehicle design speeds. For an example of typical maximum speed refer to [Table 2-3](#).

Table 2-3. Typical Maximum Speed Examples

Category	Maximum Speed
Commuter Rail	70-100 mph
Heavy Rail	50-80 mph
Light Rail	50-55 mph
People Mover	50-55 mph

2.6.3.7 Station Spacing

Criteria for planning station spacing should take into consideration land use patterns and population densities. Stations in central business districts and areas of high employment concentration will often require closer spacing than suburban stations. The availability of distribution and feeder systems will also affect station locations and spacing. Commuter rail stations are often several miles apart. Station spacings for heavy and light rail systems are progressively less. For automated people mover systems, spacing may be measured in the hundreds of feet, depending on the specific application. For an example of typical station spacing refer to [Table 2-4](#).

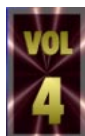
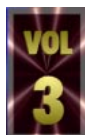
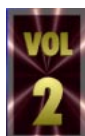
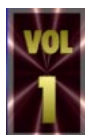
Table 2-4. Typical Station Spacing Examples

Category	Downtown	Outlying
Commuter Rail	1 Mile	5 Miles
Heavy Rail	0.5 Mile	1-2 Miles
Light Rail	Every Block or 2nd Block	0.5-1 Mile
People Mover	800-1500 Feet	0.5-1 Mile

2.6.4 VEHICLE TECHNICAL CHARACTERISTICS (1992)

- Vehicle configuration is a variable of the technology selected, expected patronage loadings, and planned travel times. Commuter rail utilizes single vehicles for 80 to 185 passengers combined into trains of variable length. Commuter passengers usually require a seat because of the distances covered, limiting standee loads.





- b. Heavy rail vehicles typically have a seating capacity of 40 to 80 passengers and can accommodate crush loads well in excess of 100% additional standees. Heavy rail operates in long trainsets with high platform loading/unloading capabilities and minimum headways.
- c. Light rail employs single-vehicle seating capacities of approximately 50 to 85 passengers and utilizes three or four vehicle trainsets for peak operations. Because of operating philosophies and the street-level boarding/disembarking of the light rail vehicles, a 50% standing capacity is calculated for load analysis. When loads for light rail vehicles exceed this factor, a decision must be made as to accepting crush loads, adding more vehicles to trains, or by reducing headways. Each of these options must be looked at from a cost effectiveness standpoint.
- d. Automated people mover systems are tailored to operate with either demand-sensitive or preset headways. Personal rapid transit cars may be designed for only six to ten passengers per vehicle, while cars in airport and urban service may be designed to accommodate 50 passengers or more per vehicle.
- e. Systems can be planned for all persons seated, all standees, or a mix. [Table 2-5](#) shows the wide variety of vehicle designs.

Table 2-5. Typical Vehicle Characteristics

Category	Seating Capacity	Maximum Capacity	Accel. Rate (mphps)	Decel. Rate (mphps)	Cars/Train
Commuter Rail	80-185	120-185	0.5	2.0	6-8
Heavy Rail	40-80	100-175	2.5-3.0	2.8-3.2	6-10
Light Rail	50-85	110-175	3.0	3.0-4.0	1-4
People Mover	30-50	75-160	2.2-3.0	2.5-3.0	1-8

2.6.5 CONTROL TECHNICAL CHARACTERISTICS (1992)

- a. Signalling should not be viewed as a governing factor in the corridor selection process, but should become an outgrowth of the technology chosen, and must be appropriate for the speeds required and traffic density anticipated. Commuter rail, usually running on shared freight trackage, is best suited to operate with the system the railroad has in place. This allows quicker and less expensive start-ups. Heavy rail, by its nature, is sophisticated and modern-day systems are highly automated. Light rail, by its use of shared rights-of-way, does not need to be highly signalled. However, in tunnels and at higher speeds, a minimum of a wayside signal system should be used. With the trend of having light rail traveling down centers of boulevards and, in some cases, reverting to street running with automobiles, the signal system is often integrated with the automobile traffic signals. People movers require totally automated control systems, but generally have manually-operated backup controls for fault recovery, and for shop and yard movement.
- b. Various types of control systems in use are listed here in order of increasing protection/automation:
 - LOS – Line of Sight.
 - MB – Manual Block.
 - ABS – Automatic Block System.
 - ATS – Automatic Train Stop.
 - ATP – Automatic Train Protection.
 - ATC – Automatic Train Control.
 - ATO – Automatic Train Operation.

- c. Control systems typically employed on the various rail transit modes are shown in [Table 2-6](#).

Table 2-6. Typical Control Characteristics

Category	LOS	MB	ABS	ATS	ATP	ATC	ATO
Commuter Rail	—	X	X	—	X	—	—
Heavy Rail	—	—	X	X	X	X	X
Light Rail	X	—	X	—	—	X	—
People Mover	—	—	—	—	—	X	X

2.6.6 ELECTRIC TRACTION CHARACTERISTICS (1992)

The use of diesel power for new-start commuter operations is dictated by the joint use of trackage with diesel-powered freight operations and the capital cost of electrifying a railroad for commuter operations. Heavy rail, utilizing dedicated rights-of-way and subway operation, has commonly used a third-rail, collector strip, or overhead wire power distribution. The presence of grade crossings usually found in light rail operations will generally restrict the use of third-rail power collection and will normally require overhead contact or catenary wire. Power for automated people mover systems is always derived from the guideway. While these general guidelines apply, reference should be made to Chapter 33, Electrical Energy Utilization, for a more detailed discussion.

2.6.7 SAFETY (1992)

- a. Safety considerations must be given high priority in the planning process for corridor selection. Factors that govern safety are:
 - The level of signalization chosen.
 - Whether grade crossings are to be considered.
 - Whether the system operates on exclusive or shared right-of-way.
 - Type of power source.
 - Level of right-of-way security.
- b. While the list is not complete, it should point out that each step of evaluating the technology should emphasize the safety level of the alternative considered.

SECTION 2.7 REGIONAL TRANSPORTATION INTERFACES

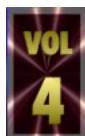
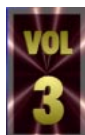
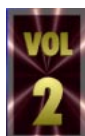
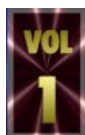
2.7.1 GENERAL (1992)

Transportation interfaces are those points where transport systems or modes meet and require the passenger to change modes. The portrayal of interfacing between a rail transit corridor and other forms of transportation is described in this section.



2.7.2 TYPES OF INTERFACES (1992)

Interfaces of rail transit with other forms of transportation are basically as follows:



- Pedestrian Traffic or “Walk-Ins.”
- Bicycles.
- Automobile Traffic:
 - Park-and-ride.
 - Drop off passengers (Kiss-and-Ride).
 - Pick up passengers.
 - Taxis.
- Other Public Transit Systems:
 - Buses and trolleys.
 - Subway systems.
 - Commuter rail systems.
 - Intercity passenger trains.
 - Airports.
 - People movers.
 - Ferries.

2.7.3 TYPICAL INTERFACES (1992)

- a. Two basic types of stations and their respective interfacing are discussed below. The reader should also refer to [Chapter 6, Buildings and Support Facilities](#), [Design Criteria for Railway Passenger Stations](#) and [Chapter 14, Yards and Terminals, Part 6, Passenger Facilities](#) for additional information concerning stations. In this section, the emphasis will be on the relationship of rail transit corridors to other transportation modes and transportation systems.
- b. Since no single system can meet all transportation needs, a set of systems exists. Ideally, an effective transportation plan combines these systems in an overall public policy. A level of service concept with a wide range of solutions is the key and requires interface coordination.
- c. For the purpose of this discussion, a transportation system should be viewed not as technology, but as a means of moving people. The eventual success of the rail corridor will depend on this ability to smoothly interface and exchange passengers with other transportation systems.
- d. The interfacing of two basic station types to their particular neighborhoods is described in the following Articles: the central business district (CBD) terminal and the suburban station. These two types of stations obviously have differing interface requirements, and generate passengers in different ways. For

CBD stations, the interfaces with pedestrian traffic and high density transportation systems predominate. For outlying stations, distributor systems of buses and automobiles generate the majority of passengers.

2.7.4 CENTRAL BUSINESS DISTRICT STATIONS (1992)

- a. In the CBD station, pedestrians make up a large share of the arrivals and departures. Interfacing is primarily concerned with the location and flow characteristics of passageways in and out of the station. One problem is how to best direct the pedestrian traffic to bus stops, adjacent rail stations or waiting taxis. A second problem is to guide passengers out of the station to continue walking at street level. Ingress and egress of pedestrian traffic may either be through buildings or via traditional sidewalk access.
- b. Understanding the basic interfaces and realizing their importance in creating a desirable transport mix is essential for decision makers and station planners. The quality of the interface of rail transit with the other transport modes will have a large impact on rider's decisions regarding all public transit use.
- c. Station interfaces, in general, must mesh with the local transportation network and be compatible with their neighborhoods.

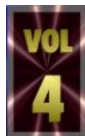
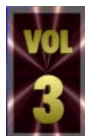
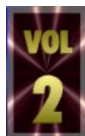
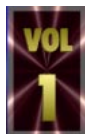
2.7.5 OUTLYING OR DISTRIBUTOR STATIONS (1992)

- a. At outlying stations, park-and-ride passengers need dedicated, secure parking areas for a reasonable fee, a covered walkway through their lot, and an entrance and exit to parking. The parking entrance/exit must be coordinated with other station traffic and not hinder traffic on public streets.
- b. Outlying stations must also accommodate kiss-and-ride auto traffic of two types, as drop-off traffic characteristics are not the same as for pickup traffic. Drop-off traffic moves through the station does not need parking and should be routed back out into surrounding streets. Drop-off traffic should be separated from pickup traffic where possible. Slow moving traffic intending to pickup people should have some short-term parking close to the station, be in view of people waiting in the station, and have a means of recircling if there are no free parking places or their pickup is not yet evident. Good coordination with the local traffic pattern is necessary.
- c. The interface with bus lines is also important. Buses properly routed at the home end act as feeders to the corridor rail line. Buses can be utilized for collection and distribution, while the rail line is utilized for the line haul. Station design needs to handle bus traffic expeditiously. A good working relationship with bus operators during planning and design is essential.
- d. Provision for secure storage of bicycles and pedestrian accessibility should also be considered.



SECTION 2.8 CORRIDOR IMPLEMENTATION STRATEGIES

2.8.1 GENERAL (1992)



- a. The preceding sections deal exclusively with conceptual engineering. At the conclusion of the conceptual phase, the feasibility of the project will be established so that a more definitive design of the proposed system can be developed in the next phase, preliminary engineering. At the end of the preliminary engineering activities, the project would be ready for implementation by the commitment of funding and the authorization of final, detailed design of all elements of the project.
- b. The political and financial ramifications of transit corridor selection and route design must be considered concurrently with the preceding steps so that implementation of the system will proceed smoothly. Planning and design functions will be coordinated closely with the sponsor throughout the corridor selection process to insure accuracy of land acquisition needs and construction cost estimates.
- c. Right-of-way acquisition is often the “make or break” factor for a proposed rail transit system and will, in some instances, govern the vertical location of the system. During the evaluation phase, the planning team must be constantly attuned to this important factor and be authoritative in assessments that sufficient right-of-way is available for the trackway, stations, substations, yards, maintenance shops, and storage facilities. Wherever possible, viable alternate routes should be presented in addition to the preferred alignment. Costs and noneconomic implications of each alternate approach should be clearly set forth for evaluation by public sector decision-makers. Very often legislation at one or more government levels is required to make the necessary land obtainable, and errors can be costly, or perhaps fatal, to the project.
- d. Most rail transit systems are funded through a combination of sources such as local government, regional authorities, and state, provincial and federal governments. Here again, much care must be exercised during the evaluation process to provide accurate and defensible cost information to take to the supporting agencies, and sometimes the voting public, for approval of loans, grants, and bond issues. Major transit endeavors which overrun estimated construction costs and fail to achieve ridership and revenue targets alienate the general public. Legislators must be heavily involved in the evaluation phase of corridor and route selection activities. The time, cost, and effort associated with intense public involvement is a small price to pay for acceptance and approval of the proposed rail transit system by the general public and the involved agencies.

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American Railway Engineering and
Maintenance-of-Way Association



Part 3



Track and Roadway Considerations¹

— 1996 —



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¹ References, Vol. 92, 1991, p. 65; Vol. 94, 1994, p. 131; Vol. 97, p. 117.



SECTION 3.1 INTRODUCTION (1996)

Material being developed.

SECTION 3.2 DESIGN CONSIDERATIONS

3.2.1 INTRODUCTION (1994)

- a. This section's purpose is to delineate differences in design considerations for transit and commuter rail systems from those for a freight railroad. The following subsections should be considered as a check list of factors which will be elaborated upon in other sections of this chapter. Many of the engineering considerations for design of rail transit are the same as freight railroads. In such cases, this chapter will reference other chapters of the Manual.
- b. The following topics are a number of general considerations which make distinctions regarding rail transit or commuter railroading necessary. A partial list of these unique or differently weighted factors is as follows:
 - *Reliability.* Importance of on-time performance.
 - *Quality of Ride.* Passenger comfort of seated and standing patrons is a consideration in determining track modulus, spiral lengths and quality of alignment to be maintained.
 - *Headways.* Frequency of trains and effect of decreased flexibility due to importance of maintaining schedule.
 - *Homogeneity of Fleet.* Increased control regarding uniform characteristics of equipment such as truck arrangement, wheel contour and center of gravity.
 - *Truck Arrangement/Vehicle Configuration.* Effect on rail wear.
 - *Loading.* Effects on track of applying highly repetitive but relatively small loads.
 - *Maintenance Costs.* Impact of very limited track availability and/or out-of-service work hours on cost to maintain.
 - *Urban Environment.* Increased difficulty in constructing and maintaining due to limited access, noise and vibration issues, need to be sensitive to concerns of surrounding community.
 - *Geometry.* Criteria for horizontal and vertical curves impacted by truck arrangement, coupling arrangement, center of gravity, etc.
 - *Underbalance.* Importance of passenger comfort in determining underbalance.
 - *Electric Traction.* Effects on other track/infrastructure components, stray current issues and safety considerations.
 - *Cleanliness Issues.* Increased importance of interior and exterior cleanliness on quality of service.

