FEASIBILITY OF UTILIZING EXISTING RAILROAD RIGHTS-OF-WAY FOR TRANSIT CORRIDORS IN URBAN AREAS

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ABSTRACT

This research, sponsored by the Texas State Department of Highways and Public Transportation in cooperation with the Urban Mass Transportation Administration, investigates the utilization of railroad rights-of-way for public transportation purposes in urban areas. The feasibility of implementing transit on or adjacent to railroad property depends upon a number of factors including: 1) existing right-of-way width; 2) proposed transit technology or mode; 3) type of fixed-guideway contemplated; 4) presence or absence of industrial spurs and sidings; 5) freight railroad expansion plans; 6) operational and safety considerations; and 7) required horizontal and vertical clearances. The final report documents the data collection efforts undertaken by the study team and summarizes the information assembled from the following sources:

- Literature Search and Review;
- Survey of 63 Public Transportation Agencies;
- Survey of 23 Private Railroad Companies; and
- Survey of 26 Professional Organizations or Associations.

In practice, numerous examples of shared use of rail properties exist throughout the United States and Canada. The utilization of railroad right-of-way within urbanized areas of Texas offers considerable potential to new or expanded transit services. As pointed out in the data analysis section of the report, the feasibility of implementing transit service on any particular railroad right-of-way will be determined by technical and practical factors associated with a given project. The information presented should prove valuable to public officials in planning transit services and in negotiating arrangements with private railroad companies.

SUMMARY

This study investigates the feasibility of using existing railroad rights-of-way for public transit facilities in the urbanized areas of Texas. Numerous secondary and primary data sources were employed by the study team in accomplishing the research objectives. Through a comprehensive review of published literature, 14 urbanized areas and transit authorities in North America were identified as examples of successful joint operations of transit on railroad rights-of-way:

Atlanta, GA (MARTA)	New Jersey (N.J. Transit)
Boston, MA (MBTA)	New York/New Jersey (Port Authority)
Calgary, Alberta (City of)	Philadelphia, PA (SEPTA)
Chicago, IL (CTA)	Portland, OR (Ti-Co. District)
Cleveland, OH (RTA)	San Diego, CA (MTDB)
Edmonton, Alberta (City of)	Toronto, Ontario (Transit Comm.)
New York, N.Y. (MTA)	Washington, D.C. (WMATA)

At the present time, commuter rail service is the only example of transit and freight vehicles operating on the same trackage during the same time period in North America. Most cases of shared right-of-way involve transit operations on separate track placed on railroad property for that purpose. There are situations where light rail transit and freight services share the same trackage but at different times of the day such as the system in San Diego, California.

Mailout and telephone surveys were conducted to identify planning, construction and operational considerations of joint railroad right-of-way usage. Sixty-three state, local and transit agencies in 31 urbanized areas received a mailout questionnaire regarding their experiences with joint railroad/transit projects. In addition to the 14 urban areas previously

listed, the survey identified 8 other locations which currently have transit services operating on portions of railroad rights-of-way:

Baltimore, MD	Pittsburgh, PA
Detroit, MI	San Francisco, CA
Miami, FL	Seattle, WA
Oakland, CA	Tallahassee, Fl

The urbanized areas of Buffalo, New York and Dallas/Fort Worth are in the process of implementing rail transit on railroad properties.

Most Commuter Rail Transit (CRT) operates on railroad rights-of-way, as determined from the survey results. Approximately 58% of Heavy Rail Transit (HRT) mileage is constructed on railroad properties while some 29% of Light Rail Transit (LRT) mileage shares available rail corridors. Some 68% of the survey respondents indicated that a purchase arrangement was involved in acquiring rights-of-way for transit use. The inflated 1983 cost of railroad property ranged from $264,000 to $6.2 million per mile and averaged $2.3 million per mile, as determined from the survey data.

Some 30 different railroad companies were identified by the public agencies responding to the questionnaire as having been involved in providing rights-of-way for transit purposes. Many of these railroad companies were contacted by telephone to determine the concerns and perspectives of private railroad officials in allowing transit operations on their properties. Several observations were drawn from the survey of railroad companies:

1. Most railroads will generally cooperate with local transit officials if the proposed projects are reasonable and the compensation is fair.

2. Railroads prefer to sell land outright for parallel transit operations and insist upon maintaining minimum clearances from their track centerline.

3. During negotiations, railroads insist on maintaining financial and operational integrity.

4. Commuter Rail Transit (CRT) services are increasing in popularity with transit authorities leasing rolling stock to the railroad company which operates the service under a service contract.

5. Some railroad officials expressed concern about crime, vandalism, safety and liability of joint transit projects; many of the same concerns of public agency officials.

6. Negotiations for railroad rights-of-way usually take a number of years and require approvals of many railroad officials; local officials generally can not approve plans or contracts.

The above items, drawn from the telephone survey of railroad companies, should be taken into account when planning a new or expanded rail transit system in conjunction with railroad rights-of-way.

In addition to the literature review, mailout questionnaire to public agencies and the telephone survey of railroad companies, the study team contacted some 26 professional associations to provide related input to the research effort. Inventories of rail facilities in the State of Texas and of facilities in the cities of Houston, Dallas and Fort Worth were prepared and are contained in the final report. A review of applicable laws, regulations and policies affecting the joint use of railroad rights-of-way is also presented within the final document for reference by the transit planner. These data sources were the basis for assessing the feasibility of utilizing existing railroad rights-of-way for transit services in urban areas of Texas.

The implementation of fixed-guideway transit systems on or adjacent to operating freight rail lines is very common throughout the United States and Canada. Both Light Rail Transit (LRT) and Heavy Rail Transit (HRT) services are being provided to the commuting public on portions of railroad rights-of-way. Commuter Rail Transit (CRT), is increasing in popularity and, for the most part, operates totally on existing railroad properties. The use of railroad rights-of-way for public transportation is a widely employed practice and offers a viable approach to providing new or expanded transit service within urban areas of Texas.

The most common way to provide LRT or HRT operations is for the transit authority to negotiate either the purchase or long term lease of right-of-way from the railroad company. The railroads have definite concerns which must be addressed by the public entity during the planning and negotiation phases for rail transit service. Commuter Rail Transit (CRT) seems to offer very high potential for economically serving the suburban areas of sprawling metropolitan centers such as Houston, Dallas and Fort Worth. CRT can be implemented fairly quickly on the existing rails providing that sufficient capacity exists and that railroad companies are adequately compensated for their services.

Rail transit is one form of meeting the transportation demand in major urbanized areas of Texas. To date, no urban rail transit has been implemented in the State. With the creation of DART, the Dallas Area Rapid Transit Authority, in August 1983, rail services will become a reality and will offer many challenging opportunities to transportation officials in utilizing railroad rights-of-way for public transit.

IMPLEMENTATION STATEMENT

This research investigates and analyzes the feasibility of using railroad rights-of-way in support of urban transit systems. The information collected and presented herein will be useful in planning and designing future rail transit services within major urbanized areas.

More specifically, the findings and recommendations clearly identify the considerations which the city official, transit operator and/or State administrator must address when looking at railroad property for public transportation purposes. Data obtained from public operating agencies and private railroad companies throughout North America provide a planning framework for railroad right-of-way use based upon current practices and agreements. Presentation of the railroads' points-of-view regarding the use of their property equips the public transportation official or planner with a differing perspective prior to actual design finalization and/or contract negotiations.

DISCLAIMER

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

INTRODUCTION

Public officials frequently focus their attention on railroad rights-of-way within their respective urban areas as ready-made corridors for implementing public transit services. The purpose of this research is to investigate the potential and feasibility of utilizing existing railroads and/or railroad rights-of-way for providing public transportation in Texas.

Through a comprehensive literature search, a survey of public agencies and associations, plus telephone contact with railroad companies already sharing portions of their properties, the study team assembles and presents within this report numerous factors and considerations which must be addressed in using railroad rights-of-way for transit. The report summarizes the information gathered in the data collection efforts and relates the experiences, concerns and practices of urban areas in other states and Canada to the State of Texas. It is hoped that the information contained herein will assist transit planning activities, particularly in the Dallas, Houston and Fort Worth areas, and provide guidance in developing public transportation services in conjunction with private railroad facilities.

STUDY OBJECTIVES AND PROCEDURE

The primary goal of this study was to determine the feasibility of using existing railroad rights-of-way for public transit facilities and services in urban areas within the State of Texas. The work program undertaken in this project was designed to meet the following general objectives:

- To identify, survey and assess U.S. transit projects which utilize railroad rights-of-way within major urbanized areas.
- To identify, investigate and summarize the institutional, jurisdictional and legal constraints, considerations and/or concerns associated with the joint use of rail facilities by transit systems.
- To identify and assess construction and operational considerations of high capacity transit systems operating within existing railroad rights-of-way in major urban areas.
- To assess the general feasibility and potential of utilizing existing railroad rights-of-way for public transportation purposes in major urban areas within the State of Texas.

The following presents an outline of the major tasks accomplished in performing this study:

- Literature search and review;
- Assembly of reports, studies and publications on rail planning in Houston and Dallas/Fort Worth regions;
- Inventory of rail facilities and companies within the State of Texas and within the Houston and Dallas/Fort Worth areas;
- Survey of transportation associations/organizations and professional groups for collection of relevant study data;
- Identification of joint railroad/transit projects within the United States and Canada along with participating public agencies and railroad companies;
- Telephone survey of railroad companies known, or believed, to have experience with public transit service or projects;

- Mailout questionnaire to public agencies (i.e., planning, operating, funding) having experience with, or knowledge of, the use of railroad rights-of-way for the provision of public transportation;
- Identification of institutional, jurisdictional and legal considerations associated with utilizing existing railroad rights-of-way for transit facilities and services;
- Identification of design, construction and operational considerations associated with the use of railroad rights-of-way for transit;
- Assessment of the overall feasibility of utilizing existing railroad rights-of-way for public transit purposes in urban areas within the State of Texas; and
- Documentation of the study effort, its major findings and appropriate recommendations in this final research report.

LITERATURE SEARCH AND REVIEW

In an attempt to assemble and assess the current state-of-the-art for investigating, planning and implementing public transit services in cooperation with railroad companies, an extensive literature search was undertaken by the research team. Four primary sources were utilized in the literature investigation:

1. Texas State Department of Highways and Public Transportation's access to the Railroad Research Information Service (RRIS), Transportation Research Board.

2. Texas A&M University's Automated Information Retrieval Service (AIRS).

3. Personal contact with local transportation professionals in the Dallas/Fort Worth and Houston areas.

4. Contacting and surveying of various agencies, associations, institutes, organizations and companies familiar with, or knowledgeable of, the use of railroad rights-of-way for public transit.

The Railroad Research Information Service (RRIS), accessed in February 1982 by the State Department of Highways and Public Transportation, revealed 31 reports and publications dealing with "Railroad R-O-W for transit use".

The Automated Information Retrieval Service (AIRS), available to Texas Transportation Institute staff, provides customized searches of published literature in over 150 indices, abstracting services, and directories. Identification of relevant work is based on the occurrence of data elements, keywords, subject codes, author names, etc. The researcher creates a profile of the subject area being investigated and specifies the key words or terms used by AIRS in the literature search. Five principal transportation and information directories were used in the AIRS search for relevant railroad/transit data.

1. Transportation Research Information Service (TRIS).

2. National Technical Information Service (NTIS).

3. SSIE, Inc. (a directory of current/on-going research).

4. Management Contents, Inc.

5. Legal Reporting Service.

Over 370 reports and publications were identified by AIRS which related to the joint or shared use of railroad property for public transportation. Abstracts of these published works were obtained and reviewed for possible utilization in this feasibility study. The applicable publications have been referenced where appropriate and are included in the Bibliography Section at the end of this report.

Relevant transportation rail planning data were provided by numerous transportation officials within the Dallas-Fort Worth and Houston regions. Local agencies which provided valuable information and assistance in this study effort include:

- City of Dallas;
- City of Fort Worth;
- North Central Texas Council of Governments (NCTCOG), Arlington;
- Dallas Area Rapid Transit (DART), Dallas;
- Dallas County Appraisal District (DCAD), Dallas;
- Regional Planning Office, State Department of Highways and Public Transportation (RPO-SDHPT), Arlington;
- City of Houston;
- Metropolitan Transit Authority (MTA), Houston;
- Houston-Galveston Area Council (H-GAC), Houston; and
- Harris County Tax Office, Houston.

Numerous reports, studies and documents were obtained from public agencies, private railroad companies, and professional associations or societies. As described later in this report, some 30 transportation associations were contacted and invited to provide input to the study effort. In addition, survey questionnaires were mailed to over 60 cities, planning organizations, state DOT's and transit operating agencies to collect information relevant to the research objectives. Valuable data were obtained both verbally and by mail in response to a telephone survey of some 28 railroad companies.

IDENTIFICATION OF JOINT RAILROAD/TRANSIT PROJECTS

Primarily through the efforts of the detailed literature search and review, a number of transit projects which utilize portions of railroad rights-of-way in both the United States and Canada were identified. These projects varied greatly in scope, design, age, operation and in the availability of published information on the system. Nevertheless, it was this initial identification process that enabled further data collection specific to the objectives of this research. This section of the report summarizes, from the published references, the Location and General Characteristics of Joint Railroad/Transit Projects. The description presents the highlights of joint or shared right-of-way usage in terms of geographic area transit service coverage, historical background and transit operating statistics for the fourteen identified projects. Note that commuter rail projects, which almost universally share right-of-way with railroad vehicles, are not included.

Location and General Characteristics of Joint Railroad/Transit Projects

Fourteen transit authorities were identified as sharing railroad right-of-way with railroad freight traffic. Joint usage, in these cases, takes one of three forms: 1.) The operation of transit and freight vehicles over the same trackage during the same time periods; 2.) Transit and freight vehicle operation temporarily separated from freight vehicle operation over the same trackage but not during the same time periods; and 3.) Operation over the same right-of-way but on separate tracks. At present, no examples of concurrent operation (Case #1) exist in North America. Most cases of shared right-of-way fall into the third category, as evidenced in the descriptions below.

Atlanta, GA

Atlanta, with an SMSA regional population of 2,029,710 persons in a regional area of 4,341 square miles and a central city population of 425,022 persons in a central city area of 131 square miles (Bureau of the Census, 1982), encompasses 16 miles of heavy rail with 20 stations, operated by the Metropolitan Atlanta Rapid Transit Authority (Passenger Transport, 1983). The operating statistics for the rail system are as follows (Morin, 1982):

Fleet size: 72

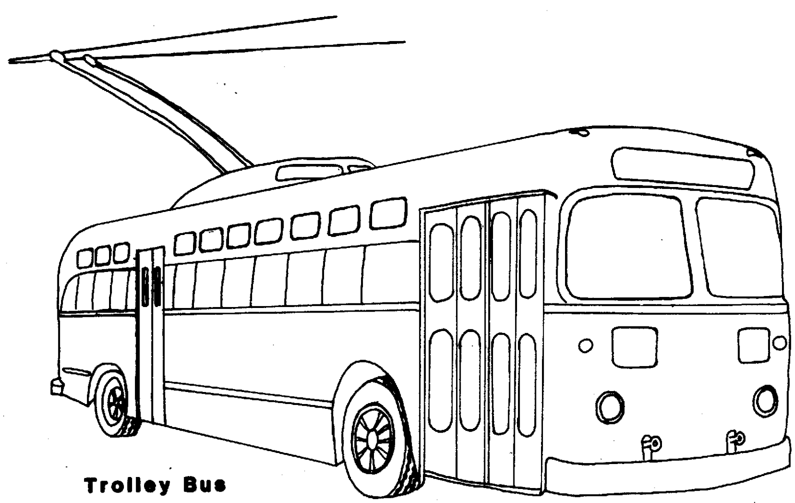
Total Operating Expenses: $11,820,520

Annual Vehicle Revenue Miles: 4,035,236

Annual Train Revenue Miles: 919,464

Average Weekday Unlinked Passenger Trips. May 1983*: 126,000
*(American Public Transit Association, 1983)

In addition, MARTA operates a fleet of 927 motor buses and 999 trolley buses (see Figure 1) in the Atlanta Metropolitan region. (Morin, 1982).



Source: From Horsecars to Streamliners

Figure 1. Typical Trolley Bus Used In Urban Transit Service

The rail system operates almost 21 hours a day, adhering to a 10-minute and 6-minute headway on the east/west and north/south lines, respectively. By December 1984, MARTA will add five stations and 8.7 miles of rail to the north/south line. Since the start of operation on the 6.7 mile east line in June 1979, the system has been well received by the general public. This is partly due to the 99% on-time performance. (Passenger Transport, 1983).

MARTA rail lines share right-of-way with three separate railroads. On the east line from Chapell Road to Hightower, there is a third track for Seaboard Coastline freight trains. Similarly, on the south line from Gordon Street to West End, there is a third track for Atlanta and West Point Freight Trains, and on the west line there are additional tracks for Georgia Railroad trains (Thompson, 1983). All three cases exemplify joint usage through separate trackage.

Boston, MA

The Massachusetts Bay Transportation Authority operates heavy rail over 42.3 rail miles and light rail over 35.1 rail miles (Shedd, 1983). In addition, the MBTA operates 1,079 motor buses over 1,420 directional miles and 50 trolley buses over 31.5 directional miles (Morin, 1982). The Boston SMSA Metropolitan region encompasses a population of 2,763,357 and a land area of 1,237 square miles. The central city population for the region is 562,994 in an area of 47 square miles (Bureau of the Census, 1982). Further operating statistics for the MBTA are presented below in Table 1.

Table 1: MBTA Operating Statistics (Morin, 1982)

MODE	Fleet Size	Operations Expense	Annual Vehicle Revenue Miles	Annual Train Revenue Miles	Annual Unlinked Passenger Trips (1000's)	Annual Weekday Trips, May 1983*
Rapid Rail	315	$106,366,640	114,953,250	5,585,917	143,344	325,000
Light Rail	300	$ 16,450,319	1,269,213	830,656	13,996	----

*(American Public Transportation Association, 1983)

MBTA light rail lines share right-of-way with Conrail freight trains on the Ashmont-Mattapan High-speed line from Butler to Mattapan. The Conrail trains operate over a separate, third track in this case. In addition, provision was made for Boston & Albany Railroad freight trains to operate over the Highland Branch from Fenway to Riverside at night, but the freight service was ordered abandoned by the Interstate Commerce Commission (Thompson, 1983).

MBTA rapid rail lines share railroad right-of-way in three cases: 1) On the Oak Grove Extension from Community College to Oak Grove, Boston & Maine Railroad freight trains operate on a third track in the right-of-way; 2) On the South Shore Line from the portal to the Neponset River there are additional tracks for Conrail freight trains; and 3) on the same line from the Neponset River to Braintree, space is provided for a third track for Conrail trains (Thompson, 1983; Lutin, 1981).

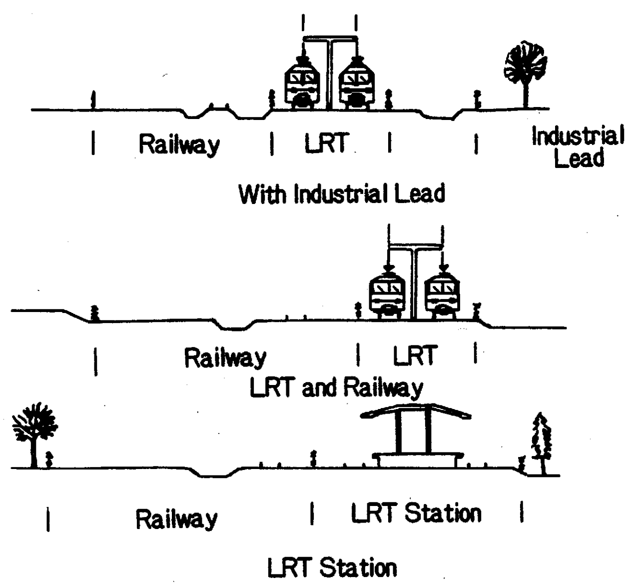
Calgary, Alberta

The City of Calgary is Canada's fastest growing large city. Its 1980 population of 553,000 represents a 5.5% increase over 1979, and a 39% increase over the 1971 population. In 1976, the area of the City was 162 square miles (Rand McNally & Co., 1982). The high density of the downtown, and the fact that its size is constrained by the Canadian Pacific Railway mainline on the south and the Bow River on all other sides, have combined to encourage the use of public transit. In 1979, 44% of persons employed downtown arrived via public transit (City of Calgary, undated).

Calgary is served by a recently opened (May 25, 1981) light rail line stretching from the CBD south for 7.5 miles (12.5 km). Seven stations are positioned outside the downtown area, approximately 4,950 feet (1500 meters) apart. These stations are served by the bus transit network, Park-and-Ride, and Kiss-and-Ride facilities. In addition, nine side load platforms are spaced every two or three blocks. The light rail line "C-Train" is operated by Calgary Transit, a component of the City's transportation department (City of Calgary, undated).

The C-Train line runs for most of its 7.5 mile length within the right-of-way of the main line of the Canadian Pacific Railway (see Figure 2). As

Calgary- Arrangement of LRT Line and Stations along Railroad Right-of-Way.



SOURCE: Kuyt,W.C. and J.D. Hemstock.

Figure 2. Calgary LRT on Canadian Pacific Railway Rights-of-Way

the transit line approaches downtown, it enters a 1,545 feet (468 meter) tunnel crossing under the Canadian Pacific right-of-way. No at-grade crossovers exist between the railroad and transit tracks (City of Calgary, undated; Thompson, 1983).

Chicago, IL

The Chicago Transit Authority operates heavy rail over 174.9 miles of directional roadway. In addition, the CTA operates 2,420 motor buses over 6.3 directional miles of exclusive right-of-way and 1.5 directional miles on mixed right-of-way (Morin, 1982). The Chicago SMSA encompasses 7,103,624 individuals in 3,724 square miles. In the 228 square miles of the central city is a population of 3,005,072 (Bureau of the Census, 1982). Operating statistics for the CTA heavy rail operation are (Morin, 1982):

Fleet Size: 1,100

Total Operating Expenses: $154,205,300

Annual Vehicle Revenue Miles: 49,454,800

Annual Train Revenue Miles: 12,471,400

Annual Unlinked Passenger Trips: 152,512,000

Average Weekday Unlinked Passenger Trips, May 1983*: 516,400
*(American Public Transit Association, 1983)

Of the four instances of shared railroad right-of-way, two represent the actual sharing of trackage by transit and freight vehicles. These two cases include the Howard Service from Wilson to Howard where, until recently, freight trains moved over the transit tracks at night (temporally separated usage), and the Evanston Service from South Boulevard to Davis which now has separate tracks for Chicago & Northwestern Railroad Freight trains but, until recently, had freight trains running on rapid transit trackage. The Lake Service from Laramie to Harlem and the Congress Service from Central Avenue to Des Plaines share right-of-way through separate trackage for the railroads: the Chicago & Northwestern Railroad in the former case and the Baltimore & Ohio Chicago Terminal Railroad in the latter (Thompson, 1983).

The CTA operates not only on rail rights-of-way but also on highway rights-of-way. One of the newer lines is being constructed within a freeway median to O'Hare Airport (see Figure 3).

Figure 3. Typical Section of Rail Service Constructed Within a Freeway Median

Cleveland, OH

The Greater Cleveland Rapid Transit Authority operates rapid rail over 19.8 miles of electrified track (see Figure 4) and light rail over 13.2 miles of electrified track. In addition the RTA operates 1,072 motor buses over

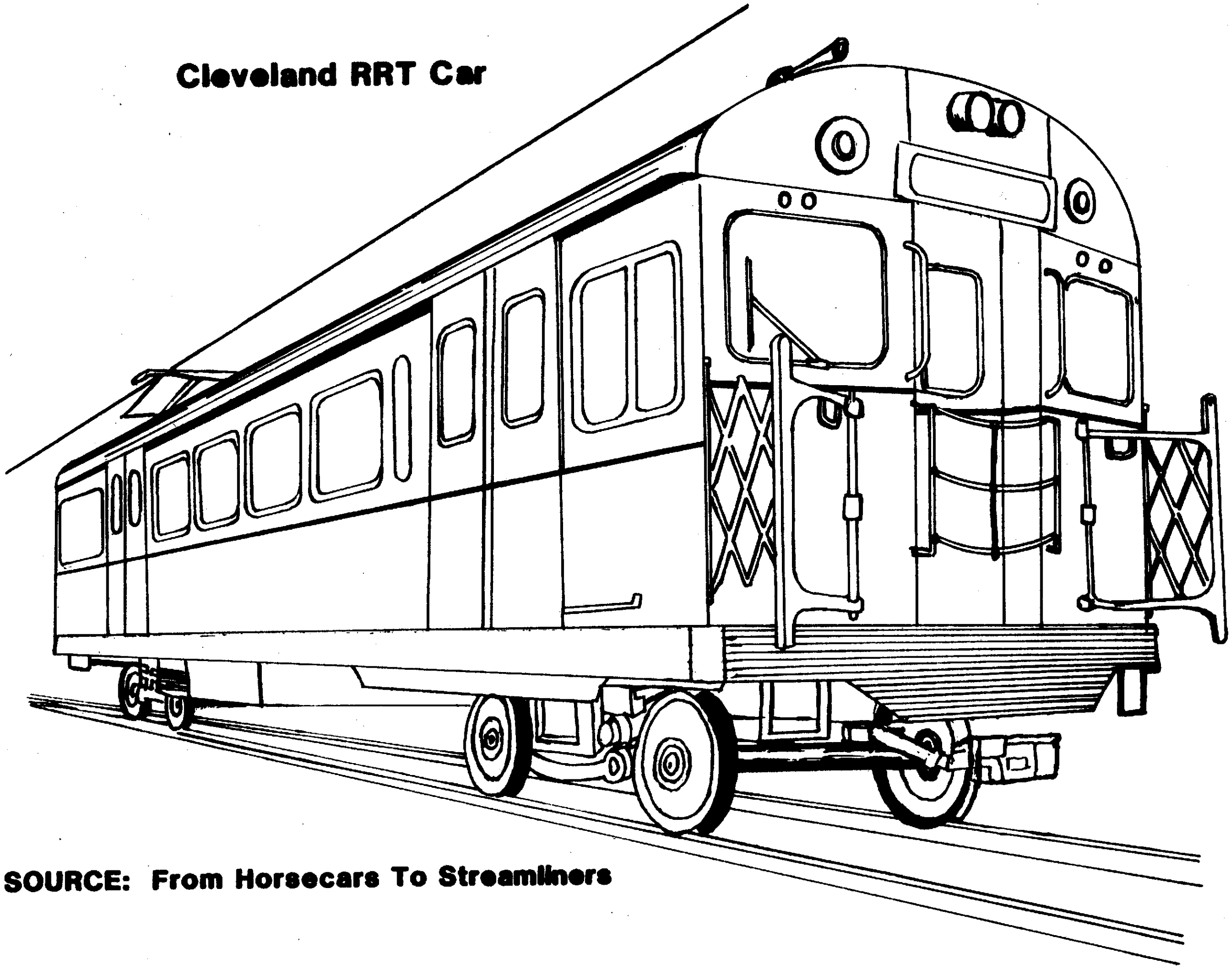


Figure 4. Single Unit Rail Car Typical of the Cleveland System

902.7 directional miles of mixed right-of-way (Morin, 1982). The Cleveland SMSA Metropolitan region encompasses a population of 1,898,825 individuals and a land area of 1,520 square miles. The central city population for the region is 573,822 in an area of 79 square miles (Bureau of the Census, 1982). Further operating statistics for the RTA are presented below in Table 2.

Table 2: RTA Operating Statistics (Morin, 1982)

Mode	Fleet Size	Operations Expenses	Annual Vehicle Revenue Miles	Annual Train Revenue Miles	Annual Unlinked Passenger Trips (1000's)	Annual Weekday Trips, May 1983*
Rapid Rail	116	$9,654,952	3,079,188	1,557,474	10,916	26,200
Light Rail	64	$7,516,225	1,297,900	956,350	5,263	17,000

*(American Public Transportation Association, 1983)

In three cases, the RTA jointly operates heavy rail over shared right-of-way. On the East Line from Union Terminal to Windermere, the roadbed was built jointly with separate tracks for Conrail and Norfolk & Western trains. On the West Line, from Union Terminal to West 98th - Detroit, the roadbed was also jointly built with separate tracks for Norfolk & Western trains. The third case is also an example of joint use through separate trackage: on the West Line, from West 117th - Madison to Brook Park, there are separate tracks for Conrail freight trains. The RTA also operates light rail on shared right-of-way on the Shaker Heights Lines from Kinsman Road to East 92nd Street. A third track (with a provision for a fourth) is used by Conrail freight trains. (Thompson, 1983).

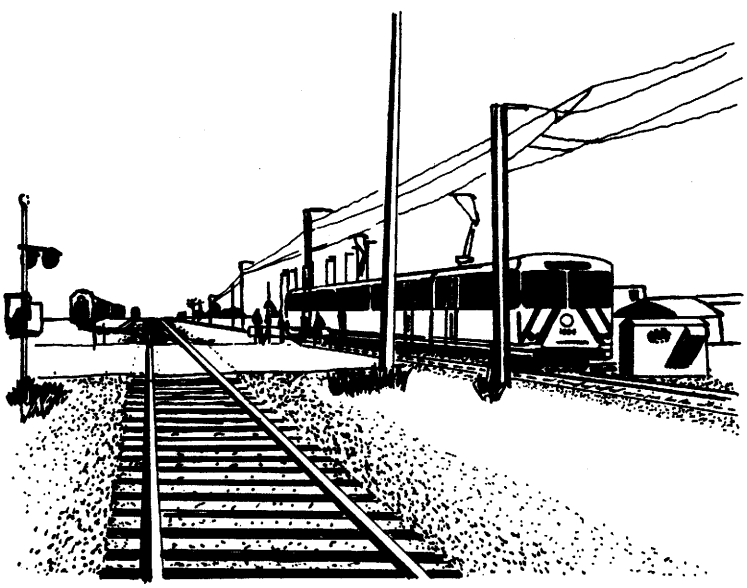
Edmonton, Alberta

Edmonton Transit, an agency of the City of Edmonton, operates a 5.8 mile light rail line from the CBD through the northeast portion of the City

(Shedd, 1983). In 1976, the City of Edmonton encompassed a population of 554,228 in an area of 1,492 square miles, with a central city population of 461,361 in an area of 120 square miles (Rand, McNally & Co., 1982).

The light rail system runs, for most of its length, on Canadian National Railway right-of-way (see Figure 5) until it enters the short downtown subway. Stations are a mile apart, with high-level platforms, and depend largely on feeder buses for outlying access. Two-car articulated trains (see

Edmonton- Railroad/LRT Share Right-of-Way.



SOURCE: Bottoms, Glen O. et al.

Figure 5. Typical Section of Shared Railroad Right-of-Way in Edmonton, Canada

Figure 6) operate on 5-minute peak headways and 10-minute midday headways (Tennyson, 1982). Daily weekday ridership is approximately 25,000 individuals (Shedd, 1983). The specific instances of shared right-of-way are from 96th street to 66th street, where the light rail tracks are between freight tracks for the Canadian National Railway and Canadian Pacific Railway, and from 129th Avenue to Clareview, where there are separate tracks for Canadian National trains (Thompson, 1983).

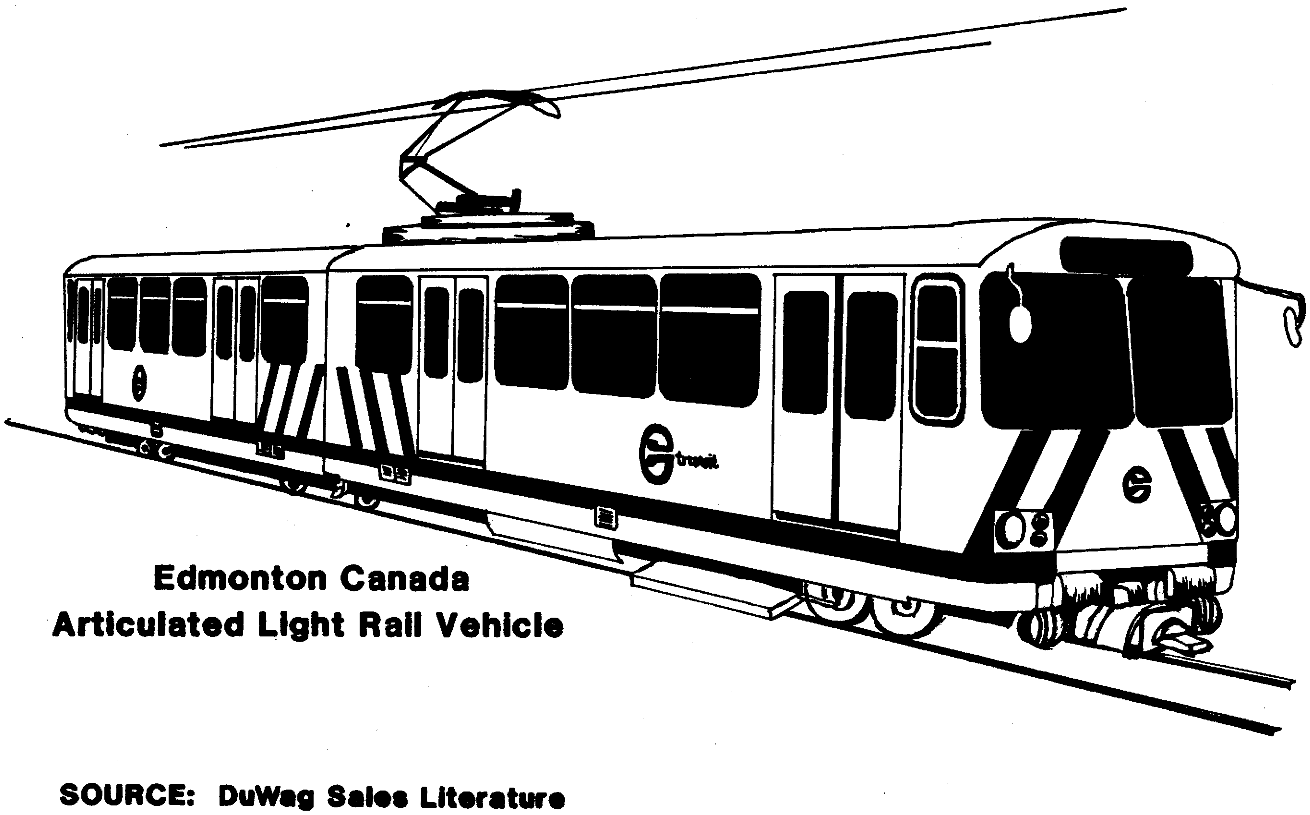


Figure 6. Articulated LRT Car In Edmonton, Canada.

New York, NY

The Metropolitan Transit Authority (MTA) coordinates mass transit in the metro area, which includes the New York City Transit Authority, the Staten Island Rapid Transit operating authority, the Long Island Railroad and the new Metro-North Commuter Railroad, composed of the former Conrail, Hudson, Harlem and New Haven Divisions plus the New York State section of the former Conrail Hoboken-Port Jervis (Shedd, 1983). This system is some 910 miles long and carries approximately 4.3 million riders each weekday. Numerous rail lines carry both freight and passenger service. See Figure 7 for a typical rail car now operating in the New York area.

New Jersey

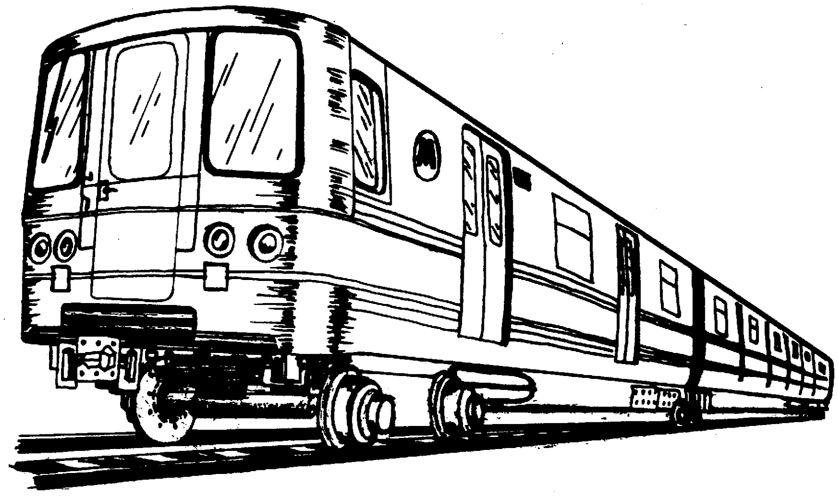
New Jersey Transit is the State agency that coordinates the operation of the 494.6 miles of rail transit. This is composed of the Newark light rail system, the former Conrail commuter lines, and an electrified operation on the south Jersey coast (Sneed, 1983). This system operates freight and passenger service over numerous lines. New Jersey Transit is responsible for some 144,106 daily riders.

New York-New Jersey

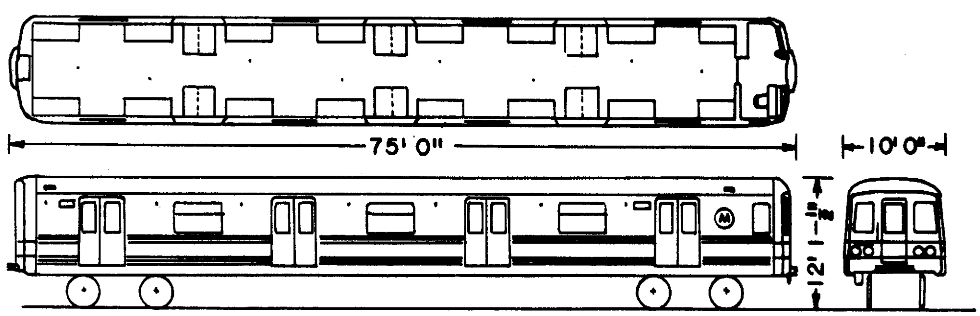
Port Authority Trans-Hudson, a subsidiary of the bi-state Port Authority of New York and New Jersey operates a 13.7 mile heavy rail line from Manhattan under the Hudson river to Hoboken, Jersey City and Newark, N.J. Rapid transit lines operate over Conrail main line tracks that until recently were also used by freight and through passenger trains.

Philadelphia, PA.

The Southeastern Pennsylvania Transportation Authority (SEPTA) operates most of the rail transit in the Philadelphia area (Sneed, 1983). On January 1, 1983, SEPTA took over all commuter rail operations formerly run by Conrail, with 550 daily trains. This system consists of 305 miles of track. Several lines are used for both freight and passenger service. The system serves some 553,000 daily riders.



**Pullman Standard RRT Cars-
New York Transit Authority**



Source: The Car and Locomotive Cyclopedia, 1980

Figure 7: Typical Rail Transit Cars Operating In the New York Area

Port Authority Transit Corp. (PATCO) operates the Philadelphia Lindenwold high speed heavy rail line. This is a 14.6 mile line that has 39,513 daily riders (Sneed, 1983).

Portland OR

Portland presently has a 15 mile section of light rail under construction. The transit system is administered by the Tri-County Metropolitan Transportation District of Oregon. Planners have shoehorned the light rail line between the Union Pacific Track and the Banfield Freeway (see Figure 8). Daily ridership is projected to be 58,000 in 1985 (Sneed, 1983).

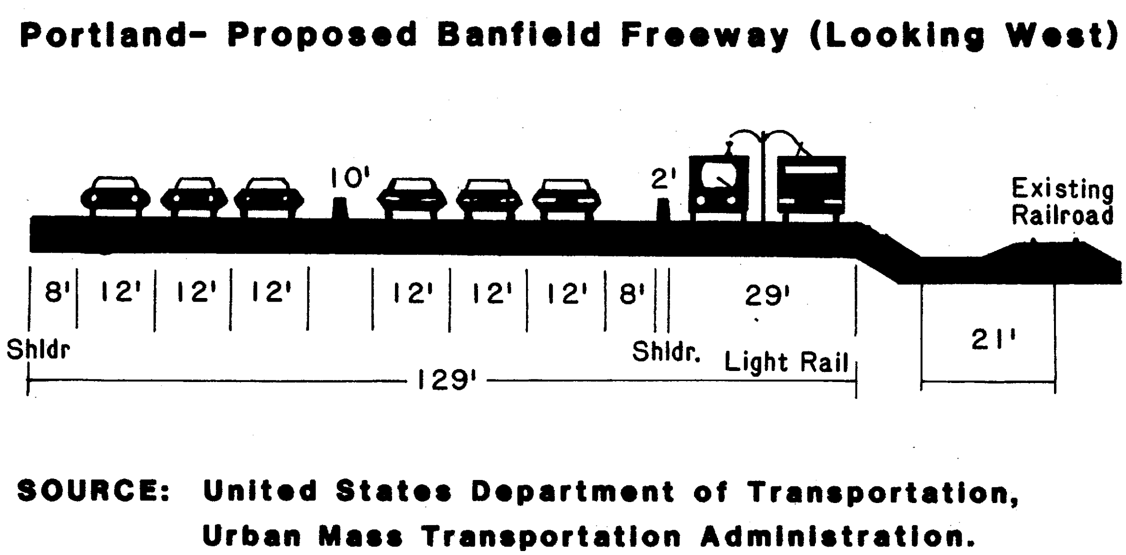


Figure 8. Cross Section of Banfield Light Rail System Between Freeway and Union Pacific Tracks

San Diego CA

Built by the Metropolitan Transit Development Board on the right-of-way purchased from the San Diego and Arizona Eastern Railroad the San Diego trolley has been a popular means of moving people from downtown to the

Mexican Border. There are approximately 11,500 daily riders over this 15.9 mile rail line. At night freight is moved over this line.

Toronto, Ontario

The Toronto Transit Commission operates heavy and light rail transit in Metro Toronto. The systems contain 35.5 miles of heavy rail and 45.6 miles of light rail with an additional 4.3 miles of light rail under construction. On the section of track from Portal to Kipling there are separate tracks for Canadian Pacific Railway freight trains. The right-of-way from Warden to Kennedy has a third track for Canadian National Railway trains. This system is responsible for transporting 893,000 daily riders (Sneed, 1983).

Washington, D.C. Maryland-Virginia

The Washington Metropolitan Area Transit Authority coordinates urban transit in Washington D.C. and parts of Maryland and Virginia. The heavy rail system presently serving the area consists of 101 miles of track that provides ridership to 346,500 daily riders. Many of the heavy rail tracks parallel freight tracks of other freight operating railroads. On the Orange Line from Minnesota Avenue to Cheverly, rapid transit tracks are located between Conrail freight tracks and AMTRAK passenger service tracks.

DATA COLLECTION

As presented in the previous sections of this report, many publications are available on the subject of providing transit service on, or in conjunction with, railroad rights-of-way. However, to fully explore the feasibility of utilizing existing rail properties for public transit in Texas and to meet the study objectives, additional data were required from various sources. An overview of the following major data collection efforts is presented in this report section along with the principal findings of each:

- Survey of Laws, Regulations, Policies and Procedures;
- Survey of Transit Agencies, Cities and Planning Organizations;
- Survey of Railroad Companies;
- Survey of Transportation Associations and Organizations;
- Inventory of Texas Railroad Facilities; and,
- Inventory of Railroad Facilities in the Houston and Dallas/Fort Worth Regions.

All of the data collection efforts were designed to assist in assessing both the technical (i.e., design, construction, operational) feasibility and the practical (i.e., institutional, jurisdictional, legal) feasibility of utilizing rail rights-of-way for providing public transit services in urban areas of Texas. Specific attention was given to Dallas/Fort Worth and Houston in this investigation due to their relatively advanced planning stage for rail transit systems.

Survey of Laws, Regulations, Policies and Procedures

General

The number of publications that contain information about laws, regulations, policies and procedures relating to rail transit are numerous. A number of the more important regulations and policies are given in Appendix A. This data was collected from the following sources:

1. Texas Almanac
2. Research Reports by TTI
3. Vernon's Civil Statutes
4. Federal Railroad Administration Publications
5. Urban Mass Transportation Administration Regulations
6. Association of American Railroad Publications
7. Personal visits with State Department of Highways and Public Transportation Personnel
8. Personal visits with Dallas Appraisal District and Harris County Tax Office's
9. General Laws of Texas
10. Code of Federal Regulations
11. American Public Transit Association Publications
12. Surface Transportation Acts
13. Federal Aid Highway Acts
14. Institute of Transportation Engineers

The rules and regulations of the many agencies are specific in nature, but it is not the intent of this report to provide the detail of all laws, regulations, policies and procedures since they frequently change. However, Appendix A presents an indication of the maze of requirements that must be met in providing mobility in urban areas. The Appendix contains the following three principal subject areas:

- Federal Legislation
- Federal Agencies and Regulations
- State Agencies, Regulations and Agreements

A few of the highlights and elements addressed in the Appendix are summarized in this section.

Federal Legislation

In all, some 23 laws enacted by Congress are presented in Appendix A and span some 112 years from the 1870's through 1982. The summarized laws are not all of the pertinent legislation affecting the use of railroad rights-of-way but do include some of the more relevant ones. The transit planner or operator is normally familiar with the regulations promulgated by the U.S. Department of Transportation, particularly UMTA and FHWA, but sometimes does not know how to evaluate these regulations or their legislative basis. Also, transit professionals are normally concerned only with their particular areas of responsibility and, unless they have had previous experience in rail planning, frequently lack an appreciation for railroad regulations and concerns. Therefore, more emphasis on rail legislation than on transit legislation has been incorporated in the Appendix. Summaries of the following Congressional Acts are provided:

- Granger Legislation, 1870's
- Interstate Commerce Act, 1887
- Transportation Act, 1920
- Davis Bacon Act, 1931
- Urban Mass Transportation Act, 1964
- Civil Rights Act, 1964
- Clean Air Act, 1965
- National Historic Preservation Act, 1966
- Transportation Act, 1966
- National Flood Insurance Act, 1968
- Rail Passenger Service Act, 1970
- National Environmental Policy Act, 1970
- Federal Railroad Safety Act, 1970
- Uniform Relocation Assistance and Real Property Acquisition Policies Act, 1970
- Regional Rail Reorganization Act, 1973
- Federal Aid Highway Act, 1973
- Rehabilitation Act, 1973
- Railroad Revitalization and Regulatory Reform Act, 1975
- Energy Policy and Conservation Act, 1975
- Water Pollution Control Act, 1977
- Local Rail Service Assistance Act, 1978
- Staggers Rail Act, 1980
- Surface Transportation Act, 1982

Some of the above laws have been amended by subsequent actions of Congress. The discussion in Appendix A frequently makes reference to other enactments which affect the administration of the original 23 legislative pieces.

Federal Agencies and Regulations

In addition to the U.S. Department of Transportation agencies of UMTA and FHWA, the transit planner considering joint railroad rights-of-way use will need to be familiar with the role and responsibilities of the Federal Railroad Administration (FRA) and of the Interstate Commerce Commission (ICC). Appendix A discusses both of these regulatory groups along with providing a listing of federal regulations pertinent to the study. Regardless of the federal agency or agencies involved, administrative procedures in using federal funding must adhere to the requirements set forth by the Office of Management and Budget (OMB).

State Agencies, Regulations and Agreements

The two principal Texas agencies involved in planning and/or regulating the use of railroad rights-of-way for transit purposes are:

- State Department of Highways and Public Transportation (SDHPT)
- Railroad Commission (RRC)

Appendix A presents a discussion of the differing roles of these two State agencies. Included as part of the SDHPT presentation are four sample agreements currently used between the State of Texas and the various railroad companies for the following:

1. Railroad License and Planking Agreement
2. Overpass Construction Agreement
3. Highway-Railroad Grade Crossing Agreement
4. Railroad Spur Agreement

The information contained in the above four types of agreement should provide valuable assistance to a transit authority and/or local agency desiring to enter into a contractual arrangement with a Texas railroad company for the use of their rights-of-way. However, since all agreements or contracts are legal instruments, the transportation planner is cautioned to seek assistance from their lawyer(s) or legal staff prior to undertaking actual negotiations.

In addition to the above items, Appendix A contains short discussions of:

- Metropolitan Planning Organizations (MPO's)
- Creation of Regional Transit Authorities
- Taxation of Railroads

The section on taxation presents a few of the laws and court cases associated with taxing railroad property. Also included is a general discussion of three approaches used in appraising railroads: 1) Cost Approach; 2) Market Approach; and, 3) Income Approach. It would be well for the planner considering the use of rail property to have an appreciation for the taxing issues associated with railroad companies; Appendix A provides a working knowledge regarding railroad taxation.

Survey of Transit Agencies, Cities and Planning Organizations

Sixty-three public entities were identified as possible sources of information pertaining to joint use of rail property for the provision of public transit. The 63 agencies, listed in Appendix B, consisted of transit authorities, metropolitan planning organizations, cities, state departments of transportation, and councils of governments. These agencies, all of which received a mailout questionnaire, were geographically dispersed throughout 17 states and provinces in the United States and Canada, and included transit systems in some 31 major urbanized areas.

- Albany
- Atlanta
- Baltimore
- Boston
- Buffalo
- Calgary
- Chicago
- Cleveland
- Columbus
- Dallas/Fort Worth
- Detroit
- Edmonton
- Harrisburg
- Houston
- Lansing
- Miami
- Newark
- New York
- Oakland
- Philadelphia
- Pittsburgh
- Portland
- Salem
- San Diego
- San Francisco
- Seattle
- Springfield
- Tallahassee
- Toronto
- Trenton
- Washington

A copy of the questionnaire used in this data collection effort is included along with the mailing addresses in Appendix B. The survey instrument was designed to obtain the following types of information:

- Whether or not the agency operates transit on railroad rights-of-way.
- The type of transit operated and the miles of service.
- The agency or company responsible for operating the transit service.
- Whether or not rail track is shared by freight and passenger service.
- The method used for acquiring railroad right-of-way.
- Names of railroad companies involved with the transit service.
- Names of governmental agencies involved in acquiring rights-of-way.
- The methods used in calculating fees, assessments or reimbursements.
- Approximate population densities within the rail corridors.
- Approximate cost of purchasing railroad rights-of-way.
- The perceived major problems of using railroad rights-of-way for transit purposes.

In addition to the above items, the survey requested copies of any lease agreements, contracts, studies or investigations available from the agency which relate to the study's objectives. A total of 35 responses were received to the mailout survey, representing an overall response rate of 55.6% of those contacted. A summary of the survey results follows.

Results of Survey Analysis

Eighteen urbanized areas within 14 states or provinces were represented by the survey participants. Due to the distribution of questionnaires to multiple agencies within various urban areas, some of the respondents provided duplicate information on the same transit system. Table 3 summarizes the number of responses received from the survey participants providing information on the 18 urbanized areas.

Table 3: Summary of Responses by Urbanized Area

Urbanized Area	State or Province	Number of Responses (total n=35)
Atlanta	Georgia	n = 3
Baltimore	Maryland	n = 4
Boston	Massachusetts	n = 2
Buffalo	New York	n = 1
Calgary	Alberta, Canada	n = 1
Chicago	Illinois	n = 2
Houston	Texas	n = 1
Miami	Florida	n = 3
New York	New York	n = 2
Oakland	California	n = 1
Philadelphia	Pennsylvania	n = 2
Portland	Oregon	n = 1
San Diego	California	n = 2
San Francisco	California	n = 4
Seattle	Washington	n = 1
Tallahassee	Florida	n = 1
Trenton	New Jersey	n = 1
Washington	D.C.	n = 3

Five general types of agencies provided information on the use of railroad right-of-way for transit service as follows:

Transit Agency or Operator (n=13) - 37.1%

State DOT or Administration (n=9) - 25.7%

Regional Council or Commission (n=8) - 22.9%

City/County Planning Organization (n=3) - 8.6%

Other Agency Type (n=2) - 5.7%

Twenty-eight agencies which received a mailout questionnaire failed to respond. Those receiving a survey but not returning one for analysis are listed in Table 4. Only 5 major urbanized areas contacted with known rail transit systems were not represented by the returned surveys:

- Cleveland
- Detroit
- Edmonton
- Pittsburgh
- Toronto

Does Agency Operate on RR Right-of-Way

Question #1 of the survey asked "Does Your Agency Currently Operate Transit Service Within Any Portion of Railroad Right-Of-Way?" Twenty-four of the respondents, or 68.6%, said that they do operate on railroad right-of-way. Table 5 summarizes those urbanized areas which indicated shared usage of railroad property for transit service at the current time.

As shown in the table, 16 (88.9%) of the 18 responding urbanized areas reported shared or joint usage of rail right-of-way. The only two urbanized areas not currently operating on railroad right-of-way were Houston and Buffalo; both of which have plans to do so in the future.

Table 4: Agencies Contacted But Not Returning a Survey (n=28)

Urbanized Area:	State or Province:	Type of Agency Contacted:
Albany	New York	State Dot or Admin.
Arlington	Texas	Regional Council or Comm.
Boston	Massachusetts	Transit Agency or Operator Regional Council or Comm.
Chicago	Illinois	Transit Agency or Operator
Cleveland	Ohio	Transit Agency or Operator Regional Council or Comm.
Columbus	Ohio	State Dot or Admin.
Detroit	Michigan	Transit AGency or Operator Regional Council or Com.
Edmonton	Alberta, Canada	City Planning Org. or Admin.
Harrisburg	Pennsylvania	State Dot or Admin.
Lansing	Michigan	State Dot or Admin.
Newark	New Jersey	Transit Agency or Operator
New York	New York	Transit Agency or Operator Transit Agency or Operator Transit Agency or Operator
Philadelphia	Pennsylvania	Regional Council or Comm.
Pittsburg	Pennsylvania	Transit Agency or Operator Regional Council or Comm.
Portland	Oregon	Regional Council or Comm. Other
Salem	Oregon	State Dot or Admin.
Seattle	Washington	Regional Council or Comm. City Planning Org. or Admin.
Springfield	Illinois	State Dot or Admin.
Toronto	Ontario, Canada	City Planning Org. or Admin.
Washington	D.C.	Regional Council or Comm.

Table 5 Urban Areas Currently Operating Transit Service on Railroad Right-of-Way

Urbanized Area	State or Province	Number of Responses (total n=24)
Atlanta	Georgia	n = 2
Baltimore	Maryland	n = 2
Boston	Massachusetts	n = 2
Calgary	Alberta, Canada	n = 1
Chicago	Illinois	n = 1
Miami	Florida	n = 3
New York	New York	n = 1
Oakland	California	n = 1
Philadelphia	Pennsylvania	n = 2
Portland	Oregon	n = 1
San Diego	California	n = 2
San Francisco	California	n = 2
Seattle	Washington	n = 1
Tallahassee	Florida	n = 1
Trenton	New Jersey	n = 1
Washington	D.C.	n = 1

Table 6 presents a summary of the 35 responses received to the current operation question and identifies the type of agency participating in the survey. Of those saying that they do operate on railroad right-of-way at the present time, 50% were transit agencies within the urbanized area while 29.2% were State DOT agencies. As can be seen from the tables, 7 of the 16 urban areas had more than one respondent which indicated current operation on railroad right-of-way:

- Atlanta
- Baltimore
- Boston
- Miami
- Philadelphia
- San Diego
- San Francisco

In most cases, this represents joint or cooperative responsibility between multiple agencies within a given area.

Table 6: Responses By Type of Agency for Current Operation on Railroad Right-of-Way

Urbanized Area:	State or Province:	Type of Responding Agency:	Response to Question #1
Atlanta	Georgia	Transit Agency or Operator	Yes
		Regional Council or Comm.	Yes
		State Dot or Admin.	No
Baltimore	Maryland	Regional Council or Comm.	No
		Other	No
		State Dot or Admin.	Yes
		State Dot or Admin.	Yes
Boston	Massachusetts	Regional Council or Comm.	Yes
		State Dot or Admin.	Yes
Buffalo	New York	Transit Agency or Operator	No
Calgary	Alberta, Canada	Transit Agency or Operator	Yes
Chicago	Illinois	Transit Agency or Operator	Yes
		Regional Council or Comm.	No
Houston	Texas	Regional Council or Comm.	No
Miami	Florida	Transit Agency or Operator	Yes
		Regional Council or Comm.	Yes
		City Planning Org. or Admin.	Yes
New York	New York	Transit Agency or Operator	Yes
		State Dot or Admin.	No
Oakland	California	Transit Agency or Operator	Yes
Philadelphia	Pennsylvania	Transit Agency or Operator	Yes
		Transit Agency or Operator	Yes
Portland	Oregon	Transit Agency or Operator	Yes
San Diego	California	Transit Agency or Operator	Yes
		City Planning Org. or Admin.	Yes
San Francisco	California	Transit Agency or Operator	Yes
		Regional Council or Comm.	No
		City Planning Org. or Admin.	No
		State Dot or Admin.	Yes
Seattle	Washington	State Dot or Admin.	Yes
Tallahassee	Florida	State Dot or Admin.	Yes
Trenton	New Jersey	State Dot or Admin.	Yes
Washington	D.C.	Transit Agency or Operator	Yes
		Regional Council or Comm.	No
		Other	No

Type of Service Operated

Question #1.A asked those respondents which currently operate transit service on railroad right-of-way to "indicate the type of service operated and the approximate mileage" of the service. Table 7 summarizes the responses received to this inquiry.

Table 7: Type of Service and Approximate Mileage of Transit on Rail Right-of-way

Type of Service	Number of Respondents	Percentage of Service on Rail Right-of-Way		
		Low	High	Mean
Light Rail	8	0.0%	100.0%	57.7%
Heavy Rail	12	6.4%	100.0%	58.4%
Commuter Rail	8	100.0%	100.0%	100.0%
Busways or HOV Lanes	0	NA	NA	NA
Other	2			

Some of the agencies operate more than one type of transit service and provided information on several different modes. Considerable variation between transit systems and their utilization of railroad right-of-way exists; the percentage of transit on railroad property ranges from 0% (for Light Rail) to 100%. Based upon the information supplied by the survey participants, approximately 58% of Light and Heavy Rail service is provided on railroad rights-of-way while 100% of all Commuter Rail service is on railroad property.

Two organizations responded "other" to question 1.A (Type of service operated?). The Florida Department of Transportation specified that monorail and Westinghouse-type people-movers are being considered, in addition to light rail and exclusive HOV lanes, for possible use on a 21 mile abandoned railroad right-of-way between Clearwater and St. Petersburg, Florida. The

Metropolitan Dade County Transit Agency (Metro rail) specified that their usage of railroad right-of-way is limited to transportation of rapid transit trains to stations from a maintenance facility.

Table 8 summarizes the responses received with regard to the Light Rail Transit (LRT) Service while Table 9 presents the Heavy Rail (HRT) Service data. Table 10 shows the urban areas and agency type providing information on Commuter Rail Transit (CRT) service.

Table 8: Summary of Those Having LRT - 8 Respondents

Urbanized Area:	Agency Type	Miles On RR ROW:	Total Miles:	Percent On RR ROW:
Boston	Regional Council or Comm.			
	State Dor or Admin.	0.0	29.0	0.0%
Calgary	Transit Agency or Operator			
Portland	Transit Agency of Operator	2.0	15.0	13.3%
San Diego	Transit Agency or Operator	14.0	16.0	87.5%
	City Planning Org. or Admin.	14.0	16.0	87.5%
San Francisco	Transit Agency or Operator	---	25.0	---
Seattle	State Dot or Admin.	2.0	2.0	100.0%

The summary tables on LRT, HRT and CRT are for those survey respondents indicating that their agency currently operates service on railroad right-of-way. Some data were incomplete and the percentage of service on railroad property was, therefore, unavailable. The two responding agencies from San Diego provided identical data on their Light Rail System; by excluding one of the San Diego responses, the percentage of all LRT service on railroad right-of-way identified amounts to 29% in the remaining 4 urban areas.

Table 9: Summary of Those Having HRT - 12 Respondents

Urbanized Area:	Agency Type	Miles On RR ROW:	Total Miles:	Percent On RR ROW:
Atlanta	Transit Agency or Operator Regional Council or Comm.	12.5	16.2	77.2%
Baltimore	State Dot or Admin.	3.5	8.0	43.8%
Boston	Regional Council or Comm. State Dot or Admin.	23.4	39.0	60.0%
Chicago	Transit Agency or Operator	7.6		
Miami	Regional Council or Comm. City Planning Org. or Admin.	10.0 1.0	20.5 1.0	48.8% 100.0%
New York	Transit Agency or Operator	525.0	710.0	73.9%
Oakland	Transit Agency or Operator	5.0	78.0	6.4%
Philadelphia	Transit Agency or Operator	10.5	14.3	73.4%
Washington	Transit Agency or Operator	13.5	32.0	42.2%

Table 10: Summary of Those Having CRT - 8 Respondents

Urbanized Area:	Agency Type	Miles On RR ROW:	Total Miles:	Percent On RR ROW:
Baltimore	State Dot or Admin. State Dot or Admin.	180 127	180 127	100.0% 100.0%
Boston	Regional Council or Comm. State Dot or Admin.	242	242	100.0%
New York	Transit Agency or Operator	1091	1091	100.0%
Philadelphia	Transit Agency or Operator	512	512	100.0%
San Francisco	State Dot or Admin.	47	47	100.0%
Trenton	State Dot or Admin.	463	463	100.0%

Investigation of Railroad Right-of-Way for Transit

As previously mentioned, 24 or 68.6% of the survey participants indicated that they operate transit service on portions of railroad right-of-way while 11 or 31.4% stated they did not. Question 1.B asked those agencies which currently do not operate on rail right-of-way "if the use of railroad right-of-way for transit has been investigated?" Seventy percent of the respondents (n=10) said that the use of rail property for transit has been studied.

Question #1.C asked those not currently operating on railroad right-of-way "does your agency have plans to utilize railroad right-of-way for transit in the future?" Seven responses were received to the inquiry with 42.9% indicating that they do have plans to utilize railroad right-of-way. Out of the 35 respondents, only 4 or 11.4% indicated that they do not currently, nor do they have future plans, to operate transit service within portions of rail properties.

Table 11 presents a tabulation of responses to question #1.C regarding the investigation of railroad right-of-way and the agencies' plans for future use of right-of-way for those survey participants which do not currently operate on railroad property.

As can be seen from the table, some conflicts exist within an urban area as to the responses received. However, given the intended personal wording of the questions ("Does your agency have --?"), even though a particular respondent may not be planning to operate on railroad right-of-way within an urbanized area, others in the area may be planning to do so. Examples of this are Baltimore and Houston where the Regional Planning Councils do not have plans to use railroad property but others within the area do.

Table 11: Future Use of Railroad Right-of-Way for Transit Purposes

Urbanized Area:	Agency Type Not Currently Operating On RR ROW:	Has Use Been Investigated?	Does Agency Have Plans to Use?
Atlanta	State DOT or ADMIN.	No	No
Baltimore	Regional Council or Comm.	No	No
	Other	Yes	Yes
Buffalo	Transit Agency or Operator	Yes	Yes
Chicago	Regional Council or Comm.	Yes	Yes
Houston	Regional Council or Comm.	No	No
New York	State DOT or Admin.	--	--
San Francisco	Regional Council or Comm.	Yes	--
	City Planning Org. or Admin.	Yes	--
Washington	Regional Council or Comm.	Yes	--
	Other	Yes	No

Who Operates Transit Service?

Question #2.A asked "If transit service is currently operated or planned on railroad right-of-way who operates the transit service?" Table 12 summarizes the responses received to this inquiry.

Table 12: Agency Operating Transit Service on Railroad Right-of-Way

Operating Agency	Responses	
	Number	Percentage
Transit Agency	20	64.5%
Railroad Company	4	12.9%
Both Transit Agency and Railroad	5	16.1%
Other	2	6.5%
Totals	31	100.0%

The vast majority (64.5%) of transit service provided on railroad property is operated by the local transit agency. Two other operating arrangements include the Maryland Department of Transportation as a commuter service operator (listed by the Metropolitan Washington Council of Governments) and the Dade County Government as the transit service provider (listed by Metro rail-Metropolitan Dade County Transit Agency).

Joint Passenger and Freight Operations

Question #2.B asked "If transit service is currently operated or planned on railroad right-of-way is any railroad trackage jointly shared by passenger and freight service?" Some 53.1% of the respondents (n=32) indicated that joint freight and passenger service was provided within the railroad right-of-way. Those respondents answering yes to the inquiry were asked to provide the approximate percentage of railroad right-of-way miles that are jointly shared. Responses ranged from 5% to 100% and averaged 66.9% for all 14 respondents to the question.

It should be noted that some respondents were considering "railroad trackage" as any portion of the railroad right-of-way while others were believed to be commenting only on behalf of the transit rail system. A more detailed discussion of joint freight and transit operation is presented in the "Survey of Railroad Companies" and the appendices of this report.

Ten or 55.6% of the 18 responding urbanized areas reported joint passenger and freight service operation. Table 13 summarizes the responses received from those indicating joint operational activity.

How Railroad Right-of-Way Is Obtained

Question #2.C asked "If transit service is currently operated or planned on railroad right-of-way how was/is railroad right-of-way obtained by the public agency for transit use?" The options included on the survey form

Table 13: Joint Passenger/Freight Operations

Urbanized Area:	Agency Type Indicating Joint Operations:	Approximate Percentage of System:
Baltimore	State Dot or Admin.	100%
	State Dot or Admin.	NA
Boston	Regional Council or Comm.	35%
	State Dot or Admin.	100%
Chicago	Regional Council or Comm.	NA
Miami	Regional Council or Comm.	5%
New York	Transit Agency or Operator	100%
	State Dot or Admin.	87%
Philadelphia	Transit Agency or Operator	NA
San Diego	Transit Agency or Operator	13%
	City Planning Org. or Admin.	89%
San Francisco	Regional Council or Comm.	100%
	State Dot or Admin.	100%
Tallahesse	State Dot or Admin.	20%
Trenton	State Dot or Admin.	27%
Washington	Regional Council or Comm.	100%
	Other	60%

were abandonment, condemnation, purchase, service contract, lease, and, other (specify). As shown in Table 14, more than one method is commonly used in acquiring railroad right-of-way for use in providing transit service.

Twenty-one or 67.7% of the survey participants indicated that purchase of railroad property was/is involved in acquiring right-of-way for transit use. Eight of the respondents, or 26.7%, mentioned that a lease was involved while 7 participants (23.3%) listed abandonment and/or a service contract as a method used in obtaining right-of-way. Only one of the 30 respondents mentioned condemnation and purchase as a means of right-of-way acquisition.

Table 14: How Right-of-Way Is Acquired for Transit Use

Method or Methods of Acquisition:	Responses	
	Number	Percentage
Purchase	8	26.7%
Service Contract	4	13.3%
Abandonment and Purchase	4	13.3%
Lease	3	10.0%
Lease and Purchase	3	10.0%
Abandonment; Lease and Purchase	2	6.7%
Service Contract and Purchase	2	6.7%
Condemnation and Purchase	1	3.3%
Service Contract, Abandonment and Purchase	1	3.3%
Other	2	6.7%
Totals	30	100.0%

Two other responses included the Metropolitan Dade County Transit Agency (Metro rail) and the Southeastern Pennsylvania Transportation Authority (SEPTA) which operate under a service agreement with the railroads.

Involved Railroad Companies

Question #2.D asked "If transit service is currently operated or planned on railroad right-of-way, what railroad Company or companies is/are involved with the provision of railroad right-of-way or the operation?" Between one and six railroad companies were identified by each of the 31 survey respondents.

In all, 30 different railroad companies were listed on the returned surveys as having been involved in providing railroad right-of-way or transit service for the surveyed organizations. Thirteen of the railroad companies were listed on more than one returned survey. A listing of all the railroad companies and the frequency with which they appeared follows:

- Baltimore & Ohio Railroad (n=2)
- Boston & Maine (n=2)

- Burlington Northern Railroad (n=2)
- California State Belt Line Railroad (n=1)
- Canadian Pacific (n=1)
- Chessie System (n=3)
- Chicago & Northwestern Transportation Co. (n=2)
- Chicago, Milwaukee, St. Paul & Pacific Railroad (n=1)
- Chicago Northshore & Milwaukee (n=1)
- Chicago, Rock Island & Pacific Railroad (n=1)
- Chicago South Shore & South Bend Railroad (n=1)
- Consolidated Rail Corporation (Conrail) (n=8)
- Family Lines of Georgia (n=1)
- Florida East Coast Railway (n=3)
- Georgia Railroad (n=1)
- Illinois Central Gulf Railroad (n=1)
- Kyle Railway (n=1)
- Long Island Railroad (n=1)
- Metro north Commuter Railroad (n=1)
- National Railroad Passenger Corporation (Amtrak) (n=6)
- New Jersey Transit Corporation (n=1)
- Penn Central Corporation (n=1)
- Richmond, Fredericksburg & Potomac Railroad (n=1)
- San Diego & Arizona Eastern Transportation Co. (n=2)
- Seaboard Coastline (n=2)
- Seaboard System Railroad (n=1)
- Southern Pacific Transportation Co. (n=4)
- Southern Railway Co. (n=3)
- Union Pacific Railroad (n=2)
- Western Maryland Railway (n=1)

Involved Governmental Agencies

Question #2.E asked "If transit service is currently operated or planned on railroad right-of-way, which governmental agencies were (or will be) involved in acquiring the railroad right-of-way?" Between one and four governmental agencies were listed by each of the 27 survey participants to this inquiry. Table 15 presents a listing of the 38 agencies identified and is arranged by reporting state. A total of 11 states are reported in the table. Of the 38 governmental agencies mentioned by the respondents, 6 agencies were branches of the federal government which include:

- Amtrak
- Conrail
- Federal Highway Administration (FHWA)
- Interstate Commerce Commission (ICC)
- Urban Mass Transportation Administration (UMTA)
- U.S. Department of Justice

Table 15: Governmental Agencies Involved in Right-of-Way Acquisition, By Responding State (n=27)

State	Governmental Agencies	Number of Respondents
California	Bay Area Rapid Transit (BART)	1
	California Department of Transportation (Caltrans)	1
	Metropolitan Transportation Commission	1
	San Diego Metropolitan Transit Development Board	2
	San Francisco Muni Railway	1
	San Mateo Transportation Department	1
	Santa Clara County Transportation Agency	1
	State and Local Agencies	1
District of Columbia	Maryland Department of Transportation (State Rail Admin.)	1
	U.S. Department of Justice	1
	Washington Metropolitan Area Transit Authority (WMATA)	2
Florida	Dade County Government	2
	Metropolitan Dade County Transit Agency (Metrorail)	1
	State Department of Transportation	2
Georgia	Dekalb County	1
	Fulton County	1
	Metropolitan Atlanta Rapid Transit Authority (MARTA)	2
	Urban Mass Transportation Administration (UMTA)	1
Illinois	Chicago Transit Authority (CTA)	1
	City of Chicago	1
	Cook County	1
	Municipal Governments	1
	Regional Transportation Authority (RTA)	1
Massachusetts	Executive Office: Transportation & Construction	2
	Massachusetts Bay Transportation Authority (MBTA)	2
Maryland	Federal Highway Administration (FHWA)	1
	Maryland Department of Transportation	1
	Mass Transit Administration of Maryland	1
	State Railroad Administration	1
	Urban Mass Transportation Administration (UMTA)	1
New York	Metropolitan Transportation Authority (NY Region)	2
	Niagara Frontier Transportation Authority	1
Oregon	Oregon Department of Transportation	1
	Tri-County Metropolitan Transportation District	1
Pennsylvania	Amtrak	1
	Conrail	1
	Delaware River Port Authority	1
	Federal Agencies	1
	Interstate Commerce Commission (ICC)	1
	Southeast Pennsylvania Transportation Authority (SEPTA)	1
	Urban Mass Transportation Administration (UMTA)	1
Washington	City of Seattle	1
	Seattle Metro	1

How Fees/Assessments Calculated

Question #3 asked "If both public passenger service and private freight service are operated on shared right-of-way, how are the fees or assessments calculated?" Fifteen of the 35 survey respondents provided information on the method used in calculating fees and assessments. The information supplied by the 15 participants covered 11 urbanized areas and is presented in table 16.

Some of the more frequent methods used in calculating fees and assessments listed by the survey respondents include:

- Annual Lease Rate
- Contracted Agreement
- Car Mile Formula
- Purchase Service Agreement
- Ton Mile Formula
- Trackage Rights Agreement
- Train Mile Formula

Population Densities Within Rail Corridors

Question #4 asked "What are the approximate population densities (persons per square mile) within your rail corridors?" Both a low and a high estimate in addition to an overall average estimate of population densities were requested. Table 17 summarizes the responses received to this survey inquiry.

Table 17: Summary of Population Densities Within Rail Corridors Provided By Survey Participants; Persons Per Square Mile

Density:	Range of Reported Densities		Mean Density	Respondents
	Minimum	Maximum		
Low Estimate	20	11,520	2,912	n=16
High Estimate	500	50,000	21,388	n=16
Overage Average Estimate	275	30,000	7,062	n=15

Table 16: How Fees and Assessments are Calculated, By Urbanized Area (n=15)

Urbanized Area:	Response(s):
Baltimore, Maryland	Railroads operate the service for the State through a purchase service agreement.
Boston, Massachusetts	The non-maintaining party pays the maintaining party for their use on a "ton mile formula" for track, bridges and ROW and a "train mile formula" for maintenance. Exclusive facilities are paid by using party.
	(Calculated by:) 1. Percent of gross freight revenue; 2. Ton Mile Charge; 3. Free, exclusive and perpetual easement; and 4. Other (ways).
Buffalo, New York	Under consideration is the granting of trackage rights over 1 1/2 mile of LRRT to enable switching to several industries (freight service is currently abandoned).
Calgary, Canada	Negotiated long term lease at annual rate unescalated.
New York, New York	The Long Island Railroad, a subsidiary of the MTA, operates both freight and passenger service. Conrail fees are set by the Penn Central lease at $0.
	Gross Ton Miles for maintenance; Car Miles for supervision, dispatching and blocking.
Philadelphia, Pennsylvania	Delaware River Port Authority (DRPA) purchased ROW from predecessor railroads in 1964. DRPA provides space within ROW for one track for exclusive use of railroad (Conrail) through area.
	1. For SEPTA service on Amtrak property (since 1-1-83): fixed-term, fixed fee agreement. 2. For SEPTA service on Conrail property: a reciprocal agreement for trackage rights - no fee unless traffic exceeds certain level.
San Diego, California	Freight operator pays proportional maintenance costs to transit agency. Transit agency maintains joint use track.
	Current lease is $3000 monthly plus contribution toward shared track maintenance.
San Francisco, California	Contractual agreement between Southern Pacific and California DOT ($559,000 per year until 1990).
Tallahassee, Florida	Amtrak: short term avoidable cost agreement.
Trenton, New Jersey	Interstate Commerce Commission (ICC) - R.S.P.O. Standards
Washington, D.C.	Transit Authority acquires ROW from railroads in fee.

Estimates of population density within particular segments of rail corridors ranged from 20 to 50,000 persons per square mile. Figure 9 presents the cumulative frequency distribution of the low population density estimates while Figure 10 shows the responses received for the high estimates. As shown in the figures, 50% of the survey participants estimated population densities of 500 or fewer persons per square mile within the less dense portions of their rail system while 50% of the respondents indicated densities of 16,900 or more in the more populated segments of their system.

Overall average estimates of population densities ranged from 275 to 30,000 persons per square mile for the entire rail system with the median (50th percentile) estimate being 3,616 persons per square mile. The cumulative frequency distribution of the average density estimate is presented in Figure 11 for the 15 respondents to this inquiry.

Table 18 summarizes the responses received to population density inquiry and provides estimates for 13 of the 18 participating urban areas. Three of the 13 urbanized areas were represented by more than one type of agency which provides dual information from multiple sources. It is interesting to note the discrepancies in reported density figures for some of the urban areas (i.e., Boston, Chicago and San Francisco).

Considerable attention is frequently given to population densities within an urbanized area and the relationship of those densities to existing or estimated rail transit patronage. Unfortunately, much planning or rail transit investigation is conducted at the <u>macro</u>scopic scale with generalized statements of "minimum" densities necessary to support a given system. To adequately assess rail transit potential, <u>micro</u>scopic analysis along any particular rail corridor is required. Several data sources are available to

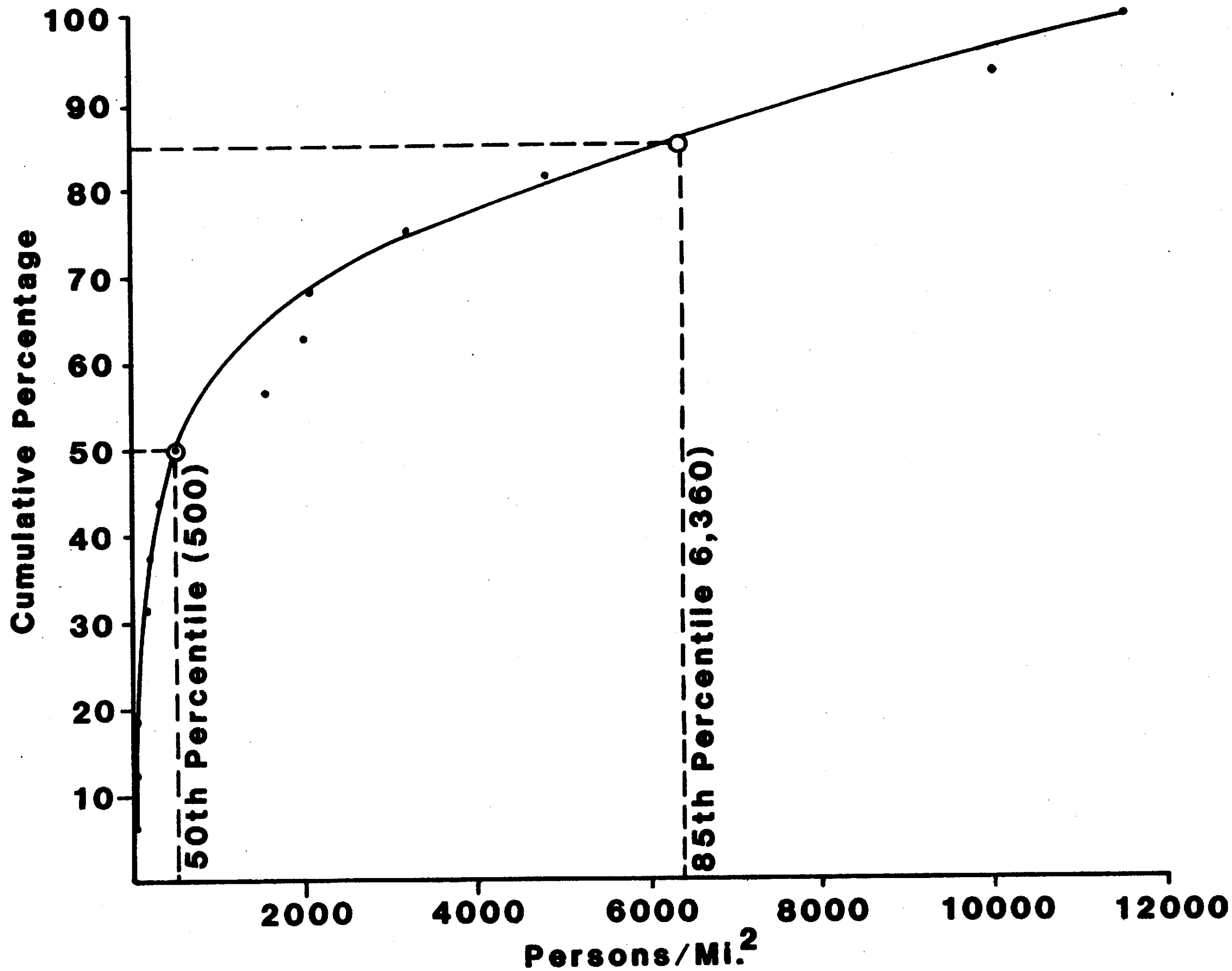


Figure 9: Cumulative Frequency Distribution, Low Estimates of Population Densities (n=16)

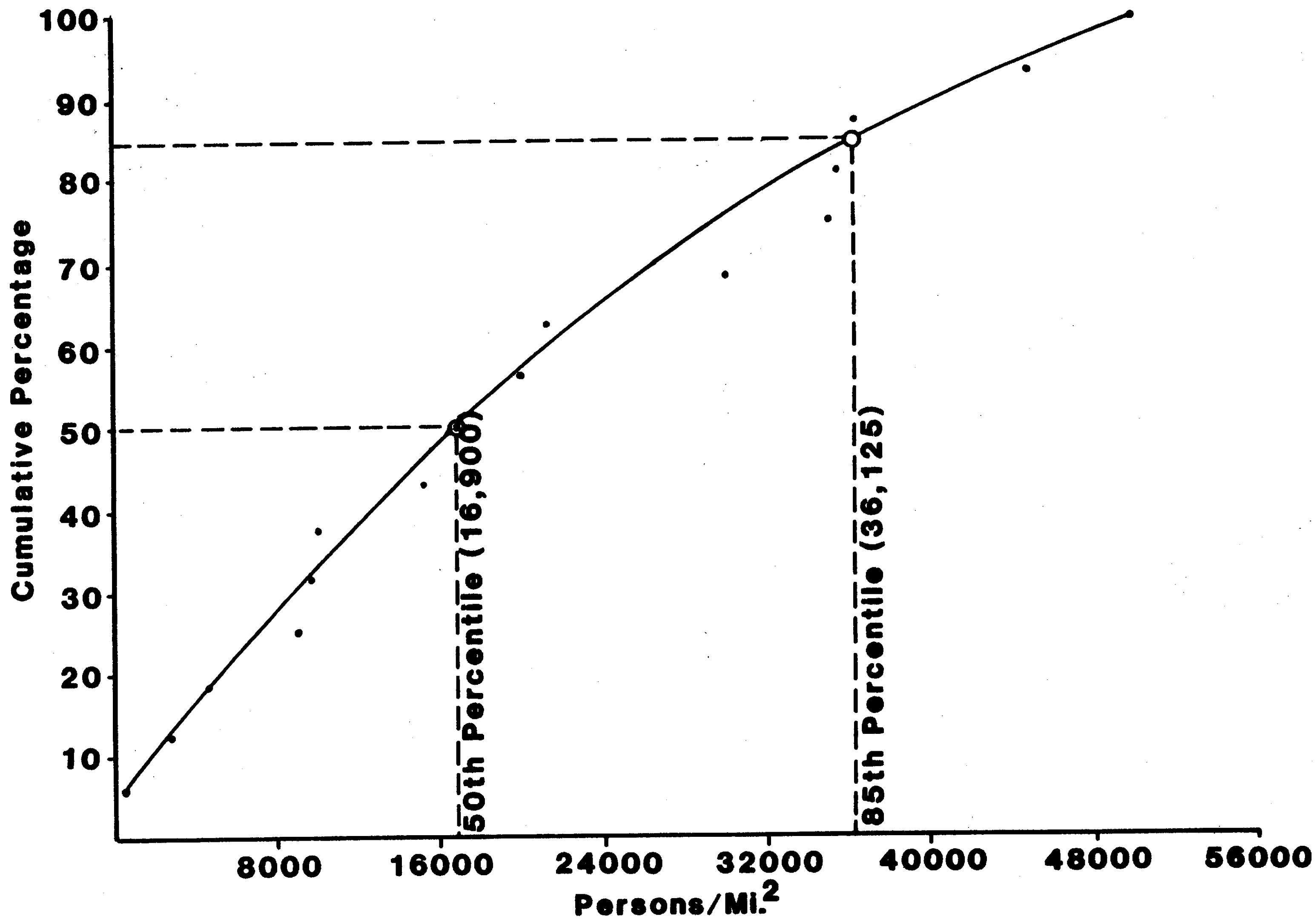


Figure 10: Cumulative Frequency Distribution, High Estimates of Population Density (n=16)

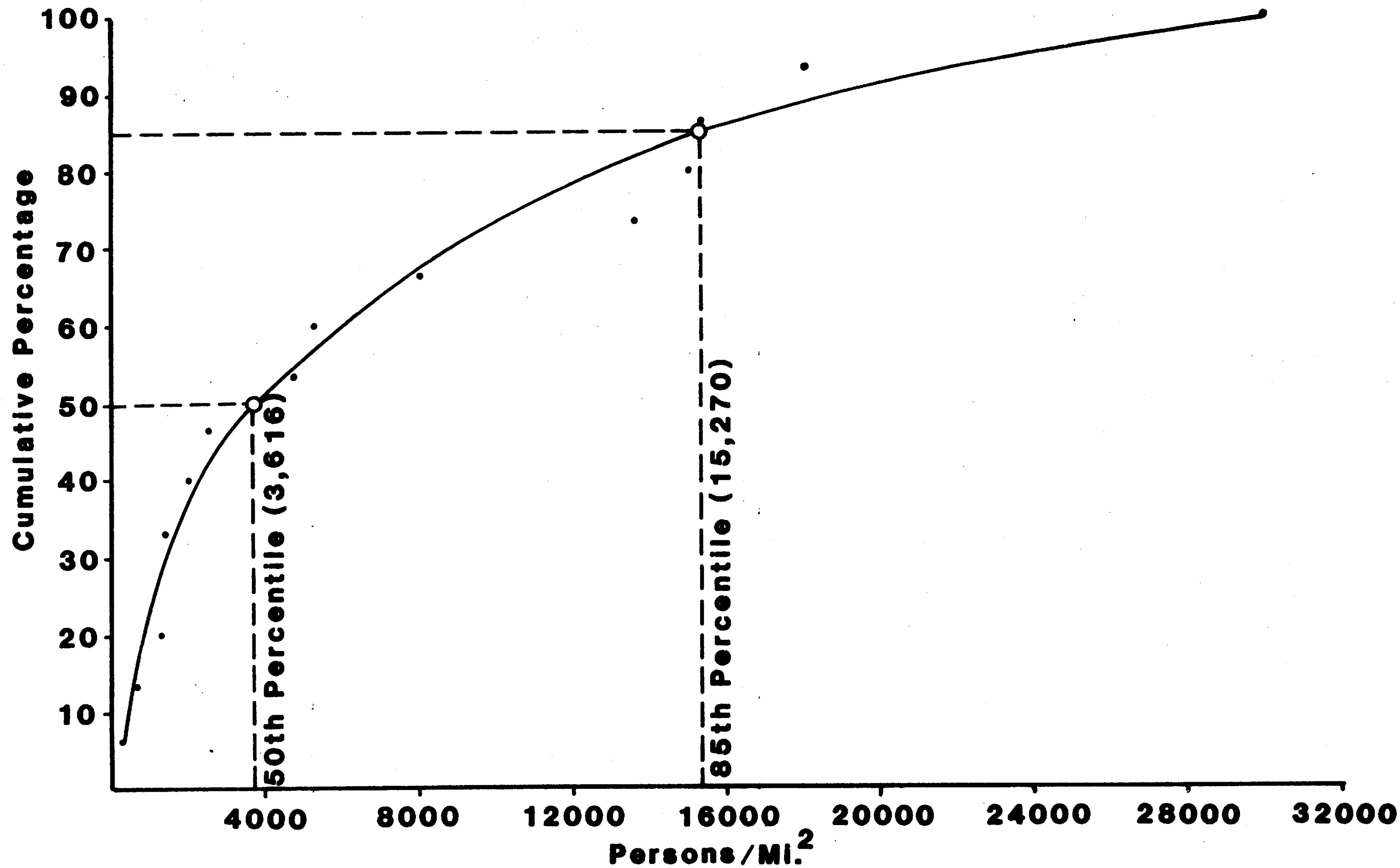


Figure 11: Cumulative Frequency Distribution, Overall Average Estimates of Population Density (n=15)

Table 18: **Population Density Estimates in Persons Per Square Mile By Survey Respondents (n=17)**

Urbanized Area:	Type of Reporting Agency:	Low Estimate	High Estimate	Average Estimate
Atlanta	Regional Council or Comm.	96	36,320	1,333
Baltimore	Other	10,000	20,000	15,000
Boston	Regional Council or Comm.	189	9,359	1,400
	State Dot or Admin.	189	4,670	1,400
Buffalo	Transit Agency or Operator	4,800	21,790	NA
Chicago	Transit Agency or Operator	2,031	35,832	18,000
	Regional Council or Comm.	500	35,000	2,000
Miami	City Planning Org. or Admin.	2,000	9,000	8,000
New York	Transit Agency or Operator	20	500	275
Oakland	Transit Agency or Operator	10,000	50,000	30,000
Philadelphia	Transit Agency or Operator	3,200	10,000	4,700
San Francisco	Transit Agency or Operator			13,600
	Regional Council or Comm.	11,520	44,800	15,360
	State Dot or Admin.	1,525	15,240	5,206
Tallahassee	State Dot or Admin.	27	2,805	623
Trenton	State Dot or Admin.	200	30,000	NA
Washington	Regional Council or Comm.	300	16,900	2,531

transportation planners in developing population density profiles along an existing or proposed rail corridor within an urbanized area. The planner must consider the geographic boundaries of these data sources and the relationship of these geographic areas to the alignment of a new or proposed rail transit system.

To illustrate the variation that may arise from employing different sources of data, population densities for the 13 urbanized areas are presented based upon:

1. Returned Survey Data;

2. Bureau of the Census Data; and,

3. Rand McNally and Company Data.

Census data for defined Standard Metropolitan Statistical Areas (SMSA's) was obtained from the State and Metropolitan Area Data Book, 1982. The Rand McNally and Company publication entitled 1982 Commercial Atlas and Marketing Guide was used to compute a second estimate of densities. Both sources provide population and land area for the urbanized area and for the central city within the urbanized area.

The Ranally Metropolitan Areas (RMA's) listed in the 1982 Commercial Atlas and Marketing Guide represent Rand McNally's definitions of the Metropolitan areas of the nation's important cities. They are intended to provide accurate information on the population growth and the extent of each metropolitan area. The RMA's are defined on a township and locality basis, in contrast to the official Standard Metropolitan Statistical Areas (SMSA's) which are generally defined in terms of whole counties. In 1980, the 300 RMA's that approximate the 284 SMSA's comprised about 92% of the SMSA population although only 28% of the SMSA area. Therefore, the use of RMA's will normally provide higher estimates of density than those derived from SMSA's.

The basis used by Rand McNally and Company in defining RMA's includes for each defined RMA:

1. A central city or cities;

2. Any adjacent continuously built up areas; and

3. Other communities not connected to the city(s) by continuously built-up territory but whose bulk of population (either 8% of total population or 20% of the workforce) commutes to the city areas, and whose population density is at least 60 persons/per square mile.

Table 19 presents the overall estimates of population density for the 13 urbanized areas derived from the three data sources. Table 20 sets forth the

Table 19: Comparison of Average Population Densities for Participating Urbanized Areas

Urbanized Area	Estimated Overall Density (Note #1)	SMSA Density (Note #2)	RMA Density (Note #3)
Atlanta	1,333	468	620
Baltimore	15,000	968	1,349
Boston	1,400	2,234	1,522
Buffalo	NA	791	1,160
Chicago	18,000 2,000	1,908	2,092
Miami	8,000	832	3,205
New York	275	6,599	2,945
Oakland	30,000	NA	2,087
Philadelphia	4,700	1,335	1,624
San Francisco	15,360 13,600 5,206	1,310	2,087
Tallahasse	623	125	1,120
Trenton	NA	1,356	1,624
Washington	2,531	1,089	1,140

Note #1: Population Density from Survey Participants for Rail Corridors
Note #2: Population Density Computed from Bureau of the Census Data
Note #3: Population Density Computed from Rand McNally and Company Data

Table 20: Comparison of High Estimates of Population Densities with Computed Central City Densities

Urbanized Area:	Estimated High Density (Note #1)	SMSA Central City Density (Note #2)	RMA Central City Densities (Note #3)
Atlanta	36,320	3,244	3,220
Baltimore	20,000	9,835	10,087
Boston	9,359 4,670	11,979	12,239
Buffalo	21,790	8,521	8,729
Chicago	35,832 35,000	13,180	13,476
Miami	9,000	10,202	10,203
New York	500	23,494	23,570
Oakland	50,000	NA	6,283
Philadelphia	10,000	12,413	13,087
San Francisco	44,800 15,240	10,183	15,089
Tallahassee	2,805	2,912	2,810
Trenton	30,000	13,161	11,512
Washington	16,900	10,132	10,454

Note #1: Population Density from Survey Participants for Rail Corridors
Note #2: Population Density Computed from Bureau of Census Data
Note #3: Population Density Computed from Rand McNally and Company Data

high estimates provided by the survey respondents and compares those estimates with central city densities computed from the other two data sources. In both tables, the densities associated with the reported rail systems are generally higher than those derived from published sources; this clearly points to the necessity of microscopic planning for rail transit service. The reported average population densities within the rail corridors are approximately 5 times as great as the ones computed from SMSA's or RMA's. Similarly, but to a lesser degree, the high estimates provided by survey participants were about twice those computed for central city areas using the published data sources.

Cost of Railroad Right-of-Way

Question #6 of the survey asked "If you have purchased railroad right-of-way, what was the approximate cost and year of acquisition?" Provision on the questionnaire was made for the "cost per acre" and the "cost per mile" along with the date of acquisition to allow conversion of the purchase price to 1983 figures. Three respondents provided usable per acre costs while 10 indicated per mile cost of right-of-way acquisition. The reported costs were inflated by 12% per year to arrive at current (1983) purchase price estimates. Table 21 presents the computed 1983 acquisition costs for Railroad Right-of-way as determined from the survey data.

As can be seen from the cost figures shown in the table, considerable variation exists in the reported acquisition prices for railroad rights-of-way. The 1983 per mile estimates range from approximately $264,000 to over $6.2 million and average some $2.3 million per mile. No information was obtained in the survey to allow conversion of the per mile prices to cost per acre.

Table 22 summarizes the purchase costs reported by the various participants from the 11 urbanized areas providing information. Agencies (types of) have been intentionally omitted from the table to protect the confidentiality of the respondents.

Major Problem(s) for Joint Use of Railroad Right-of-Way

Question #8 on the mailout questionnaire asked "If your agency does not operate transit service within any portion of railroad right-of-way, then what do you consider the major problem to the railroad for joint use of the right-of-way?" Ten of the 35 survey participants listed one or more problems of joint right-of-way usage. These 10 responses are presented in Table 23 and are arranged by the 9 states represented by the survey returns.

Highlights of Returned Surveys

Approximately 89% of the 18 represented urbanized areas currently operated transit service on railroad rights-of-way. The remaining urban areas have plans to do so in the future. The types of service being operated on rail property include Light Rail Transit (LRT), Heavy Rail Transit (HRT) and Commuter Rail Transit (CRT). One-hundred percent of all reported CRT service operates on railroad rights-of-way, while 29% of LRT mileage and 58% of HRT mileage is provided in this fashion.

Some 56% of the participating urbanized areas reported joint freight and passenger service on railroad trackage. The percent of track mileage shared for these types of operations ranged from 5% to 100% and averaged approximately 67%.

Population densities within the rail corridors ranged from 20 to 50,000 persons per square mile. A comparison of reported densities to computed densities from published sources revealed the importance of microscopic planning techniques for investigating rail transit in urban areas. The

Table 21: Estimated 1983 Acquisition Cost of Railroad Right-of-Way

	Cost per Acre (n=3)	Cost per Mile (n=10)
Range of Purchase Price:		
Low Estimate	$10,080	$263,706
High Estimate	$121,072	$6,272,000
Mean (average) Purchase Price:	$65,927	$2,307,647
Median (50th Percentile) Purchase Price:	$38,354	$1,120,000

Table 22: Summary of Railroad Right-of-Way Costs

Urbanized Area:	Year Acquired:	Reported Cost Per Acre:	*1983 Cost Per Acre:	Reported Cost Per Mile:	*1983 Cost Per Mile:
Atlanta	1982	$108,100	$121,072	$685,960	$768,275
Baltimore	1974	---	---	---	---
Boston	1977	---	---	$336,780	$664,744
Buffalo	1982	$9,000	$10,080	---	---
Miami	1978	---	---	$2,500,000	$4,405,854
	1981	---	---	$5,000,000	$6,272,000
New York	1966	---	---	$199,390	$1,369,020
Oakland	1982	---	---	$2,400,000	$2,688,000
Philadelphia	1964	---	---	$584,710	$5,044,581
Portland	1982	---	---	$1,000,000	$1,120,000
San Diego	---	$8,227	---	$166,000	---
	1979	---	---	$167,590	$263,706
Tallahassee	1982	$59,490	$66,629	$428,830	$480,290

*NOTE: The 1983 Cost is Estimated using a 12% per year inflation rate.

Table 23: Major Problem(s) Associated with Joint Railroad Right-of-Way Use By Responding State (n=11)

State	Major Problem(s):
California	Problems include cost arrangements, engineering to allow both passenger and freight service. Safety.
District of Columbia	Institutional arrangements for commuter rail operation and funding assistance for operating deficits.
Florida	Getting railroad to agree to joint usage at an equitable price.
Maryland	Providing adequate service to both freight traffic and peak passenger traffic on shared tracks.
New Jersey	Freight railroad resistance to sharing right-of-way.
New York	We look at use of railroad rights-of-way as opportunities, not as "problems" for the expansion of Buffalo's under-construction LRRT system into the suburbs. Envisioned are (1) use of abandoned railroad roadbeds, (2) joint use track where freight service is sparse, and (3) joint use of right-of-way where existing tracks are busy. Note: In conjunction with an Alternative Analysis for a corridor study just getting undersay, we investigate shared facilities in North America. (A draft of the resulting work was attached to survey).
Oregon	Technically, the light rail design (particularly wheel, truck and gear box) are not designed for freight tracks. If one shares ROW, LRT has to have larger (AAR) wheels/ axles and this affects upsprung mass. In turn, this affect suspension, gear boxes, motors, etc. Moreover, RR regulations are different (clearances for example) and will cause problems.
Texas	Negotiation with RR companies. Safety.
Washington	Cost.

population densities within the rail corridors of the 13 represented urbanized areas were generally 2 to 5 times greater than those densities computed from SMSA or Rand McNally's RMA data.

The inflated 1983 acquisition cost of railroad right-of-way ranged from $264,000 to $6.3 million per mile and averaged about $2.3 million per mile. The per acre cost varied from $10,000 to $121,000 and averaged some $66,000. Some 68% of the survey respondents indicated that some form of "purchase" was involved in the acquiring of right-of-way for transit use.

Survey of Railroad Companies

Officials of 21 United States railroads, 2 Canadian railroads, and 5 passenger transportation agencies, representing a total of 28, were contacted by telephone. Questions asked are summarized in Appendix C. Actual survey questions were tailored to each situation; not all questions were applicable in each case. Some responses were more complete than others due to unavailability of concise information and/or caution about releasing the information for publication, in which case the information was derived from other sources. Results are summarized, by contacted railroad, in Table 24. The "Freight Railroad Use" column defines light use as 4 or fewer trains per day, medium use as 5 to 8 trains per day, and heavy use as 9 or more trains per day. The abbreviations used in the table are:

AT&SF:	Atchinson, Topeka & Sante Fe Railway System
CR:	Commuter Rail
CSSMTD:	Chicago South Suburban Mass Transit District
DOT:	Department of Transportation
FRA:	Federal Railroad Administration
ICC:	Interstate Commerce Commission
LRT:	Light Rail Transit
MBTA:	Metropolitan Boston Transportation Authority
ODOT:	Oregon Department of Transportation
PAAC:	Port Authority of Allegheny County
PUC:	Public Utilities Commission
RRT:	Rapid Rail Transit (Also Heavy Rail Transit or HRT)
RTA:	Regional Transportation Authority (of Chicago)
SEMTA:	Southeastern Michigan Transportation Authority
SEPTA:	Southeastern Pennsylvania Transportation Authority
TRK:	Track
WMATA:	Washington Metropolitan Area Transit Authority
WMSTD:	Western Metropolitan Suburban Transportation District

Table 24: Summary of Telephone Survey of Railroad Companies

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Equip. by	Equip. by	Other Comments/ Clearances
AMTRAK	Baltimore	CR	B&O	45	Subsidy	FRA/Congress	-	Std-Pass	Amtrak	B&O	By Contract with Maryland.
	Martinsburg	CR	B&O	70	Special	FRA/Congress	-	Std-Pass	Amtrak	B&O	Sunset Commuter (Special Legislation).
	Philadelphia	RRT	AMTRAK	252	Trk Rigts	FRA	-	RRT	SEPTA	SEPTA	SEPTA operates over AMTRAK trks.
AT&SF	San Francisco	RRT	BART	0	Purchase	-	None	RRT	BART	BART	Lite-use line now abandoned; Row Sold. 23.5' vert
	S. Cal.	-	-	-	-	-	-	-	-	-	Contacted due to San-Diege to LA High Speed Rail Proposal. AT&SF does not favor.
BALTIMORE & OHIO	Baltimore Wash.	CR	B&O	37	Service	MD DOT FRA	Heavy	CR	MD B&O	B&O	
	Washington DC. to Martinsburg	CR	B&O	70	Service	MD DOT ICC	Heavy	CR	B&O	B&O	MD portion subsidized, W. Va. unfunded & ICC Regulated.
	Pittsburg	CR	B&O	18	Service	FRA PAAC	Heavy	CR	B&O	B&O	Push-pull, funded by Port Authority of Allegheny County.
	Wash DC	RRT	WMATA	6.2	*	-	Heavy	RRT	WMATA	WMSTA	2 main tracks spread; METRO in center.
BOSTON & MAINE	Boston	CR	MBTA	242	Sale Serv	FRA MBTA	Med	Std. Comm	MBTA	B&MRR	Sold to MBTA; operated by B&M.
	Boston	RRT	MBTA	5	Sale	-	Med	RRT	MBTA	MBTA	RRT line reduced clearances; new Hi-wide route built. RR changed to single track.

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Table 24: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Equip. by	Equip. by	Other Comments/ Clearances.
BURLINGTON NORTHERN	Chicago	CR	BN	37.7	Service	FRA RTA	Heavy	CR	Dist	BN	3 track (CTC Main Line, Freight is Time-Restricted.
	Seattle	LRT	BN	2	Trk Rights	FRA	Light	LRT	City	Cty	Tourists-Time separated. 23' to catenary.
CANADIAN NATIONAL	Montreal	CR	CN	20	Service	Ministry of Transport/ Province/ Local Govt.	Light	CR	Cit	CN	3 yrs Negotiation
	Toronto	CR	CP	180.7	Service		Heavy	CR	GOTRANS	CN	Model of cooperation.
	Edmonton	LRT	City	3.5	Lease		Med	LRT	City	City	CN, did rail installation. Tunnel under track. Fence at stations.
CANADIAN PACIFIC	Montreal	CR	CP	40	Service	Ministry of Transport Province/ Local Govt.	Heavy	CR	City	CP	
	Toronto	CR	CP	31.2	Service		Heavy	CR	City	CP	Freight Time-Restricted.
	Vancouver	LRT	City	1	Lease		Heavy	LRT	City	City	Under CP-owned Buildings already on columns. 84" Horiz, 26' vertical clearance. Fence, signal changes.
	Calgary	LRT	Calgary	11	Lease		Light	LRT	City	City	14' Horizontal. Grade xing signal changes.
CHICAGO RTA	Chicago	CR	NIRC	46.9	Owned	FRA	Light	CR	NIRC	NIRC	Refers to purchase of Rock Island only - see also BN, C&NW, CSS&SB, ICG, Milw, N&W.

Table 24: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Equip. by	Equip. by	Other Comments/ Clearances
CHICAGO & NORTHWESTERN	Chicago	CR	CNW	150.2	Service	FRA RTA	Heavy	CR	RTA	C&NW	Freight time restricted.
CHICAGO, SOUTH SHORE & SOUTH BEND	CHICAGO	CR	CSS&SB	90	Service	FRA RTA ICC North Indiana Comm Trans	Med	CR	RTA &	CSS&SB	Once Interurban - 2 miles of street running. Freight time restricted.
CONRAIL	None	-	Govt's	0	Purchase	-	-	-	-	-	All operations and track sold to MBTA, SEPTA, NJ Transit, Conn TA, New York, Del. DOT, MD DOT. Trackage rights retained.
	Philadelphia	RRT	SEPTA	36	Purchase	Govt's	Heavy	RRT	SEPTA	SEPTA	
FAMILY LINES	Atlanta	RRT	MARTA	4	Purchase	MARTA	Heavy	RRT	MARTA	MARTA	SCL Relocated. 20'Horizontal.
FLORIDA EAST COAST	Miami	RRT	Dade Co.	9.2	Purchase	Dade Co.	Light	RRT	County	County	12' Horizontal, 23'' vertical
GO TRANSIT	Toronto	CR	GOTRANS	211.9	Service	Province/Min of Transport	Heavy	CR	GOTRANS	GOTRANS	31.2 miles on CP; 180.7 miles on CN
GRAND TRUNK WESTERN	Detroit	CR	GTW	25.5	Service	FRA SEMTA	Med	CR	SEMTA	GTW	
ILLINOIS CENTRAL GULF	Chicago	CR	ICG	77.8	Service	FRA RTA	None	CR	RTA & Distr	ICG	Special Commuter tracks not shared with freight on 3 Electric Lines. One diesel Line.
LONG ISLAND RR	New York Long Island	CR	LIRR	320	Subsidy	FRA NY ICC METRO		CR	LIRR	LIRR	Owned by NY State. Passenger service is first. Common Carrier. Problems include Vandalism & Suicides.

Table 24: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Equip. by	Equip. by	Other Comments/ Clearances
MILWAUKEE	Chicago	CR	Milw	80.7	Service	FRA RTA	Light	CR	NIRC	NIRC	No Switching during rush hour.
NORFOLK & WESTERN	Chicago	CR	N&W	23	Service	FRA RTA	Light	CR	RTA	N&W	Freight Time Restricted.
PITTSBURG & LAKE ERIE	Pittsburg	CR	P&LE	40	Subsidy	FRA ICC	Heavy	CR	P&LE	P&LE	Subsidy from State of PA & Beaver County run at a loss, but provides good will.
SAN DIEGO & ARIZONA EASTERN	San Diego	LRT	METRO	17	RR TRK Rights	FRA CAL PUC	Med	LRT	City	City	Only LRT/FRT RR Joint Operations. See special RR Listings.
SEMTA	Detroit	CR	GTW	25.5	Contract	FRA SEMTA	Med	CR	SEMTA	SEMTA	
SE.PA.TRANS. AUTHORITY	Philadelphia	CR	AMTRAK	252	Trk Rights	ICC	Light	CR	SEPTA	SEPTA	90 MPH Max. Portion operates over AMTRAK tracks.
SOUTHERN	Atlanta	RRT	MARTA	12.5	Purchased	MARTA	Heavy	RRT	MARTA	MARTA	One corridor lost 1 track. Tracks shifted. Shoo-fly needed during construction. 19.5' Horiz., 23' Vert. clearance.
	Washington DC	RRT	WMATA	2	Purchased	WMATA	Heavy	RRT	WMATA	WMATA	
SOUTHERN PACIFIC	San Franciso	CR	SP	47	Contract	FRA CALDOT	Heavy	CR	SP	SP	
	Portland	LRT	ODOT	3	Purchase	FRA CALDOT	None	LRT	City	City	Portland Traction (jointly owned by SP & UP). 3 miles closed & sold for LRT line.

Table 24: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Equip. by	Equip. by	Other Comments/ Clearances
UNION PACIFIC	Portland	LRT	ODOT	5	Purchase	FRA ODOT	Med	LRT	City	City	Between RR & Freeway. Special Drainage. 21' horiz. clearance.
WESTERN PACIFIC	Oakland	RRT	BART	30	Purchase	FRA CALDOT	Med	BART	BART	BART	Slow orders, shoo-flys, spur track removed. 22.5 vert.
YAKIMA VALLEY TRANSPORTATION	Yakima	LRT	YVT	10+	Track rts.	FRA	Light	Trolleys	City	City	Tourist Attraction Trolley-time separated.

The following generalizations, observations, and trends emerge from the responses:

1. During negotiations, railroads insist upon being "kept whole", that is, not being harmed financially or operationally, or being compensated fairly if harm is unavoidable. (See Technical Feasibility Section).

2. Most railroads will cooperate with local Public Transit Authorities, provided the proposals are reasonable and compensation is fair.

3. To date, freight trains have not shared the same track "at the same time" with Light Rail Transit (LRT) vehicles. Only one United States railroad currently has this possibility, the San Diego and Arizona Eastern, but safety considerations so far have kept operations time-separated, with freight trains running only at night. (See the Technical Feasibility Section and Appendix C for more detail).

4. Rapid Rail Transit (RRT) trains share track with railroads only in the New York City area with the cars being heavy in weight compared to LRT's.

5. Railroads prefer to sell land outright for parallel transit operations, insisting upon minimum clearance from centerline of the nearest track of 15 feet or more, and other measures such as fences to protect the railroad. (A leased right-of-way in Vancouver required clearance of only 8 1/2 feet on tangents and wider on curves. The railroad retained the land; available downtown right-of-way width was too narrow to allow greater clearance.)

6. An adjacent transitway will generally disrupt railroad operations during construction, and may require permanent signal changes.

7. Commuter operations are increasingly being provided by regional transit or transportation authorities, which often purchase the rolling stock and sometimes even the tracks, then contract with the private railroad company to operate the service. Only the Pittsburgh and Lake Erie Railroad still operates a commuter train at a loss under ICC regulations, and even this is subsidized by the State of Pennsylvania and Beaver County.

8. Currently there are no "high technology" modes sharing right-of-way or tracks. The most advanced parallel transit system is a fully-automated linear induction advanced LRT-type Intermediate Capacity Transit System (ICTS), similar to that shown in Figure 12. This system is under construction in Vancouver, British Columbia, Canada.

UTDC ICTS VEHICLE

Source: Lea, Elliott, McGreen/DeLeuw Cather, Dallas Fixed Guideway Rapid Transit Mode Analysis, March 1983.

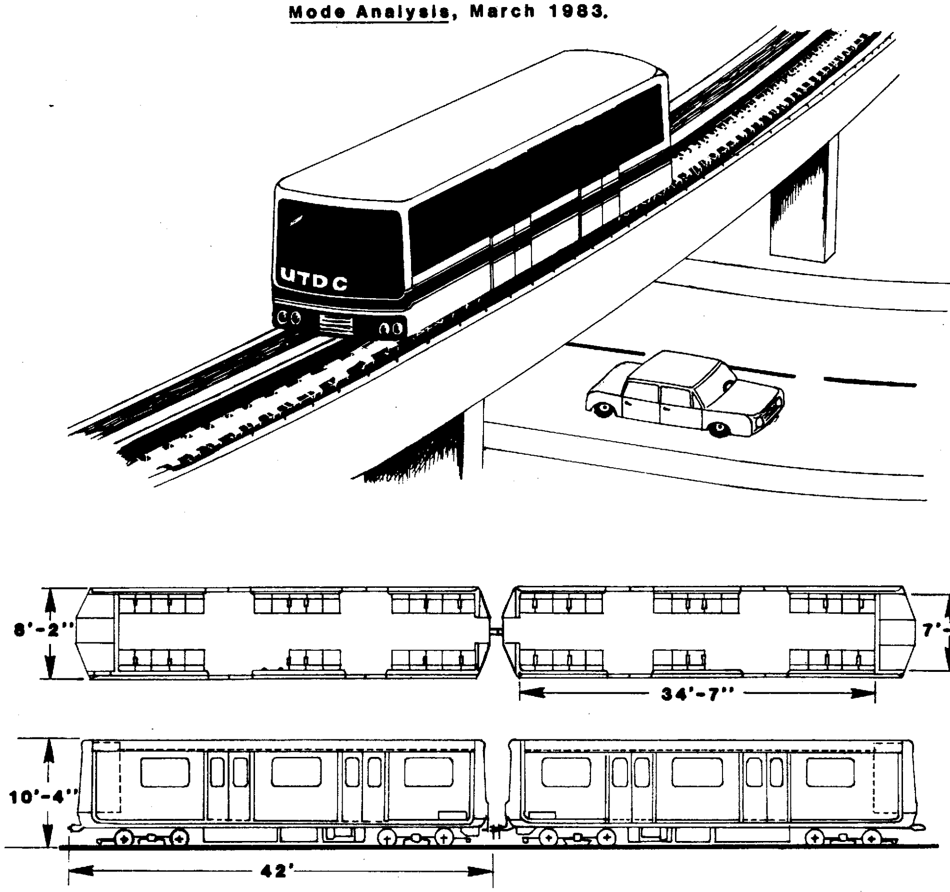


Figure 12. Advanced Fully-Automated Linear Induction LRT System Under Construction In Vancouver, Canada.

9. Negotiations usually take a number of years, requiring approvals by many railroad officials. Rapid approval of plans by local railroad officials is generally not possible.

10. Care must be taken to avoid harming local industry by restricting clearances or hindering future freight traffic growth.

11. Some railroad officials expressed concern about crime, vandalism, and public safety. These should be properly addressed during the planning phase.

12. While transit guideways cross over and/or under freight railroad tracks, no United States example exists of "piggybacking" a parallel guideway directly over or under railroad tracks.

Transit projects directly adjacent to, but not upon railroad rights-of-way, were not included in the survey nor were locations where transit lines simply crossed the railroad, even when the crossings were at a gentle angle.

Results of this survey suggest that increased joint-use of railroad right-of-way for a separate transit guideway or for a commuter operation is quite possible for some lines, provided the railroad interests and good engineering practice are provided for, and the agreement assures that the railroad be kept whole.

Survey of Transportation Associations and Organizations

A total of 26 professional associations, societies and organizations concerned with various aspects of transportation were contacted and invited to provide input to the study. Each of the professional groups received a short letter outlining the principal areas being investigated in this research effort and requesting any adopted policies or position papers related to the shared use of rail right-of-way for freight and passenger service. Those professional organizations invited to participate in the study are listed below and are included, along with their mailing addresses, in Appendix D.

- Air Transport Association
- American Association of Motor Vehicle Administrators
- American Association of State Highway and Transportation Officials
- American Institute for Shipper's Association
- American Public Transit Association
- American Short Line Railroad Association
- American Society of Traffic and Transportation
- American Trucking Association
- Association of American Railroads
- Association of Interstate Motor Carriers
- Commuter Airline Association of America
- Equipment Interchange Association

- Freight Forwarders Institute
- Highway Users Federation for Safety and Mobility
- Institute of Transportation Engineers
- National Association of Regulatory Utility Commissioners
- National Association of Shippers Advisory Board
- National Association of Women Highway Safety Leaders
- North American Trackless Trolley Association
- Railway Progress Institute
- Slurry Transport Association
- The National Industrial Traffic League
- Traffic Clubs International
- Transportation Association of America
- Transportation Data Coordinating Committee
- Western Highway Institute

Some 12, or 46.2%, of the contacted organizations responded to the invitation to participate in the study. With the exception of the Institute of Transportation Engineers, none of the professional groups had adopted any position papers on the subject of utilizing railroad rights-of-way for transit purposes. However, several of the responding associations provided helpful information in the form of additional references, publications and suggested resources or contacts. The Institute of Transportation Engineers (ITE) published an informational report entitled "Public Transportation Uses of Existing Railroad Right-of-Way --What's Happening?", in the August 1982 issue of the ITE Journal. This report was prepared by Technical Committee 5C-7 under the guidance of ITE's Technical Council and provides several examples of successful joint rail right-of-way usage by freight and transit concerns.

Inventory of Texas Railroad Facilities

All railroads in Texas file annual reports with the Texas Railroad Commission (RRC). This annual report was the primary source of data for developing the inventory of Texas Railroad Facilities. Other sources were:

1. The Official Railway Guide

2. Texas Almanac

3. United States Transportation Zone Maps

4. Texas Railroad Map

The railroads and their descriptions, mileage, locations and route maps are shown in Appendix E. Several tables also included in the Appendix provide operating characteristics of the Class I, Class II and Class III railroads.

Interstate Commerce Commission (ICC) Classifications

The ICC has a Freight Classification Procedure for grouping operating railroad companies. Class I railroads are defined as those that have annual operating revenues of $50 million or more. Class II railroads have less than $50 million but more than $10 million in revenues while Class III have less than $10 million per year.

Class I Railroads

The State of Texas currently has 7 operating Class I Railroad companies (those having annual operating revenues of $50 million or more) which consist of:

1. Atchinson, Topeka & Santa Fe Railway Company (ATSF)
2. Burlington Northern Railway Company (BN)
3. Kansas City Southern Railway Company (KCS)
4. Missouri-Kansas-Texas Railroad Company (MKT)
5. Missouri Pacific Railroad Company (MKT)
6. St. Louis Southwestern Railway Company (SSW)
7. Southern Pacific Transportation Company (SP)

Operating characteristics, historical background, service to urbanized areas and route maps for the 7 Class I railroads are shown in Appendix E.

Class II and Class III Railroads

There are 23 Class II and Class III railroads currently operating in Texas. (Class II railroads have annual operating revenues less than $50 million but more than $10 million; Class III railroads have revenues of $10 million or less). All switching and terminal railroads are designated as Class III. Class II and III railroads for Texas are shown below:

- Angelina & Neches River Railroad Company
- Belton Railroad Company
- Galveston, Houston & Henderson Railroad Company
- Galveston Wharves, Board of Trustees of the
- Georgetown Railroad Company, Incorporated
- Great Southwest Railroad, Inc.
- Houston Belt and Terminal Railway Company
- Moscow, Camden & San Augustine Railroad
- Pecos Valley Southern Railway Company
- Point Comfort & Northern Railway Company
- Rockdale, Sandow & Southern Railway Company
- Roscoe, Snyder & Pacific Railway Company
- Sabine River & Northern Railroad Company, Inc.
- Texas & Northern Railway Company
- Texas Central Railroad Company
- Texas City Terminal Railway Co.
- Texas Mexican Railway Company
- Texas North-Western Railroad
- Texas South-Eastern Railroad Company
- Texas Transportation Company
- Weatherford, Mineral Wells & Northwestern Railway Co.
- Western Railroad Company
- Oklahoma, Kansas and Texas Railroad Company

The Oklahoma-Kansas-Texas Railroad (OKT) was formed on June 3, 1982 when the Interstate Commerce Commission (ICC) approved a $40 million agreement for the 3 Oklahoma, Kansas and Texas Rail Users Association to purchase 630 miles of the bankrupt Rock Island line from Salina, Kansas to the Dallas-Fort Worth area. The users group consists of the State of Oklahoma and others. The line has a total of 630 miles with 354 miles in Oklahoma, 156 miles in Kansas, and 120 miles in Texas. A subsidiary of the Missouri, Kansas and Texas Railroad (MKT), the Oklahoma-Kansas-Texas Railroad Company (OKT) was formed to operate the rail service. No operating data currently exists for this company; however, the other 22 railroads are summarized and presented in Appendix E of this report.

AMTRAK

Limited AMTRAK service is still provided in the State of Texas by two lines: 1) the Eagle, and, 2) the Sunset Limited. The Eagle originates in Chicago and terminates in San Antonio, via Texarkana, Dallas, Fort Worth and Austin. The Sunset Limited provides east-west service and extends (within Texas) from El Paso to Beaumont via Alpine, San Antonio and Houston. More information on AMTRAK is provided in Appendix E.

Inventory of Railroad Facilities in The Houston and Dallas/Fort Worth Regions

General

The railroad facilities in the Houston and Dallas/Fort Worth Regions were well documented in two 1980 rail studies performed through funds issued to the Texas Railroad Commission for State Rail Planning by the Federal Railroad Administration (FRA), U.S. Department of Transportation.

The Houston study, conducted by Turner, Collie & Braden Inc., prepared a regional rail inventory of the 13 county Houston-Galveston Area Council of Governments (H-GAC). All rail routes were inventoried for speed, condition, grade crossings, train volume and safety considerations. Projected future train volume to the year 2000 was made for each route. Capacity estimates for many lines indicated that all existing right-of-way would be required for future freight movement demand projections. However, under certain consolidations and joint trackage rights and/or the building of several new lines, some corridors could be feasible for rail passenger movement. The Houston Rail Inventory and System Maps are contained in Appendix F of this report.

The Dallas rail planning program, performed under the same arrangements as the Houston study, was completed by Peat, Marwick, Mitchell & Company. This study was sponsored by the North Central Texas Council of Governments with participation by the local entities. Unlike the Houston study that covered all counties under the Councils' jurisdiction, the North Central Texas Council of Governments (NCTCOG) chose to study, inventory and plan for only Dallas and Tarrant counties. While the two studies are similar in parts, data are not the same and cannot be directly compared. Where data are similar, comparisons are drawn and presented in Appendix F of this report. The rail system maps and descriptions are also found in the Appendix for the Fort Worth/Dallas area.

Houston Rail Facilities

There are currently five Class I railroads operating within the Houston/Galveston area:

- Atchinson, Topeka and Santa Fe (ATSF)
- Burlington Northern (BN)
- Missouri-Kansas-Texas (MKT)
- Missouri Pacific (MP)
- Southern Pacific (SP)

In addition, four terminal railroads are in operation (plus one non-operating company) within the port area.

Harris County has some 842 route miles of track of which 2.5% is double trackage and 97.5% is single trackage. Considering the 13 county H-GAC planning region, some 1,106 route miles of railroad are in place which have approximately 1,600 public at-grade crossings. Appendix F contains more information along with railroad system route maps for the Houston area.

Dallas/Fort Worth Rail Facilities

A total of seven Class I line-haul railroads currently operate in the two county (Dallas and Tarrant) area:

- Atchinson, Topeka and Santa Fe (ATSF)
- Burlington Northern (BN)
- Kansas City Southern (KCS)
- Missouri-Kansas-Texas (MKT)
- Missouri Pacific (MP)
- St. Louis-Southwestern (SSW)
- Southern Pacific (SP)

Of the total 514.3 line miles of rail network, some 267.9 miles (52.1%) are in Tarrant County while 246.4 miles (47.9%) are in Dallas county.

The cities of Dallas and Fort Worth are currently in the process of purchasing some 34 miles of railroad right-of-way form the bankrupt Chicago, Rock Island and Pacific Company. This right-of-way provides a line between the two central business districts and is intended to accommodate future rail transit connecting Fort Worth, DFW Airport and Dallas.

The August 13, 1983 referendum by Dallas area voters created the new Dallas Area Rapid Transit (DART) Authority and authorized the implementation of a 160 mile rail transit system. Approximately 89% of the 1984-2010 capital improvement expenditures will go toward the new rail system with some 58% of this amount allocated to track and civil works projects. Preliminary estimates call for about 78% of the 160 mile rail system to be constructed on or adjacent to existing railroad rights-of-way. Appendix F contains more information along with rail system route maps for the Dallas area.

DATA ANALYSIS AND APPLICATION TO TEXAS

This section of the report is developed from an analysis of the published literature, the surveys of agencies, railroad companies and transportation organizations, and other sources of data pertinent to the study's objectives. The results of the data analyses are presented in the following major categories:

- Technical Feasibility;
- Practical Feasibility; and
- Overall Feasibility.

Technical Feasibility

Introduction

Engineers, urban planners, and the general public increasingly are looking at the rights-of-way of freight railroads, radiating outward from city centers like spokes of a wheel or encircling them like a belt, as ideal locations for proposed public transit systems, and formulating plans using these rights-of-way or even the existing freight railroad tracks. Many of these individuals think that when the railroad companies voice objections to these plans, they are being uncooperative. This section, written by a former Assistant Division Engineer of a midwestern railroad and now a transportation researcher, presents some of the railroads' positions based upon the legal, technical, and operational problems which must be confronted by any railroad being asked to share its rights-of-way with a public transit system.

The purpose of this section is two-fold: First, the realities of railroad operations and the effects of various systems on the communities will be presented to enable system designers to understand and incorporate design features necessary to avoid hazards and hardships to the railroad and surrounding area. And, to provide an understanding why certain ideas (such as light rail vehicles sharing track and time with multiple freight trains on a heavily-used single-track main line) may be rejected as infeasible from safety and operational standpoints. Second, by explaining mutual problems which are likely to arise, it is hoped that a spirit of cooperation and understanding can be developed to aid the implementation of needed public transit projects. This cooperative spirit will vary, but no railroad official can be expected to appreciate public presentation of an impossible design, followed by public denunciation of the railroad for its rejection of the plan. Most railroads will be cooperative if urban transportation planners involve the railroad in their plans before contacting the media, and if the planners understand not only the technical problems presented here, but also the organizational problems of the railroad officials. (Local engineers usually do not have the authority to approve plans; they must first contact their central headquarters.)

Various public transit modes and railroad construction details are treated generally in this section. Appendix H (Design, Construction and Safety Considerations) contains more specific system-by-system information.

Railroad Requirements

Railroad companies which are approached about the possibility of joint right-of-way use by public bodies usually insist that any agreements "keep the railroad whole." This means that the railroad insists not only that it receive fair compensation for all railroad lands, but that the public agency agrees to pay all railroad operating and equipment costs incurred by the project, as well as fair compensation for any potential business losses.

Critics have wrongfully claimed that this is an unwarranted, anti-public attack on already-meager public funds available for transit project. In order to appreciate the railroads' position, it is necessary to briefly examine some history, keeping in mind that railroads are privately-owned companies trying to make a profit.

Reasons for the Position of the Railroads

Most railroad companies in the United States are privately owned by stockholders and are expected to produce a profit for them. The first responsibility of all railroad officials is to protect the interests of the company and to maximize the return to the owners. While railroad officials are as public-spirited as officials of other major corporations, they cannot be expected to give away assets or to incur operating expenses which would endanger corporate solvency. Those railroads which make profits are taxed like any other business; however, some of these taxes go to subsidize highways for trucks, waterways for barges, and airports for airplanes. Furthermore, railroads have been highly regulated by government bodies such as the Interstate Commerce Commission (ICC) and the Federal Railroad Administration (FRA) and have often been legally required to provide public services at a loss to the railroad. At this time, railroads no longer have a monopoly, and most earn a return on capital investment which is far below passbook savings account rates. In addition, some public officials expect the railroads to willingly provide assets and incur costs in the name of the public good, and publicly denounce the railroads for failing to readily do so, even though two government studies (1944 Board of Investigation and Research; Report by Secretary of Transportation, 1977) have concluded that railroads (including land-grant railroads) have repaid to the Federal Government almost all pre-1975 Federal aid (including the value of all lands given a century ago).

Passenger service is a sensitive issue to railroad companies. As public tax monies (including those from the railroads) were employed to improve public highways and airways, railroad passenger demand fell precipitously. Some critics claim that the costs of this have been greatly inflated; however, the operation of passenger trains results in maintenance costs far above that for freight trains on a ton-mile basis, due to engineering differences in the two types of operation. Yet regulatory bodies, such as the Interstate Commerce Commission, were reluctant to allow railroads to abandon unprofitable passenger service. Even when AMTRAK was initiated in 1971 to take over intercity passenger services, railroads were forced either to participate with AMTRAK at costs to the railroads based upon the previous year's losses due to passenger operations, or to continue 1970 passenger operations at a loss. Some railroads (Southern, Rock Island, Rio Grande) decided that the purchase price and interference with operations was too expensive and chose to continue their existing passenger operations.

Railroad officials who remember these operating losses are particularly reluctant to agree to operation of any type of public transit service on their existing tracks, for fear that history will repeat itself. Considering the past multi-million dollar losses incurred by enforced, continued passenger service, railroads can be expected to insist upon adequate protection against such losses. Thus, most modern commuter operations are provided by railroads on a contract basis to the transit agency while other public transportation authorities have made outright purchases of commuter operations. The largest volume passenger commuter railroad in the United States, the Long Island Railroad, is owned by the State of New York. (Long Island RR Interview, 1983.)

Technical/Operational Requirements

As explained above, railroads which are approached concerning joint right-of-way use by public transit will insist on maintaining financial and operational integrity, and will insist that the public agency protect against the following:

- Transit system hinderance of railroad operations;
- Blockage of access to railroad customers;
- Prevention of future railroad expansion;
- Potential increase in railroad liability due to the presence of the transit system;
- Transit electrical power affecting railroad signals; and
- Increase in railroad costs due to the costs of grade separation required by transit.

Transit System Hinderance of Railroad Operations

The presence of a transit system on freight railroad rights-of-way can interfere with adjacent railroad operations or maintenance in a number of ways. First, track maintenance may suffer. Railroads often distribute track materials such as ties and continuous welded rail prior to actual installation. If an adjacent transit system does not leave enough room for early material distribution, the added costs of transporting material as it is being used can be substantial. Furthermore, railroad track maintenance gangs are usually required to cease operations for safety reasons each time a transit vehicle passes. Interference may occur to switching movements of way freights serving industries. In the rare case of derailments of transit vehicles, railroad operations may be completely blocked until the derailment has been cleared. In addition, railroads are often called upon to carry loads much higher, wider, and/or longer than normal. To facilitate oversized loads, railroads have compiled lists of minimum clearances by line, and use this list to route oversize loads to assure adequate clearances (Railway Line Clearances, 1980 etc.). Construction of an adjacent transit system could reduce clearances for high-wide oversized loads to such an extent that they could no longer be shipped on that line. A recently proposed MBTA project reduced clearances on one line of the Boston and Maine Railroad so severely that it would have prevented movements of certain high-wide loads of any kind in the Boston area. The MBTA agreed to pay to increase clearances on a different line in order to allow the oversized traffic to continue to move. (Boston and Maine RR Interview, 1983.) Finally, during construction it may be necessary for the railroad to build additional by-pass tracks to allow safe clearance.

In some cases, proper planning can minimize these problems by providing for adequate clearances throughout the project. In other cases, the transit authority could agree to upgrade a different line (as did the MBTA), or to relocate shippers now on an industrial spur whose right-of-way is desired for transit use, allowing abandonment of the existing trackage for transit use. The third possibility is for the transit authority to negotiate fair compensation for future added expenses and/or lost revenues. (Railroad/Transit Agreements, 1983).

When the plans involve operation of public transit vehicles directly on the existing tracks, there will certainly be interference with railroad operations which will incur additional costs to the railroad. Commuter traffic will usually preclude normal railroad operations during rush hour times. In case of railroad trouble, there will be additional expense to clear the line as quickly as possible to avoid delaying transit. More track usage will minimize time "windows" for needed track maintenance, and maintenance standards may be much more stringent in order to provide a smooth, safe transit ride. Finally, unless the transit vehicles are built to passenger car standards (AAR Standards), the hazard to the public in case of a collision will mean that freight trains should not share tracks with transit vehicles unless adequate fail-safe measures are taken to eliminate any possibility of collisions. (San Diego and Arizona Eastern Railroad Interview, 1983).

Another critical consideration in the planning of joint railroad-transit operations is that operation of freight trains on a track is very different from operation of free-steering rubber-tired vehicles on a roadway. A train is not an automobile, and cannot stop as quickly. Many people see a stretch of railroad track which has only two or three trains operating over it per hour, and think that there is a large amount of excess capacity. In reality, based on spacing of sidings, lengths of signal blocks, and industrial activity, that track may already be operating at capacity. Unlike automobiles, trains may take thousands of feet to stop, even in an emergency situation (an emergency stop can cause derailments and flat wheels). Freight trains must often rely upon signal indications, instead of vision, to safely prevent collisions (except when one train has the complete section of line exclusively to itself under specific train orders). Without going into details of signal operations, which can be explained for any given rail line by operating officials, same-direction freight trains in block signal, single-track territory must be separated by one or more blocks for safe operation. As the length of a railroad signal block must at least equal the stopping distance of a train, track capacity is severely limited. Multiple-aspect block signal systems may require less distance by calling for a reduced speed when operating on an approach indication, but then more than a single block will be needed to safely separate trains (Armstrong, 1978). Opposing-direction trains must be separated by siding spacing which can amount to several miles. Thus, joint operation may not be feasible, even if the line seems to have adequate capacity..

Even if joint operation is possible, the signal system may be incompatible with transit. Signal height is generally greater for freight trains than for LRT. Lighter transit vehicles may not properly "shunt" the track, or an unproven open circuit vehicle detection system may "lose" transit vehicles, giving a false clear indication to freight trains which can lead to collisions. In addition, the electrical power distribution system of the transit vehicles may interfere with proper signal operation, also requiring new signal system components and circuits. Railroads have evolved an excellent fail-safe system and are reluctant to change to an untried system to accommodate transit vehicles. (Interviews with railroad officials, 1983).

A major consideration in the case of shared tracks is the fact that added expenses to the host railroad cannot be avoided. "Keeping the railroad whole" requires that the transit agency negotiate a fair settlement and pay the railroad's additional costs, or else (in the case of lightly-used branch lines) negotiate fair compensation for lost traffic, protect or relocate shippers, and/or purchase the tracks outright.

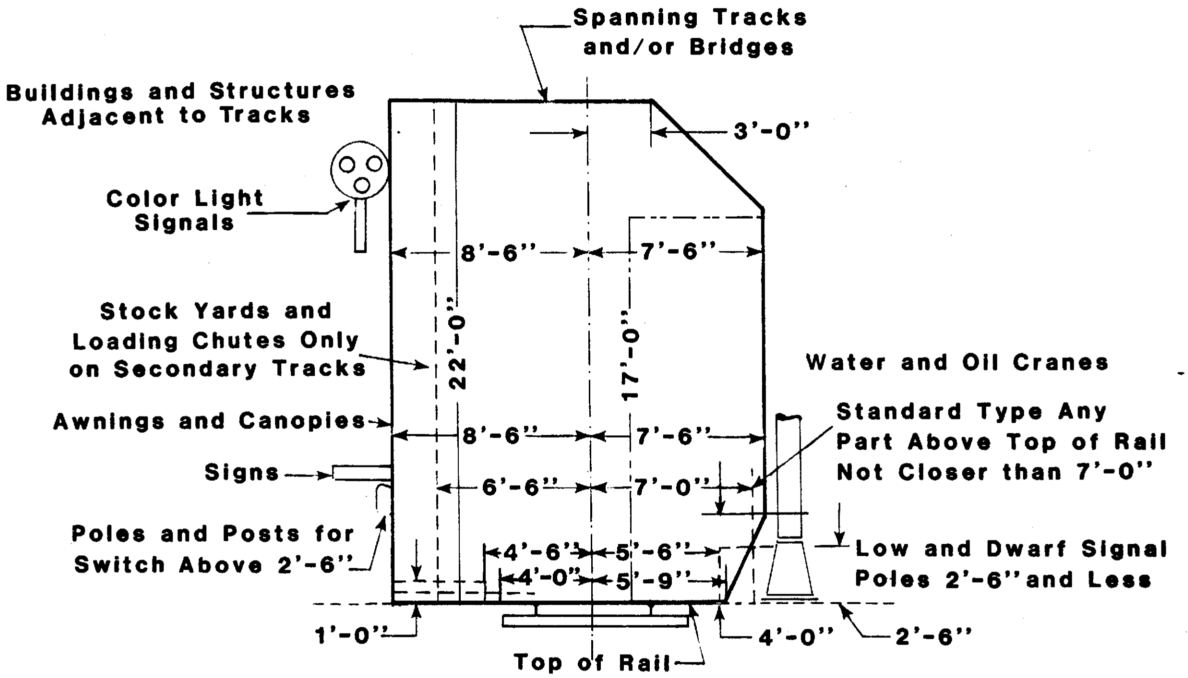
Blockage of Access to Railroad Customers

Railroads serve many industries, often delivering one or a few cars at a time to be loaded or unloaded. Industries which can benefit from rail service often locate adjacent to railroad lines, building their own industrial spurs to connect with the main line (with electrically protected turnouts). The construction of an adjacent transitway will have an adverse effect on railroad access to industries on the other side of the transitway. If at-grade, the transitway will block any present or future access to the railroad, harming both the railroad and any industries located or desiring to locate along the railroad. If elevated high enough to provide vertical clearance, the supports for the transitway may still provide a barrier to rail access. Although these problems are less severe if the transitway is constructed between the railroad tracks and an adjacent street, there are instances of industries locating across a street or highway from a railroad, with the connecting spur crossing the street at grade, often flagged by a train crew member during switching operations. Railroads will expect provision to be made to prevent loss of present or future customers, or fair compensation if the losses cannot be prevented.

There is no railroad access problem when no present customers exist and the surrounding lands are permanently zoned residential. In such a case, there will be no present or future loss of customers. A problem arises when there is no zoning (such as in Houston) or when the zoning board is known to frequently grant exceptions and variances to zoning regulations. In these cases, even though no customers presently exist, the railroad may insist upon a contract clause which states that provision will be made by the transit agency to allow the railroad to serve future customers should the demand arise.

Naturally, if there are existing or future customers, the railroad will be damaged if this business is lost due to the construction of a transitway. Railroads prefer to keep industrial spur grades below 3% (varying with individual railroad requirements), making it impossible in most cases for the railroad spur to pass over or under an at-grade transitway (the length of grade would usually be excessive). While at-grade crossing of the transitway by a rail spur is technically possible for some modes, this is not used in most cases due to the combination of collision hazard and possible delays to both transit and railroad operations. Thus, the transitway may be required to be elevated (or, in a few cases, depressed under the tracks). Although railcars rarely exceed seventeen feet in height above the top of rail (AAR Plate F), most railroads will require approximately six additional feet to allow vertical clearance for maintenance, special loads, or a switchman on top of a car. While this last practice is frowned upon, some trainmen still climb on cars to pass signals. Many states (including Texas - See Figure 13) have minimum clearances of 22 feet above top-of-rail. Railroads prefer to have at least one foot of additional clearance to allow for track raises during maintenance and to guarantee compliance with state regulations. Thus, if access is to be provided to industries on the other side of an elevated transitway, minimum vertical clearance will approximately be 23 feet above the top of the railroad rail. If instead, it is desired for the transitway to pass beneath the railroad, then, it is vital that the railroad's engineering office be brought into the design process as soon as possible, in order to assure safe support for the tracks while minimizing future maintenance problems for the railroad. Guardrails may be required to avoid safety hazards to train crew members during switching.

Required Railroad Clearances In Texas



NOTE: Passenger Train Sheds are
Exempt from General Orders

Texas

General Laws of Texas - Senate Bill No. 56-February 18, 1925-page 32,
Chap. 11 and General Order-Circular No. 6632-effective July 15, 1925.

Clearance Diagram

Figure 13. Minimum Clearances for the State of Texas.

If industrial access across the transitway is not feasible, a number of alternatives still exist. Theoretically, the simplest (but possibly most costly) method is to negotiate with the railroad and any affected industries and to pay a fair compensation for lost service and revenue. Aside from the cost to the transit agency, actual negotiations, based upon estimated forecasts from parties trying to protect their own interests, can be very difficult. During these negotiations, it must be kept in mind that individual railroad companies are in competition; diverting traffic to a different railroad company is harmful to the first company, which will expect fair compensation. A second approach, is to relocate the spur or to provide service from a team track where loads are transferred from railcars to trucks, and vice versa. Usually the transit authority is expected to cover the costs of track and roadway construction, as well as to reimburse the industries for any additional operating costs. A third possibility, which can be integrated with urban planning, is to develop an industrial park. A transit station can be built, modern streets and attractive landscaping can be constructed, and new industries attracted, benefiting the industries, the railroad, the transit authority, and the overall community.

A fourth option is possible if the transit system ceases all operations at night and the railroad track is a lightly used spur (only a few train movements per week). Assuming the transit track is built to railroad standards, the freight railroad might use the transit track to serve industries restricted to operating at night when no transit is running. Operational arrangements would have to be carefully negotiated during the planning phase.

Prevention of Future Railroad Expansion

A single track may appear to be a wasteful use of right-of-way but this may not always be the case. First, rail traffic may be such that the railroad is planning one or more additional tracks and/or sidings. Second, a right-of-way map must never be used for consideration of a preliminary design without also consulting profile maps and drainage, which may indicate the width shown on a flat right-of-way map is necessary to accommodate cuts and fills to give the railroad a smooth profile, as well as to handle stormwater drainage. Slopes of cuts and fills should be no steeper than the angle of repose of the soil unless stabilized or restrained in some manner such as a retaining wall. With provision for slopes and proper drainage without special treatments, there may be no room for a parallel transitway, while still leaving room for future construction of additional freight railroad tracks.

In such situations, it is sometimes possible to re-engineer the right-of-way with adequate drainage structures and/or retaining walls to provide for adequate width for future expansion, maintenance access, and the planned transitway, but railroad clearances must be maintained. The railroad should not be expected to absorb any of the reconstruction costs. Elevation of the transitway above the vertical clearance requirements of the railroad (often 23 feet above top of rail) may provide some needed width, as clearance requirements will extend to the supporting structure, while the wider transitway itself can overhang the side clearance. Depending upon the situation, minimum clearances from the centerline of the closest freight railroad track to the nearest transit obstruction (fence, guideway support, side of passing transit vehicle, etc.) can be expected to range from 15 feet to 30 feet from the centerline of the nearest railroad track (See Figure 14). Even if this side clearance is not needed for future expansion, it will be needed for maintenance, for oversized load movements, and to provide a margin of safety in case of derailments, trainmen on the side of cars, or shifted loads. When special cases (such as the extremely tight clearances in downtown Vancouver) dictate closer clearances, a legal variance may be required if clearance is less than state legal minimums, provided the railroad will approve the close clearances.

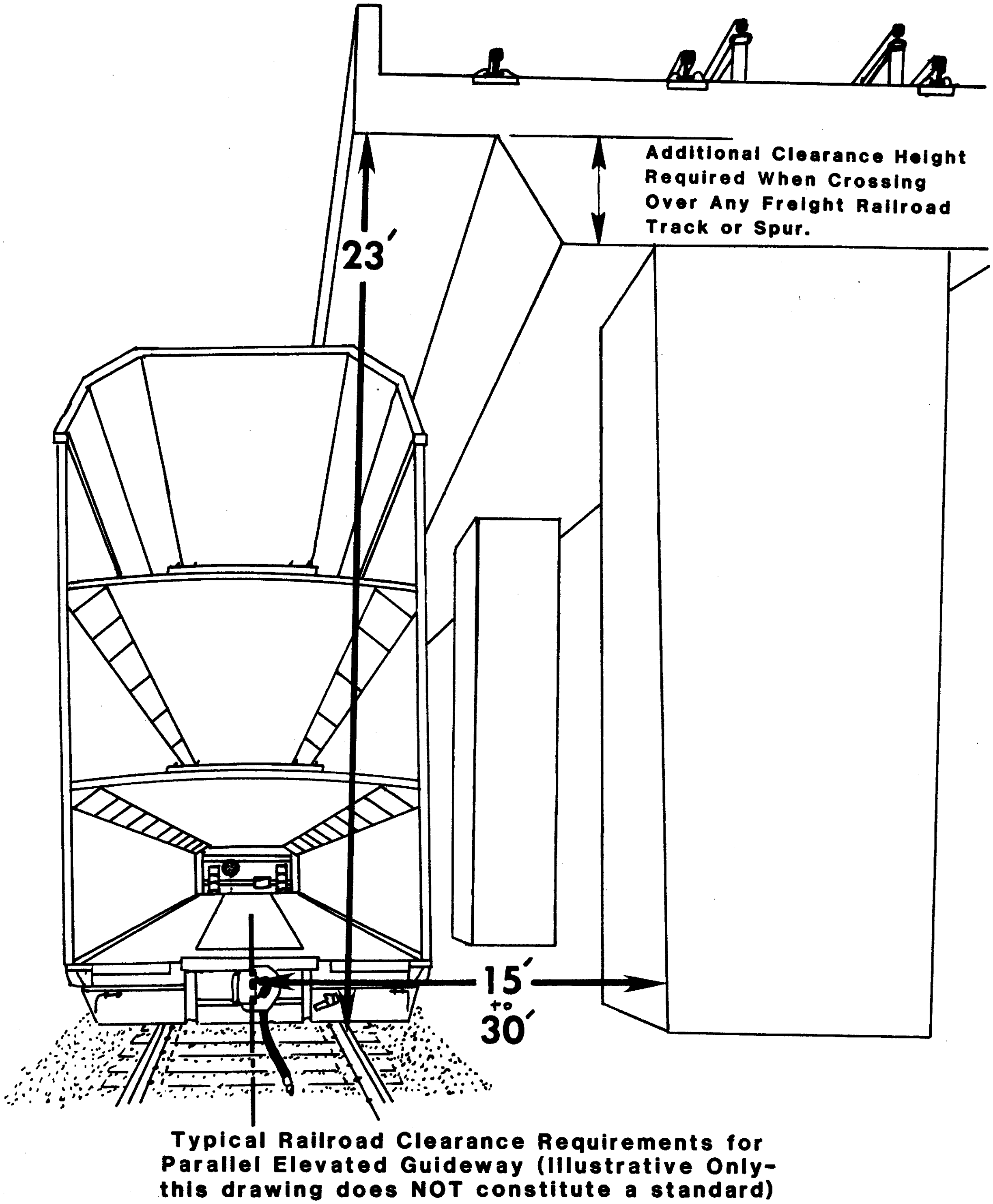


Figure 14: Varying Side Clearances Between Railroad Centerline And Transit Facilities.

deprive the railroad of customers, the customers of service, and the community of expansion opportunities.

Joint Trackage Use

Maximum interference with railroad operations will occur with joint use of track. In most cases, transit operations should be completely time separated from freight operations for safety reasons (unless adequate signal protection is provided). This can make it very difficult for railroads to schedule their operations, especially for more heavily used lines.

Collision hazards and signal compatibility are very real problems. Transit signals are often lower than railroad signals and may display different signal indications. Vehicles which are significantly lighter in weight than LRT vehicles, such as hy-rail buses, may not properly shunt the railroad signal system. For these reasons, there is increased hazard to the transit vehicles of being struck by a freight train, which could result in a high casualty toll. In some cases, neither the railroad nor the regulatory agencies will recommend joint track usage.

Joint track usage will bring the transit authority under State and Federal railroad regulations if the railroad is engaged in interstate commerce, particularly if joint operations are planned in the same time window. This is not necessarily a bad situation, however, because compliance with State and Federal railroad safety and operating regulations will, in some cases, increase the overall safety of the transit operation, but may hinder operational flexibility (e.g., by requiring a full train crew per vehicle).

Where adequate width cannot be found, it may be possible to reroute the railroad, allowing bypass of the city center. If rerouted, the railroad must not be expected to pay the full relocation costs but may participate if the bypass will help to facilitate the railroad's operations. In other situations, it may be possible for the transitway to use the railroad right-of-way along most of the route, but swing away to follow a somewhat different alignment when deep cuts or high fills are encountered. In other cases, joint right-of-way use which appeared so simple on a flat right-of-way map may prove to be impossible in practice. It is essential to involve the engineering department of the railroad before public announcements are made.

Potential Increase in Railroad Liability Due to the Presence of the Transit System

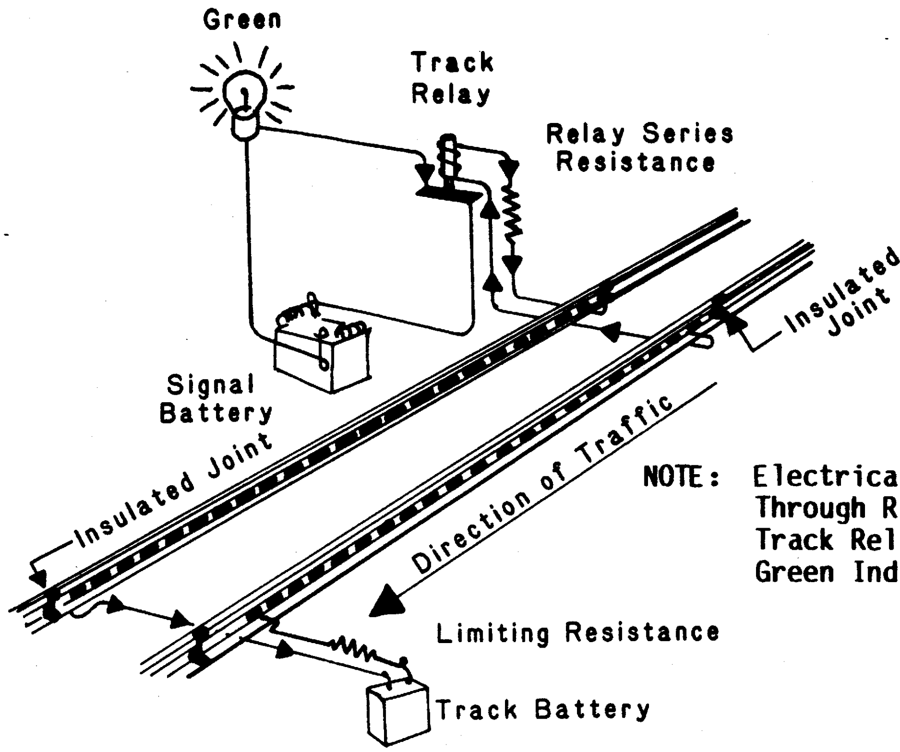
Railroads are attractive targets for vandals and lawsuits. Juries tend to find in favor of the "little guy," especially against corporations with millions of dollars worth of assets and a "Robber Baron" image. Consequently, it is not surprising that railroad officials are extremely concerned over any enterprise which will increase the potential liability of their railroad. The presence of the transitway will attract more people which will not only increase exposure to liability, but will result in greater opportunities for acts of vandalism ranging from defacing property to physical violence. The railroads' feel that they should not be forced to assume additional liability for damage to people and facilities present on railroad right-of-way for reasons which provide no benefit to the railroad. It is neither financially or operationally sound to assume new liability with no offsetting benefits.

Another problem with some transitway designs on railroad property is insensitivity to potential hazards. Park-like public areas, bridging over the tracks in a right-of-way cut section, located in a low-income public housing area may look attractive in the architect's drawing, but such parks may require extreme protective measures such as security fences, video surveillance, transit security patrols, adequate lighting, cages on bridges, as well as, waivers of liability and veto power over certain designs. While such requirements the railroads, they will serve to protect the transit system and the public as well as the railroad.

Transit Electrical Power Affecting Railroad Signals

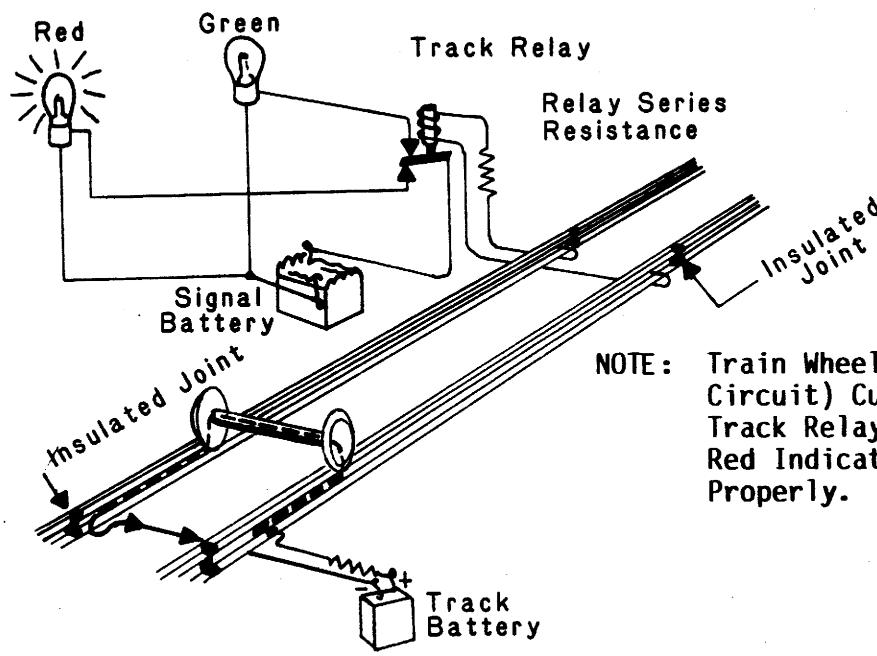
Most fixed guideway transit systems use electric propulsion power. While 600 volts DC is still common, modern thyristors, three-phase systems, and other wave-form modification controls allow the use of alternating current (sometimes at voltages considerably higher than the common 600 volts DC). Particularly during acceleration, current draw of these power systems can be fairly high. These currents can, under certain circumstances, cause leakage current or induced alternating currents in nearby conductors, such as railroad rails and signal wires. (See Figures 15 and 16). Third rail power systems could also pose a hazard to train crew members and maintenance workers, although protective non-conducting covers greatly reduce this hazard.

Railroads have an excellent record of safety per ton-mile, despite the fact that it may take a large freight train thousands of feet to come to a complete stop. Much of this safety is due to the fail-safe signal system required on today's railroads. This system must display the most restrictive aspect, usually a stop indication, if anything should malfunction. The vast majority of railroad signal-related accidents are due to human, not equipment, error (FRA Accident Reports). But these signal systems, as well as grade crossing warning detectors, operate by means of electric currents in the rails. The presence of stray currents (induced by heavy alternating current draws nearby, or leakage DC current aided by wet ballast) can prevent



NOTE: Electrical Current Through Rails Energizes Track Relay and Shows A Green Indication

Figure 15. Unoccupied Track Circuit



NOTE: Train Wheels Shunt (Short Circuit) Current Causing Track Relay to Drop and a Red Indication if Working Properly.

Figure 16: Occupied Track Circuit With No Leakage or Induced Currents

the safe operation of railroad signals. When this happens, it becomes necessary to install filters or even completely replace the existing signal system with one designed to be more immune to electrical current interference. To fail to do so could create unsafe conditions.

Any transitway adjacent to existing rail should be so designed that it will not affect railroad signals (including grade crossing signals and centralized traffic control indicator signals). Because it is a transit related cost, the transit authority should expect to absorb the total cost of installing interference-free signal systems.

Increase in Railroad Costs Due to the Costs of Grade Separation Required by Transit

To reduce accidents, potential warning devices at rail-highway grade crossings have been installed and the Federal and State Governments have instituted programs to assist in upgrading the crossing surfaces.

Traffic accidents which occur at the intersection of a rail line and a street or highway are one of the enigmas of highway safety. Available statistics indicate that such accidents are both rare and severe. Their rarity is indicated by the fact that on an annual basis, the approximately 220,000 public rail-highway grade crossings in this country have a total of 11,100 accidents, or an average of 0.05 accidents/public crossing/year. The severity statistics are also not surprising; the result of several 200 ton locomotives pulling a 5,000 ton string of freight cars and impacting a 1.5 ton car or pickup is not difficult to predict. What is perhaps surprising is that such a collision does not always result in a fatality. National data indicate that 11 percent of the collisions between trains and highway vehicles result in fatalities, while many of the remainder produce occupant injuries.

Although they account for less than 0.1 percent of nationwide traffic accidents, collisions with trains result in approximately 2 percent of the highway fatalities (Hall, 1982).

In one sense, the grade crossing is just like any other highway intersection where two flows of traffic intersect. However, the generally low train volumes create a situation where the approaching driver knows that a train may be at the crossing, but he does not expect one to be there while he is at the crossing. In an attempt to improve the safety at these locations, a variety of static and active traffic control devices have been used to warn approaching motorists and to regulate vehicular traffic when a train is nearby (Hall, 1982). See Figure 17 for typical at-grade crossing treatments.

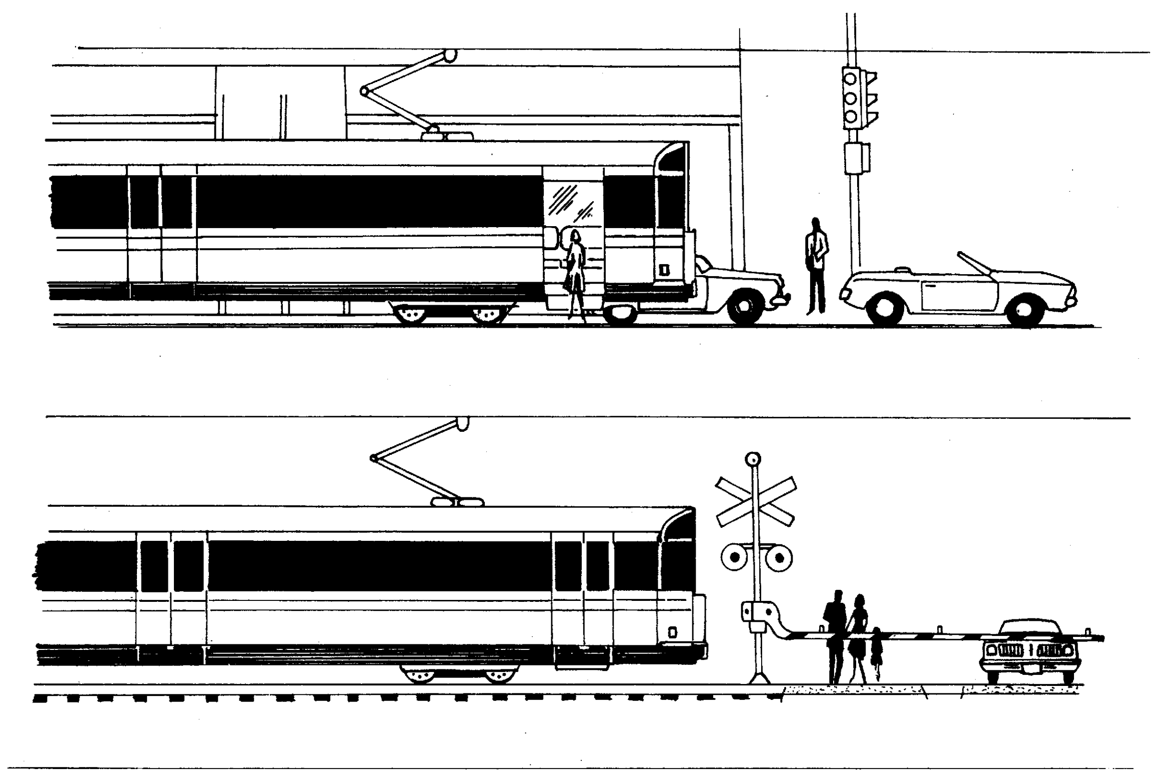


Figure 17. Grade Crossing Treatments for Rail/Roadway Intersections on LRT Line.

Grade crossings and the question of financial responsibility have long been a source of conflict between railroad and highway engineers. While the railroads may contend that they were there before the street and should not be forced to pay any of the grade crossing costs, historically this position has not been upheld. Railroads generally share in the costs of grade crossing construction and maintenance, as well as in the liability in case of accidents. Consequently, when highway engineers plan grade separations which will allow the closing of grade crossings, they cite benefits which will accrue to railroads, such as reduced liability and fewer maintenance problems, and expect the railroads to share in the costs of grade separation in return for those benefits.

When a new transitway is constructed, streets are often re-routed, grade-separated, or closed. If the transitway is constructed on railroad right-of-way, this means that some existing railroad crossings will also be closed. Sticky negotiations over how much, if any, the railroads should contribute to the grade-separations are likely to follow. The transitway planners may expect the railroads and the street maintenance budget to contribute the lion's share of grade-separation costs. This will certainly make the transit project appear more economical. The railroad may object to paying any of the costs, particularly if they have recently improved the grade crossing. A fair settlement will have to be worked out, possibly under a grade crossing improvement program which involves funding by the city, the transit agency, the highway department, and the railroad, and includes Federal and/or State funds. Under the concept of "keeping the railroad whole," railroad participation costs should not exceed proven savings.

There may be other technical/operational problems or railroad requirements. The above problems include many of those which will be encountered in planning joint transit usage of railroad rights-of-way and/or tracks. Local conditions and engineering offices will probably identify other problems which must be resolved in a manner fair to all.

Impacts on the Community

"Chinese Wall" Effect

While some transitway structures (i.e., those used for monorails) have little effect in separating one part of the community from another, other transitways (i.e., at-grade rail rapid transit) can literally split communities in two, thereby effecting property values, traffic patterns, and lifestyles. Some planners argue that railroad rights-of-way already act as "Chinese Walls," and a parallel transitway will have little or no effect. While this is often true, it is critical that the total community effect of any joint transitway be assessed on the ground and not just from maps.

Noise, Pollution, and Visual Effects

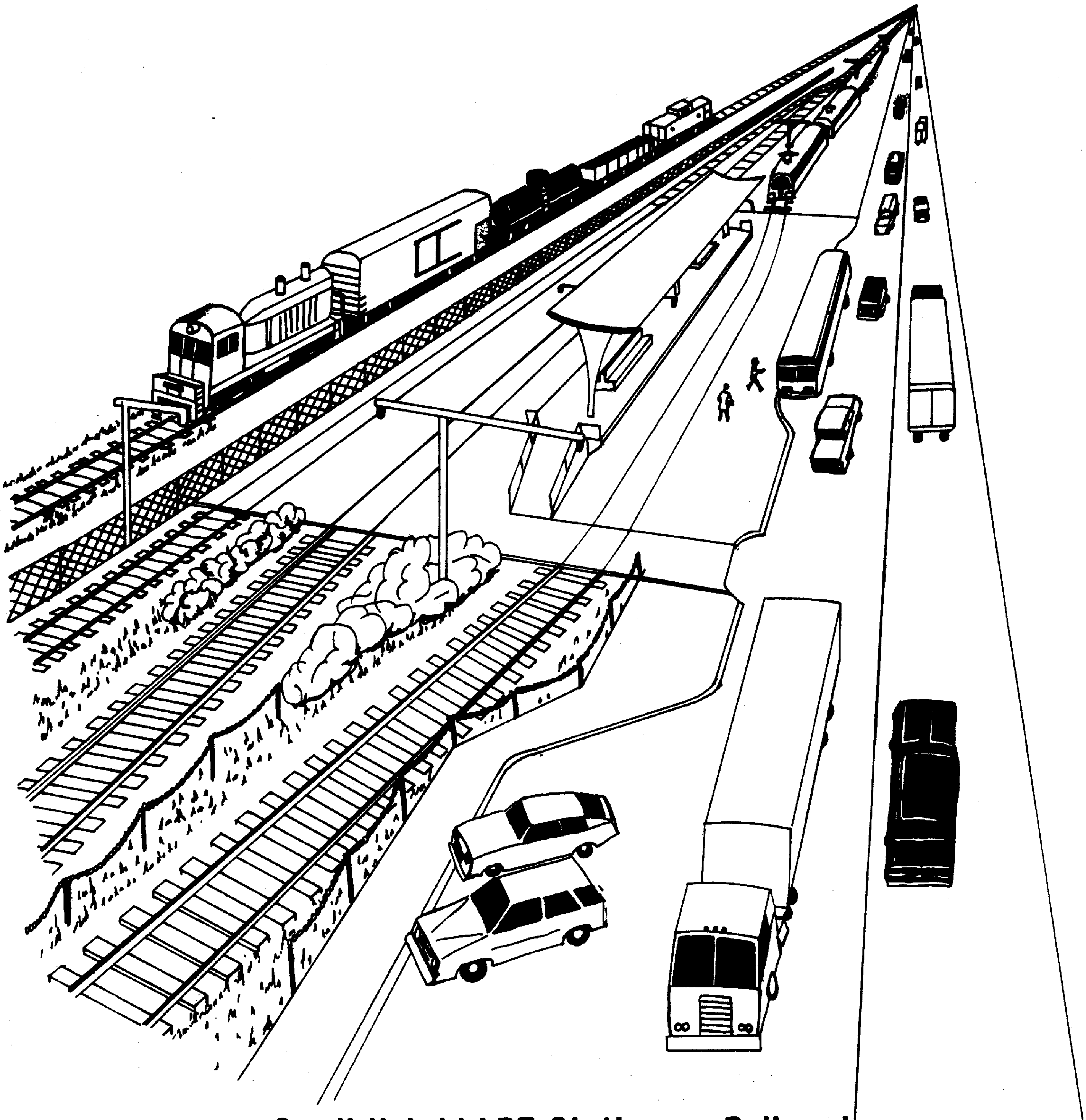
All DOT-Funded transit systems require an Environmental Impact Statement (EIS) and although each project must be considered individually in order to comply with current requirements, a few generalized comments are presented here.

Each transitway must be considered in terms of air, noise, and visual pollution. Although overall pollution by transit will normally be more than offset by automobile traffic reduction, it may be reduced near the freeway but increased at the new busway, resulting in localized neighborhood degradation. While many railroad lines are so far from an ideal aesthetic environment that an adjacent transitway will have little if any additional negative effect, situations exist where the existing rail line blends into the surrounding community and is so lightly used that it causes no real problems. In these cases, the air, noise, and visual pollution of the proposed transit systems should be measured as if the railroad track did not exist. Failure to do so can lead to sudden citizen opposition and bad feelings within the community. This problem may be minimized if the public is included in the early planning phases.

Convenience, Accessibility, Transfers for Commuters

Many railroad lines that pass through old, run-down, high-crime areas provide the opportunity for overall community improvement as well as the institution of security measures as part of the cost of locating a transit system adjacent to the railroad.

An additional problem can arise when commuters must be re-routed to take advantage of the new line as depicted in Figure 18. Some commuters who were able to ride the bus directly to their destination may now find that they are forced to ride the bus out of the way in order to transfer to the new transitway. The extra distance and time, coupled with additional cost, may push some former commuters back into automobiles, and be unattractive to other residents of the neighborhood who were potential riders (Stopher & Meyberg, 1976): If a rail line is too far out of the way, conversion of bus service to feeder service for the transitway can, in some cases, result in actual loss of ridership. The new transitway with bus feeders must be carefully planned to avoid this possibility, and it must be recognized that sometimes savings engendered by building on existing railroad right-of-way can be more than offset by poor service if the railroad's location is remote from the existing or future major travel corridors of the urban area.



Small Hybrid LRT Station on Railroad Right-of-Way with Bus Transfer

Figure 18: Rendering of Mode Change Facility (Bus/LRT) Adjacent Operating Railroad

SOURCE: H.C. Petersen

Effects on Streets and Grade Crossings

To expedite transit movement, a transitway may result in the closing of grade crossings. While some streets will be grade separated, others will simply be closed. The result is more traffic diversion increasing congestion and decreasing local access.

Another problem which may arise is the added traffic generated by transit stations. In some cases, quiet residential streets may carry more traffic than desired; in some cases, noise, hazards from traffic, and congestion will be increased. Since more recent urban construction has not always been near existing rail lines, these changes in street access and traffic may occur in older, more settled neighborhoods which may result in considerable neighborhood opposition to the new system.

Safety

While location of a transitway on railroad right-of-way can be attractive economically and may have minimal effect on the environment, it can result in reduced public safety: railroad derailments; increased risk of crime and vandalism in rundown areas; increased hazard to non-users in residential areas; and structural problems caused by mixed use, such as the vibrations of heavy trains causing elevated transit structures to settle out of line. These problems must be considered when a transitway is planned adjacent to an existing railroad track.

The safety hazards increase dramatically if joint transit-freight operations are to be conducted on the same tracks simultaneously without adequate signal protection. Many people do not realize the distance required to stop a train, nor the kinetic energy that exists in a moving train. Consequently, a collision between a freight train and a lighter transit vehicle is so potentially deadly that no non-signal protected operation now exists in the

United States where freight trains and light-rail vehicles regularly share the same tracks at the same time. While joint operation with signal protection under dispatcher control is possible on the San Diego LRT system, to date, freight trains have not operated on the system at the same time that LRT's were operating. Such operation is being considered in St Louis and elsewhere, but with adequate signal protection against potentially-fatal collisions.

Railroad cars are built with end cushioning devices and undersills capable of withstanding a 1.25 million-pound coupler buff (compressive crush) force without damage (Car & Locomotive Encyclopedia, 1980). If a freight train struck a lighter transit vehicle, the transit vehicle would crush in the same deadly manner as old and now illegal wooden coaches of the 19th century (Shaw, 1978).

Even commuter trains, constructed to full railroad standards with high buff strength bodies, are run almost exclusively during rush hour periods. Some railroads, such as the Illinois Central Gulf, provide completely separate tracks for commuter operations.

It is generally not recommended by railroad officials that joint LRT passenger and freight use without signals be planned, unless the operations are completely time separated; that is, freight trains are not allowed on the same track when the transit is in operation (Telephone Interviews with Railroad Officials, 1983). In the case of heavy rail or commuter trains with cars built to full railroad standards, there may be only minimal hazard to occasional freight operations concurrent with commuter operations during non-peak hours. But if freight operations are frequent or must be carried out during rush hours, interference between freight trains and transit service may be intolerable.

Summary of Impacts by Guideway Type

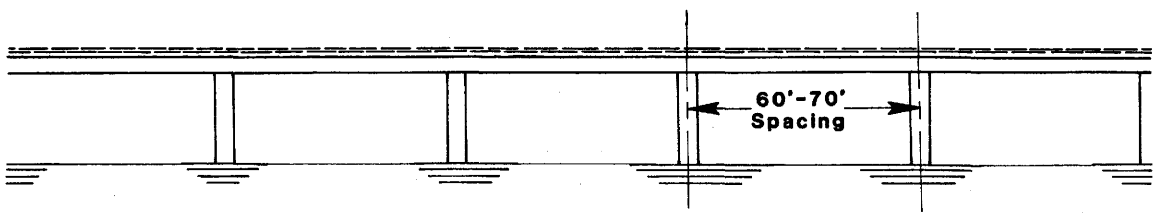
The impacts of joint right-of-way use depend more upon the type of guideway involved than they do on the individual modes. For example, although busways, monorails, and rapid rail transit are quite different operationally, the impacts of elevated structures for each of these modes will be similar. In the same way, the impacts of parallel at-grade transitways will be similar, whether the transitways are exclusive rapid transit guideways, busways, light rail, or rapid rail transit tracks. The third guideway type is joint use of existing railroad trackage, whether by hy-rail buses (which have not been proven successful in the United States to date), light rail vehicles, heavy rail vehicles, or commuter trains (regional rail transit).

Elevated Transitways

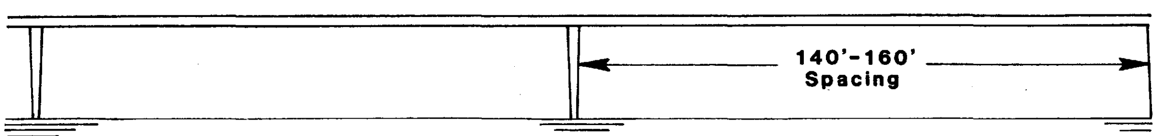
Elevated transitways minimize railroad clearance problems, because part of the transitway can be allowed to overhang the required railroad clearance area (15 to 30 feet) provided the overhanging exceeds vertical clearance requirements, 23 feet typically.

The potential for damage due to derailment of a freight train is much greater with elevated structures; a derailment which damages one or more of the support structures could result in the collapse of the transitway under the weight of a loaded transit vehicle. Also, the design of the transitway must allow for the vibration of the freight train which could cause differential settlement of the transitway supports, with attendant alignment problems.

Elevated structures tend to minimize access problems to adjacent industries. If the transitway provides adequate vertical clearance, and the spacing of the transitway supports are carefully designed, there should be no blockage of railroad access to industries on either side of the railroad line. Future industrial access may require either track re-design or relocation of one or more of the transitway supports, but this effect will be much less severe than if the transitway were at-grade. Transitways with long beam spans over 100 feet, such as monorails, will cause fewer problems than transitways such as heavy rail, which require more closely spaced vertical supports as illustrated in Figure 19.



Rapid Rail Transit Elevated Guideway



"Skyway" Monorail Elevated Guideway

SOURCE: Advanced Monorail Systems, Inc. Sales Literature

Figure 19. Typical Beam Spans for Heavy Rail and Monorail Transit Systems

Little or no effect on grade crossings should be experienced with elevated transitways, which can simply pass over the streets. Supports may reduce safe sight distances, however, necessitating more sophisticated signal warning systems or even closing of an occasional crossing for safety reasons.

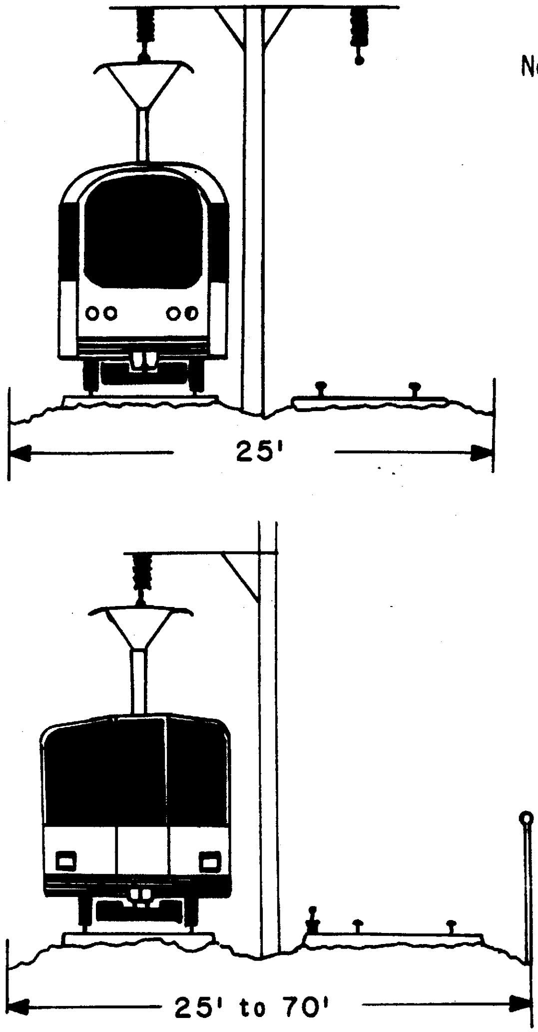
Parallel Transitway At-Grade

An at-grade parallel transitway has maximum land requirements with appropriate clearances. If the transitway is built at-grade, there can be no overlapping of any portion of the transitway or security fence within the clearance required from the center line of the nearest track (8 1/2 feet to 30 feet, depending upon railroad clearance needs and State clearance laws). As maximum possible spacing will be desired for safety reasons, the final clearance distances must be negotiated depending upon the situation. Any access roads required by the railroads for maintenance purposes usually must lie between the railroad and the transitway.

Land and vertical profile requirements of at-grade transitways may be great enough to require the use of retaining walls to obtain adequate width and even separation from the railroad right-of-way when deep cuts or high fills are necessitated. See Figure 20 and 21 for typical cross sections of rail transit lines.

While derailments will usually have a less severe impact upon the adjacent transitway, there is the danger of blockage of the transitway, or even collision with the transit vehicle if one is passing at the time of derailment. At-grade transitways increase the hazards of pedestrians wandering too close to the railroad track, particularly in station areas. Security measures (i.e., patrols, fences, TV surveillance, etc.) may be required (Railroad Interviews, 1983).

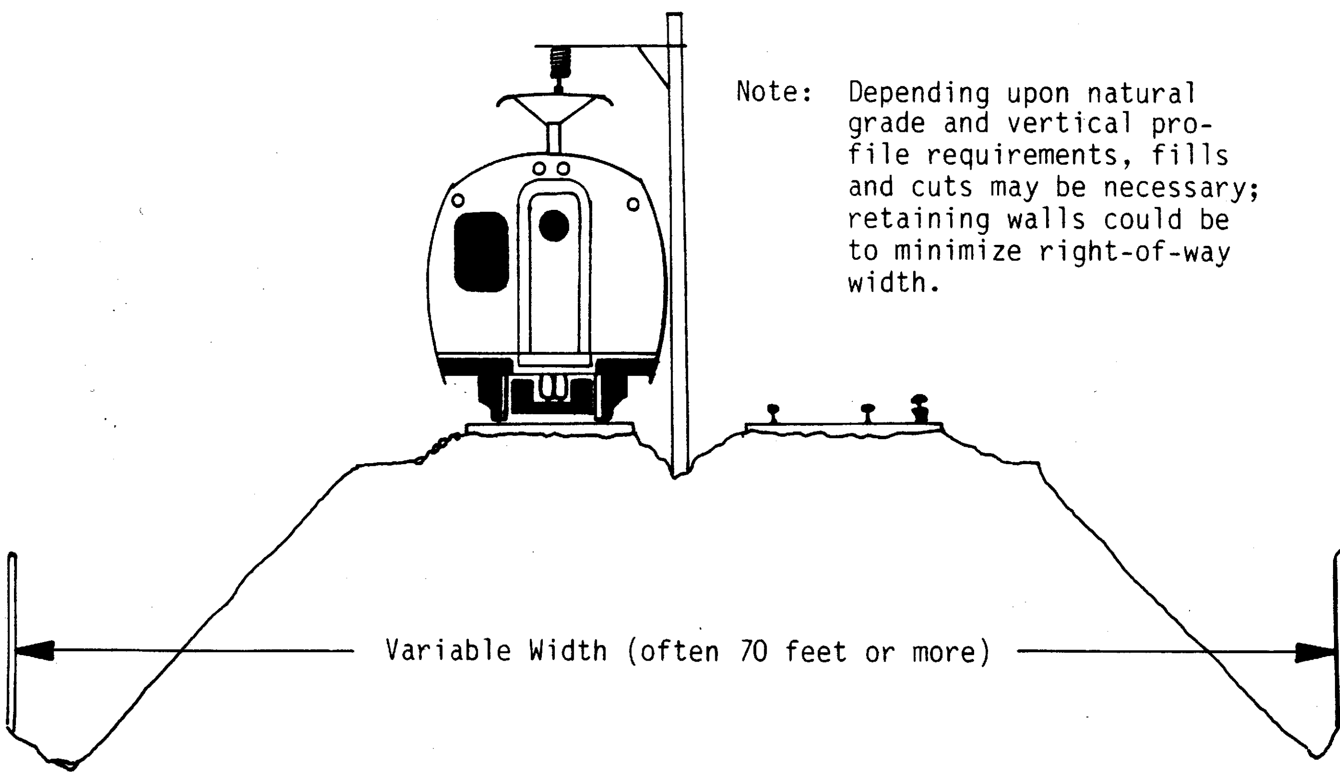
At-grade transitways will block expansion and industry access to the opposite side of the transitway. In most cases, grade crossings of spur lines are unacceptable from a safety standpoint. This means that the transitway must be grade-separated at all spurs, or one of the alternatives mentioned in the grade crossing section must be employed. Otherwise this can



Note: Absolete minimum width determined by state clearance laws and negotiated clearance agreements with railroad companies.

Note: Security fence required if 3rd-rail power pickup is used; most railroad companies will desire clearances greater than minimums for access roads, wide loads and safety.

Figure 20: Typical Cross Sections of 2-Way Light Rail Transit Adjacent Railroad Right-of-Way



Note: Depending upon natural grade and vertical profile requirements, fills and cuts may be necessary; retaining walls could be to minimize right-of-way width.

Figure 21: Cross Section of Heavy Rail Transit in a Fill Section

Labor agreements under shared track use may become more complex, as both railroad and transit unions could claim the same jurisdiction. If joint operations are planned, it is highly recommended that union negotiations be completed prior to major capital outlays, as the economics of union demands could cause an excellent system to be infeasible. For example, one study of utilizing rail buses expressed the fear that if the railroad's United Transportation Union gained jurisdiction they might require a three man crew on each rail bus, rendering the whole project uneconomical due to high labor costs (Track Sharing for Urban Transportation, 1970).

Different levels of track maintenance may be required for freight operations than for transit operations. Particularly for branchline operation, the railroad may be satisfied with Federal Railroad Administration class one or class two track (loose geometry), while the transit operation may require class three, four, or even five (better track alignment) to provide safety and a smooth ride. It may be difficult to determine the fair share of track maintenance for each party. For these reasons, as well as others mentioned previously, joint track usage should probably be minimized if possible, except for commuter trains. It is easier on both the railroad and the transit authority from an operational standpoint to keep the transit and railroad rights-of-way physically separate. While joint track usage may appear attractive from a capital investment standpoint, the track reconstruction costs, and added long-term operating costs (especially for the railroad), combined with safety considerations, will probably outweigh initial savings except for extremely lightly-used (1-5 trains per week) industrial spurs, or special cases such as use of a tunnel or bridge. A full economic and safety analysis is a must.

Practical Feasibility

The practical feasibility of utilizing existing railroad right-of-way for transit corridors in urban areas concerns a number of feasibility issues that must be addressed in reaching a solution:

1. Physical Feasibility;
2. Institutional Feasibility;
3. Financial Feasibility;
4. Economic Feasibility; and
5. Government and Public Constraints.

Physical Feasibility

Under the aspects of physical feasibility there are two real tests that must be passed: Is the railroad right-of-way of sufficient width to allow placing a transit line on the right-of-way?; and Will the placement of a transit line on the right-of-way interfere with future expansion of rail service? (See Technical Feasibility Section for more detail).

Institutional Feasibility

Under institutional feasibility the issues of ownership, operation and management of a new rail transit service must be addressed. The list of local, state and federal agency regulations that must be met is substantial. The degree of regulation and the number of requirements for a given project relate to which agency provides the funding. The Urban Mass Transportation Administration's (UMTA's) regulatory powers generally stem from the strings that are attached to the federal capital and operating assistance grants. The Transportation Act of 1964, as amended, requires that transit projects which receive federal funding assure the protection of transit employees, include an environmental impact assessment, and prepare an acceptable program to accommodate the elderly and handicapped. UMTA has the authority to investigate the safety conditions of any of the projects it funds.

Financial Feasibility

Financial feasibility requires the analysis of alternatives, funds needed, and the sources and availability of funds required to construct and operate the transit service selected. Funding may be required from local, state and federal sources to achieve project implementation.

Local funds in Texas may be derived from a 1 percent limited sales tax granted by local vote under Texas State Law, VCS 1118x or 1118y. Frequently, local funding comes from a city's general revenues if a transportation authority has not been created by referendum. State aid may be in the form of participation in feasibility studies as well as participation in the capital cost of implementing a project.

Federal funds for transit are available from several federal agencies. The Urban Mass Transportation Administration is the prime source of transit funds for study, construction, rehabilitation and new construction in urbanized areas. The Federal Aid Highway Acts of 1970 and 1973 provided Federal Urban Highway System Funds for the construction of park-and-ride facilities on the fringe of urban areas. The Act also provided funds for bus lanes, bus priority treatments, and fixed rail facilities.

Economic Feasibility

Economic feasibility deals with the cost and benefits of alternatives under consideration in order to determine whether all of the economic, social and environmental benefits outweigh the required costs. The people of Houston (June 11, 1983) defeated a bond referendum to build a rail system (see Figure 22), while the people in Dallas granted approval (August 13, 1983) to the Dallas Area Rapid Transit (DART) Authority and 160 miles of rail transit. A good economic analysis must include not only the technical feasibility of a project but consideration of a community's desires, goals and priorities, as well.

Houston RRT: Typical Elevated Section

Source: Draft Enviromental Impact Statement, Houston Rail Rapid Transit Project, March 1983

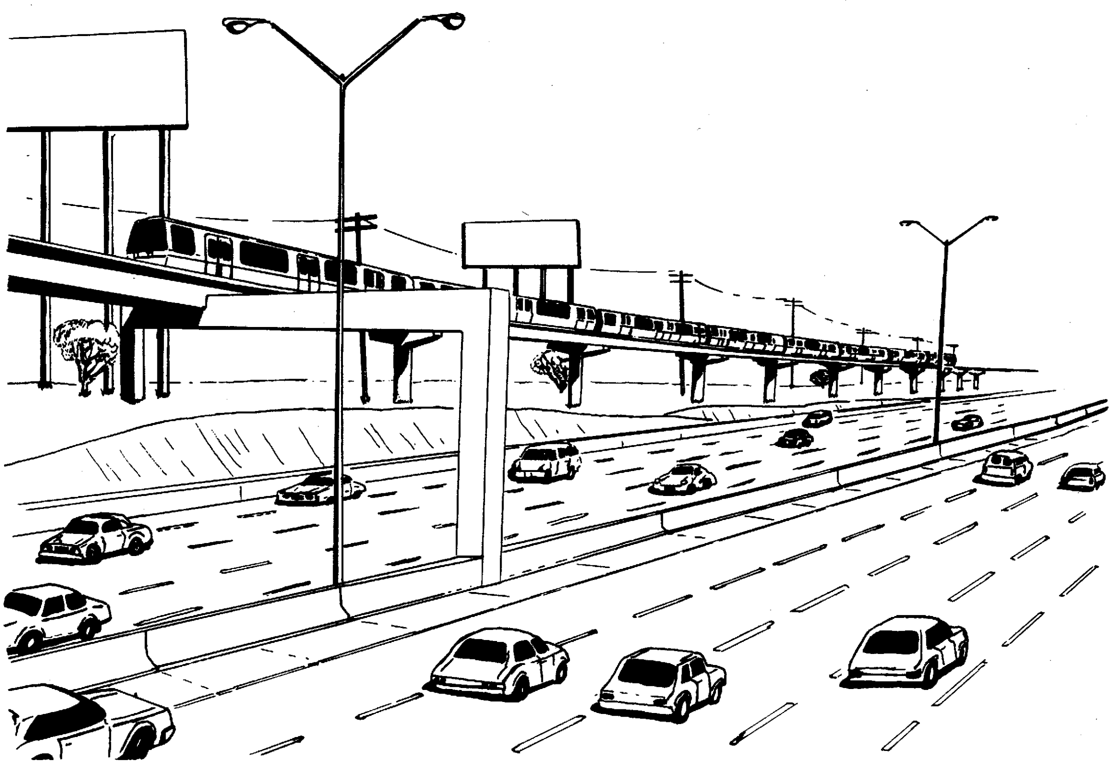


Figure 22. Proposed Houston Rail System Rejected By Voters on June 11, 1983.

Government and Public Constraints

Local and Regional Constraints

Public constraints created by local unwillingness to fund their share of transit project costs may make the project impractical from the start. However, even if local support of a project is assured a development problem may arise when choosing which rail transit corridor will be developed first; which communities are to be served; and, how the costs (capital and operating) will be divided among each of the local communities.

Another area in which local constraints will rule is in the decision of who will be responsible for the operation of the system (i.e., the local transit authority for buses; railroad company for commuter rail service). Also of interest to local residents is the question of what are the land use implications? Will the project foster further congestion in certain neighborhoods? Will building the new services disrupt neighborhoods along the route?

Similar regional constraints may surface when transit authorities cover numerous small communities and, in some cases, extend into several counties. The question of "local representation" on operating or governing boards may be a constraint to the practical feasibility of a system, and citizen participation will be an important role in determining practical avenues or corridors for rail transit.

State Constraints

At the state level, constraints may occur if special legislation is needed for the implementation of rail transit. For example, an Act passed by Congress may require special state legislation to allow local authorities to receive or benefit from available federal funds. Also at the state level, the State of Texas could fail to ask for, or make application for, federal funds authorized by Congress and available for use. Jensen and Rude in "Governmental and Public Constraints to the Implementation of Light-Rail Transit in Dayton, Ohio" (TRB Special Report 182) states that "Possibly the greatest constraint at the state level is the fact that most state departments of transportation are recently converted highway departments; they generally lack a commitment to transit and support for a fixed-guideway concept." This constraint applies to modes other than rail transit.

Federal Constraints

The necessity to comply with the maze of Federal laws and regulations may, over time, make a once viable project impractical. The requirement for alternative analysis in the development of a rail system is a major constraint in the timely development of rail systems. This requires the justification of a project on current need, not on the basis of creating need or shaping land development through urban planning techniques. Without meeting the alternative analysis requirements, federal funds will not be available for development of the system. Another constraint at the federal level is the maze of bureaucracy that grant applications and other paper work must cycle through; often passing through federal, state, regional and local jurisdictions before the final funding is committed.

OVERALL FEASIBILITY

The use of railroad rights-of-way for public transportation is a widely employed practice and offers a viable approach to providing new or expanded transit service within urban areas of Texas. As evidenced in the literature and verified by the surveys of railroad companies and transportation agencies, the implementation of fixed-guideway transit systems on or adjacent to operating freight rail lines is very common throughout the United States and Canada. Both Light Rail Transit (LRT) and Heavy Rail Transit (HRT) services are being provided to the commuting public on portions of railroad rights-of-way. All Commuter Rail Transit (CRT), sometimes referred to as Regional Rail Transit, operates on existing railroad properties.

The most common way to provide LRT or HRT operations is for the transit authority to negotiate either the purchase or long term lease of right-of-way from the railroad company. As presented in the technical feasibility section and various appendices of this report, the railroads have serious and specific concerns which must be addressed by the public entity during the planning and negotiation phases for rail transit service.

Commuter Rail Transit (CRT) seems to offer very high potential for economically serving the suburban areas of sprawling metropolitan centers (i.e., Houston, Dallas, Fort Worth). Typically, the transit authority will acquire the necessary rolling stock and enter into a contract with a railroad company to provide the actual operation. In this way, CRT can be implemented fairly quickly on the existing rails providing that sufficient capacity exists and that railroad companies are adequately compensated for their services. Appendix I of this report summarizes some current operating agreements between public agencies and railroad companies for the provision of commuter transit services.

Rail transit is one alternative for meeting the transportation demand in urbanized areas of Texas. To date, no urban rail transit has been implemented in the State. With the creation of DART, the Dallas Transportation Authority, in August 1983, rail services will begin to become a reality and will offer some challenging opportunities to public and private transportation officials in co-opting to utilize railroad rights-of-way for public transit.

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APPENDIX A

LAWS, REGULATIONS, POLICIES AND PROCEDURES

Contents:

General
Relevent Federal Legislation
Federal Agencies and Regulations
State Agencies, Regulations and Agreements
Local Agencies and Authorities
Taxation of Railroads

APPENDIX A

LAWS, REGULATIONS, POLICIES AND PROCEDURES

General

The area of "Laws, Regulations, Policies and Procedures" is very broad and complex. The purpose of this section is to identify laws, agencies and policies that affect the development of Public Transportation in Texas urban areas. Because of the varying types of rail transit modes and services (i.e., commuter rail versus other types of heavy or light rail), the list of federal agencies, policies, and procedures is extensive. The State of Texas also has numerous laws, regulations and procedures that must be addressed. Last, but not least, counties and cities also provide ordinances and local regulations that impact the development of rail transit systems in Texas.

The U.S. Congress has passed many laws dealing with transportation. Federal agencies have been created to implement such laws and to develop policies and procedures for administration.

Government has been involved in the promotion and regulation of railroads from the earliest days of their development. Government promoted rail development by granting power of eminent domain, by grants of public lands, by guaranting railroad bonds, and other devices. Because of the nature of these large governmental capital investments in railroads, the potential for monopoly services was created. This was especially evident when only one railroad served a town or city during the early 1900's; it enjoyed a monopoly on intercity transportation services because there was no other effective mode of transportation unless the city had a navigable waterway.

This section is a compilation of various laws, regulations and considerations which would be helpful to public officials in negotiating for railroad rights-of-way. It is divided into the following topic areas:

- Federal Legislation
- Federal Agencies and Regulations
- State Agencies, Regulations and Agreements

Federal Legislation

Granger Legislation

In the 1800's the use of monopoly power lead to higher prices, poor service, and discrimination against shippers. This stimulated the agriculturalists in Illinois, Iowa, Wisconsin, and Minnesota to form semi-fraternal organizations called "granges" for the purpose of seeking relief through the legislative process. The result was the now famous Granger Legislation of the 1870's, (Stout, 1977). These laws typically consisted of the following four parts:

1. Establishment of maximum rates;
2. Prohibition of local discrimination among shippers;
3. Attempts to promote completion by prohibiting railroad mergers; and,
4. Forbidding free passes to public officials.

Through very strong railroad lobbying, many of the Granger laws were repealed within a decade. The failure of the states attempts to provide the public with the desired relief set in motion the forces to create the Interstate Commerce Act to regulate commerce.

The Interstate Commerce Act of 1887

The Interstate Commerce Act was passed in 1887. The principal economic provisions of the act were:

- All charges are to be reasonable and just;
- A shipper may not be charged more than another shipper for the same service;
- No "undue or unreasonable preference or advantage" may be given to "any particular person, company, firm, corporation, or locality, or any particular description of traffic;"
- Interchange of traffic shall freely take place without discrimination in rates and charges between connecting lines;
- The carrier shall not receive greater compensation for a short haul than for a long haul "over the same line, in the same direction" (the shorter haul being included within the longer haul distance). However, "such common carrier may, in special cases after investigation by the commission, be authorized to charge less for longer than for shorter distances;"
- It is unlawful for common carriers to pool freights and to divide between them the revenue or earnings;
- Schedules showing rates and fares shall be printed and made public; and,
- Ten days public notice must be given for fare or rate increases.

The Interstate Commerce Act created the Interstate Commerce Commission (ICC) and enumerated its powers. Among these was the power to establish a uniform accounting system to which the railroads must adhere. Three legislative acts between 1903 and 1910 extended the ICC's authority to regulate competition in the rail industry. These acts were:

- Elkins Anti-Rebating Act of 1903;
- Hapburn Act of 1906; and,
- Mann-Elkins Act of 1910.

Transportation Act of 1920

The Transportation Act of 1920 directed the ICC to promote a "fair return" on investment with the ICC empowered to designate what this rate of return would be. Congress set 5.5 percent as a fair rate of return for the first two years and allowed the ICC to add another 0.5 percent for improvements. This established 6 percent as the fair rate of return on investment. This rate remained in effect until passage of the Staggers Act of 1980. Other provisions of the Transportation Act of 1920 were:

- Repealed prohibition of pooling;
- Empowered the ICC to prescribe actual rates;
- Gave the ICC power to control entry and exit;
- Gave the ICC control over extension and abandonment; and,
- Other additional powers.

This legislation gave the ICC regulation in most of the economic activities of the railroads. The Transportation Act of 1920 was the last major Federal legislation that was drafted exclusively for the railroads until the passage of the Rail Passenger Service Act of 1970.

Davis Bacon Act of 1931, As Amended

The Davis Bacon Act requires that all laborers and mechanics working on federally assisted construction projects in excess of a $2,000 contract value be paid not less often than once a week. The wage rate must be computed at an amount not less than the prevailing wages for similar work in the same geographic area of the project. The Copeland Anti-Kickback Act prohibits payroll deductions from the wages of employees who are covered by the Davis Bacon Act for any reason except those specifically stated in the Copeland Act. The Contract Work Hours and Safety Standards Act establishes the required basis and conditions for hours of work and for overtime pay of laborers and mechanics, and directs the Department of Labor to formulate construction safety and health standards.

Urban Mass Transportation Act of 1964, As Amended

The Federal Urban Mass Transportation Act of 1964, as amended, authorized the Secretary of Transportation to provide assistance for the development of comprehensive and coordinated mass transportation systems, both public and private, in metropolitan and other urban areas. The Act of 1964, as amended, provides for capital improvements, operating assistance, technical assistance, planning, management training, research, development and demonstration, and university research and training programs. A summary of the funding programs or sections of the Act are presented in Table A-1.

The Urban Mass Transportation Act is administered by the Urban Mass Transportation Administration (UMTA). A brief description of the various sections contained within the Act follows.

TABLE A-1: URBAN MASS TRANSPORTATION ACT OF 1964, AS AMENDED, FUNDING PROGRAMS

Urban Mass Transportation Act	Program Purpose	Matching Requirements Federal/ Non-Federal (Percent)
Section 3	Capital Improvements	80/20
Section 5	Operating Assistance	50/50
	Capital Improvements	80/20
Section 6	Research, Development and Demonstration	100/0
Section 8	Technical Studies	80/20
Section 10	Management Training	75/25
Section 11	University Research and Training	50/50
Section 16 (b)(2)	Capital Aid to Private, Nonprofit Organizations	80/20
Section 18	Operating Aid to Nonurbanized Areas	50/50
	Capital Aid to Nonurbanized Areas	80/20

Source: Guidelines for Evaluation of Human Services Transportation Programs (Peterson, 1981).

Section 3 Funds

Section 3 funds may be used to make grants or loans to assist states and local public bodies and agencies in financing:

1. The construction of new fixed guideway systems and extensions to existing fixed guideway systems, including the acquisition of real property, initial acquisition of rolling stock needed for such systems, and the detailed alternative analyses required for the development of such a system.

2. The acquisition, construction, reconstruction, and improvement of facilities and equipment for use, operation or lease or otherwise, in mass transportation service and the coordination of such service with highway and other transportation. Eligible facilities and equipment may include personal property and improvements needed for an efficient and coordinated public transportation system.

3. The introduction into public transportation service of new technology in the form of innovative and improved products.

4. Transportation projects that enhance the effectiveness of mass transportation and are related to projects which create new or enhanced coordination between public transportation, and urban economic development, including commercial and residential development.

Section 5 Funds

Section 5 funds are provided for construction or operating assistance. It is under this section and Section 3 that grants for construction and operating assistance projects involving commuter rail or other fixed guideway systems are made. This section outlines the guidelines to be followed between the Governor, or the designated recipient of an urbanized area, and the Secretary of Transportation for the certification that public hearings and other environmental and economic planning has been accomplished. The Surface Transportation Act of 1982 phases out Section 5 funds and replaces it with a new Section 9 Program.

Section 6 Funds

Section 6 funds are authorized for the undertaking of research development, and demonstration projects in all phases of urban mass transportation. This would include the development, testing, and demonstration of new facilities, equipment, techniques, and methods which will assist in the reduction of urban transportation needs, the improvement of mass transportation service, or the contribution of such service toward meeting total urban transportation needs at minimum cost. These projects may be undertaken independently, or by grant or contract (including working agreements with other federal departments and agencies).

Section 8 Funds

Section 8 funds are used for planning and technical studies. This section sets the criteria for the analysis of alternative transportation system management and investment strategies to make more efficient use of existing transportation facilities. The analysis process must consider all modes of transportation and shall be continuing, cooperative, and comprehensive (referred to as the 3-C process) to the degree appropriate for the complexity of the transportation problem. The urbanized area planning process must be carried out by local officials acting through a metropolitan planning organization in coordination with the state. Designations of metropolitan planning organizations (MPO's) were performed by the Governor.

Authorization of funds under this section may be more specifically used to make contracts or grants between UMTA and the State of Texas or local public bodies and agencies for the planning, engineering, designing, and evaluation of public transportation projects, and for other technical studies. Activities financially assisted under this section may include: (1) studies relating to management, operations, capital requirements, and economic feasibility; (2) preparation of engineering and architectural surveys, plans, and specifications; (3) evaluation of previously funded projects; and, (4) other similar or related activities related to the construction, acquisition, or improved operation of mass transportation systems, facilities, and equipment.

Section 10 Funds

Section 10 funds are used to make grants to state and local public bodies and agencies to provide fellowships for training of personnel employed in managerial, technical, and professional positions in the public transportation field. The selection of a recipient for a fellowship must be on the basis of demonstrated ability and for the contribution which the recipient can be reasonably expected to make to an efficient transportation operation. Fellowships are for one year of training in public or private institutions offering programs having application in the public transportation industry.

Section 11 Funds

Section 11 funds are used to make grants to public and private nonprofit institutions of higher learning to assist in establishing or carrying on comprehensive research in the problems of transportation in urban areas. These grants are to be used to conduct competent and qualified research and investigations into the theoretical or practical problems of urban transportation, or both, and to provide for the training of persons to carry on further research or to obtain employment in private or public organizations which plan, construct, operate, or manage urban transportation systems. The research and investigations may include (but not be limited to) the design and functioning of urban mass transportation systems; the design and functioning of urban roads and highways; the interrelationship between various modes of urban and inter-urban transportation; the economic allocation of transportation resources; and, the legal, financial, engineering, and esthetic aspects of urban transportation. In making grants under this section preference is to be given to institutions of higher learning that undertake such research and training by bringing together knowledge and expertise in the various social sciences and technical disciplines that relate to urban transportation problems.

Section 16 Funds

Section 16 funds are used in the planning and design of mass transportation facilities and services so the mass transportation can be effectively utilized and available to elderly and handicapped persons. It also insures that all Federal programs offering assistance in the field of mass transportation contain provisions implementing the national policy on the elderly and handicapped.

Section 18 Funds

Section 18 provides funding on public transportation projects in rural areas. Funds are apportioned by a formula under which the Governor of each state is entitled to receive an amount equal to the total amount apportioned, multiplied by the ratio of rural population in the state to the total population of areas in all states shown by the latest Federal Census.

Civil Rights Act of 1964

The Civil Rights Act of 1964, among other things, prohibits discrimination on the basis of race, color, or national origin by recipients of Federal financial assistance. It also prohibits discrimination in employment.

Clean Air Act of 1965, as Amended

The Clean Air Act establishes national standards for vehicle emissions. The provisions of the Act are administered by the Environmental Protection Agency (EPA) through the Texas Air Control Board (TACB). Subsequent amendments have required State Implementation Plans (SIP's) to be prepared for non-attainment of air quality standards which outline how the state will achieve improvements by certain dates. Frequently, public transit and ridesharing or pooling (i.e., carpools, vanpools) projects play major roles in the SIP strategies.

National Historic Preservation Act of 1966

Section 106 of the National Historic Preservation Act of 1966, as amended, directs Federal Agencies to take into account the effect of their undertakings and projects on any district, site, building, structure or object which is included in the National Register of Historic Places. Federal agencies must obtain the review and comment of the Advisory Council on Historic Preservation prior to the approval of undertakings which affect such properties. The Advisory Council is an independent agency created to advise the President and Congress on matters involving historic preservations. The Council has established procedures for the protection of historic and cultural properties on, or eligible for inclusion in the, National Register of Historic Places (36 CFR part 800).

Department of Transportation Act of 1966

Section 4(f) of the Department of Transportation Act of 1966 declares a national policy that special efforts be made to preserve public park and recreation lands, wildlife and waterfowl refuges, and historic sites. The Secretary of Transportation is permitted to approve a project which requires the use of publicly owned land from a park, recreation area, or wildlife refuge of national, state, or local significance, or any land from a historic site of local, state, or national significance only if the following determinations have been made:

1. There is no feasible or prudent alternative to the use of such land; and,
2. All possible planning has been undertaken to minimize harm to the 4(f) land(s) resulting from such use.

In Texas, Article 5421q of Vernon's Annotated Texas Statutes contains provisions similar to those of Section 4(f) including requirements of holding a public hearing on the proposed project if park property acquisition is proposed.

National Flood Insurance Act of 1968

The National Flood Insurance Act authorized a national flood insurance program which conditions the availability of insurance on the adoption of a local flood plain land use map. The Flood Disaster Protection Act of 1973 requires the purchase of flood insurance by recipients of Federal financial assistance who are located in areas having special flood hazards.

Rail Passenger Service Act of 1970

This Act provided for the establishment of a non-government, for profit, corporation (AMTRAK) that would operate a national system of rail passenger service. This gave AMTRAK exclusive right to all inter-city/intra-state passenger service. A grandfather clause gave railroads operating rail passenger service a choice of continuing the service or turning the operation over to AMTRAK.

If rail passenger service was turned over to AMTRAK, the releasing railroad was required to pay for 3 years an amount equal to 33.3% of 50% (or 16.79%) of the fully distributed passenger service deficit of the railroad as reported to the Interstate Commerce Commission for the year ending December 31, 1969.

AMTRAK operates over other railroad lines paying a user fee to the owning railroad. The main rail routes are designated by Congress. Section 403 (6) of the Rail Passenger Service Act of 1970 provides an opportunity for state, regional, or local agencies to request service beyond that included in the basic AMTRAK system. It also stipulates that not less than two-thirds (66.7%) of both the losses and the capital cost associated with the service must be financed by the requesting agency or agencies.

The Regional Rail Reorganization Act of 1973

The Regional Rail Reorganization Act of 1973 (known as the 3-R Act) was enacted after the bankruptcies of six railroads in the Northeastern and Midwestern states; the large Penn Central Railroad was the most dominant of the operators in this group. There were 17 states and 23,000 miles of track thrown into turmoil with the bankruptcies of these six rail companies.

The Regional Rail Reorganization Act of 1973 created a self-sustaining rail freight network in the 17-state region resulting in the Consolidated Rail Corporation (CONRAIL) to operate the system. This Act also created the United States Railway Association (USRA) to plan and finance the reorganization of CONRAIL. USRA developed a final system plan which recommended that 5,757 miles of the bankrupt carriers combined mileage be either abandoned or operated under public subsidy (Texas Railroads, 1982-1983 update).

National Environmental Policy Act of 1970

Section 102 (2)(c) of the National Environmental Policy Act (NEPA) of 1970, states that all agencies of the federal government shall include in every proposal or recommendation for major federal actions (which have the potential of significantly affecting the quality of human environment) a detailed statement of alternatives to the proposed action. The Environmental Impact Statement (EIS) has become the accepted form in which such description and analysis of projects requiring federal approval and/or funding has been offered for approval, modification, or rejection by concerned agencies and the public. Regarding rail transit, the Environmental Impact Statement should be prepared in conformance with the Act and appropriate policy and procedural memoranda of the U.S. Federal Highway Administration (FHWA) and the Urban Mass Transportation Administration (UTMA).

Upon completion of a draft EIS, copies should be sent to the proper Federal, State and local entities for comment before the final statement is prepared. The list of EIS recipients should include the following agencies:

Federal Agencies

Department of Transportation
- Federal Highway Administration
- Urban Mass Transportation Administration
- Federal Railroad Administration

Department of Defense
- U.S. Army Corps of Engineers

Department of Agriculture
- Soil Conservation Service
- Coordinator of Environmental Quality Activities

Environmental Protection Agency

Department of Interior
- U.S. Fish & Wildlife Service
- National Park Service
- Keeper of the National Register of Historic Places
- Bureau of Land Management
- Office of the Secretary

Department of Housing and Urban Development (HUD)

Office of Management and Budget (OMB)

Federal Energy Management Agency (FEMA)

Advisory Council on Historic Preservation

Department of Health and Human Services (DHHS)
- Environmental Affairs

Department of Energy (DOE)
- Division of NEPA Affairs

Department of Commerce
- Environmental Affairs

State Agencies

State Department of Highways and Public Transportation

Texas State Government Offices

- Texas Soil and Water Conservation Board
- Texas Parks & Wildlife Department
- Texas Air Control Board
- Texas Historical Commission/Texas Antiquities Committee
- Planning & Budget Office
- General Land Office
- Texas Energy and Natural Resources Advisory Council
- Department of Water Resources
- Department of Community Affairs
- Department of Human Resources
- Department of Health

Office of the Governor

- Division of Budget and Planning

Local Agencies

City (each city in the transit service area)

- Office of the Mayor
- Department of Public Works
- Health Department
- City Parks Department
- Community Development Department
- City Council
- City Planning Department
- City Traffic/Transportation Department
- Zoning Commission (if applicable)
- City Housing Authority

County Offices (may be more than one county involved)

- County Commissioners
- County Historical Commission
- County Office of Community Development
- County Pollution Control Office
- County Parks Department

Other Organizations who may have an interest

- League of Women Voters
- Retail Merchants' Association
- Council of Governments
- Metropolitan Planning Organization
- Audubon Society
- Sierra Club
- Other civic organizations and neighborhood associations applicable to the area.

The nature of an EIS will vary depending upon the type and extent of the proposed project. The following "Sample Table of Contents" was used in the draft EIP for the proposed Houston Rail System (METRO, March 1983):

Sample Table of Contents for EIS

Federal Railroad Safety Act of 1970

The Federal Railroad Safety Act of 1970 (Public Law 91-458) was enacted to promote safety in all areas of railroad operations and to reduce railroad related accidents. The Act was to reduce deaths and injuries to persons and to reduce damage to property caused by accidents involving any carrier of hazardous material. The Act provided the Secretary of Transportation with the authority to prescribe as necessary, appropriate rules, regulations, orders, and standards for all areas of railroad safety. In addition, the Secretary was to conduct research, development, testing, evaluation, and training for all areas of railroad safety.

A part of this public law concerned the national uniformity of laws, rules, regulations, orders and standards relating to railroad safety. The Congress declared that laws, rules, etc., relating to railroad safety shall be nationally uniform to the extent practicable. It further says that a state may adopt or continue in force an additional or more stringent law, rule, regulation, order or standard relating to railroad safety when necessary to reduce an essentially local safety hazard, and when not incompatable with any federal law, rule, regulation, order, or standard, and when not creating an undue burden on interstate commerce.

Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970

The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 establishes the terms and conditions for compensation of property owners and occupants who are displaced as a result of Federally assisted projects.

Federal Aid Highway Act of 1973

The Federal Aid Highway Act of 1973 provided important legislation for protection of motorists at railroad-highway grade crossings. This Act made grade crossing protection a public responsibility rather than railroad responsibility. The 1973 Federal Aid Highway Act established, and separately funded, a series of new highway safety construction programs including funds to eliminate hazards at railroad-highway grade crossings throughout the nation. Section 203 of the Act pertains to the railroad-highway grade crossing safety aspects on the Federal Aid Highway System.

The 1975 Highway Safety Act amended the 1973 Act to include railroad-highway crossings not on the Federal Aid System. The 1975 Act set up procedures for states to submit a statewide plan for the elimination of hazards at railroad-highway crossings and the development and maintenance of an inventory of all public crossings. Section 203 is summarized in the following:

(a) Each State shall conduct and systematically maintain a survey of all highways to identify those railroad crossings which may require signs, markings, surfacing, warning devices, separation, closing, vertical or horizontal track relocation, or other appropriate improvements. Each State shall maintain the information and data produced by such survey in the manner and in such detail as the Secretary of Transportation shall require.

(b) Not later than January 1, 1977 each State shall develop a statewide plan for the elimination of hazards at railroad-highway crossings for all public roads or segments thereof both on and off the Federal-Aid System in such state. Each such plan shall assign a schedule of priorities for improvement projects to be undertaken to correct the identified hazards at all public railroad-highway crossings. Such improvement projects shall include but not be limited to the installation of signs, markings, surfacing, or warning devices, or the separation of grades, closing of crossings, or vertical or horizontal track relocation, or other appropriate improvements. Each state shall undertake the systematic correction of such identified hazards in accordance with the schedule of priorities included in the statewide plan. As a first priority, the State shall provide appropriate signs and markings in accordance with the Manual on Uniform Traffic Control Devices at all public railroad-highway crossings and shall continue and complete the Demonstration Projects identified in Section 163 of the 1973 Federal-Aid Highway Act. The determination of improvement projects to be designated in each statewide plan shall be based on a systems analysis of the track and roadway segments. The improvement projects designated shall in each instance be the most cost effective means of increasing safety and efficiency of motor vehicle and train operations.

(c) In addition to funds which may be otherwise available to carry out Section 130 of Title 23, United States Code, there is authorized to be appropriated out of the Highway Trust Fund for projects on public roads for the elimination of hazards at railroad-highway crossings, $500,000,000 for the fiscal year ending September 30, 1978. At least 15% of the funds authorized by this section shall be available for the maintenance of the crossing survey and for the development and updating of the statewide plans required under Subsections (a) and (b) of this section.

(d) Funds authorized under Subsection (c) of this section shall be apportioned to the states in accordance with the following formula:

(1) One-half of a state's apportionment shall be based upon a ratio of the number of public railroad-highway crossings in such state to the number of public railroad-highway crossings in the United States;

(2) One-half of a state's apportionment shall be based upon a ratio of such state's population to the population of the United States.

(e) For the purpose of this section, the term "public road" means any road under the jurisdiction of and maintained by a public authority and open to public travel.

(f) Funds authorized by this section may be used to provide local government with funds to be used on a matching basis.

(g) In any state wherein the state is without legal authority to construct or maintain a project under this section, such state shall enter into a formal agreement for such construction or maintenance with the appropriate local officials of the county or municipality in which such project is located.

(h) Each state shall submit its statewide plan for the elimination of hazards at railroad-highway crossings and its survey of all public crossings as required in Subsections (a) and (b) of this section, and subsequent updates of its plan and survey, to the Secretary of Transportation. The Secretary shall analyze and evaluate each state plan and survey for compliance with the requirements of Subsections (a) and (b) of this section and shall advise the state of the adequacy of its plan and survey. The Secretary shall maintain a National Crossing File of the state's survey data on all public railroad-highway crossings for combination with the national file of railroad-highway crossing accidents and other appropriate files and shall use such data to monitor and evaluate the progress of the states' programs under this section and to perform research and investigation of the causes and cures of railroad-highway crossing accidents. The Secretary shall issue periodic reports to the states and railroad companies tabulating and summarizing the data in the National Crossing File and discussing the fundings of his research and investigations.

(i) Each state shall report to the Secretary of Transportation not later than September 30, 1977, and not later than September 30 of each year thereafter, on the progress being made to implement the railroad-highway crossings program authorized by this section and the effectiveness of such improvements. Each state report shall contain an assessment of the costs of the various treatments employed, previous and subsequent accident experience at improved locations. The Secretary of Transportation shall submit a report to the Congress not later than January 1, 1978 and not later than January 1, of each year thereafter, on the progress being made by the states in implementing projects to improve railroad-highway crossings.

Rehabilitation Act of 1973

The Rehabilitation Act of 1973, among other things, prohibits discrimination on the basis of handicap by recipients of federal financial assistance. Section 504 of the Act provides that "no otherwise qualified handicapped individual ... shall, solely by reason of his handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance ...." The Department of Transportation's 504 regulation (published in 1979) appears in 49 CFR Part 27, and implements this statute, Section 16(a) of the Urban Mass Transportation Act of 1964, and Section 165(b) of the Federal-Aid Highway Act of 1973. This regulation prescribed various planning and other administrative requirements and prohibited employment discrimination on the basis of handicap. It also imposed general requirements for the accessibility of DOT-assisted programs and activities to handicapped persons and specific accessibility requirements for federally aided highways, airports, intercity rail service, and mass transit.

The 504 regulations, as they applied to mass transit, were very costly and controversial. The American Public Transit Association (APTA) and several of its members sued the U.S. Department of Transportation in June 1979, alleging that the mass transit requirements of the rule exceeded the Department's authority and were arbitrary and capricious. The U.S. District Court for the District of Columbia upheld the rule, but the Court of Appeals for the District of Columbia Circuit reversed the District Court's decision (American Public Transit Association v. Lewis, 556 F.2d 1271 (D.C. Cir., 1981)). The Court of Appeals held that, under Section 504, a transit authority might be required to take "modest, affirmative steps to accommodate handicapped persons" in order to avoid the discrimination that Section 504 prohibits. In the Court's view, however, the regulation required extensive and costly affirmative action efforts to modify existing systems and, therefore, exceeded DOT's authority under the statute.

While the court decision was pending, the Presidential Task Force on Regulatory Relief determined that the regulation deserved priority review. As a result of this review, the U.S. DOT established a clear policy concerning mass transit for handicapped persons. The Department of Transportation currently believes that recipients of federal assistance for mass transit must provide transportation that handicapped persons can use but that local communities have the major responsibility for deciding how this transportation should be provided. The Surface Transportation Assistance Act of 1982 also addresses the provision of services for handicapped persons.

<u>The Railroad Revitalization and Regulatory Reform of 1975</u>

The Railroad Revitalization and Regulatory Reform Act, or the 4R Act, became law on February 5, 1976. The law offered some assistance to the railroads for upgrade of track, provided for transitional rail or alternative transportation services on low density rail lines which railroads wished to abandon, transferred the Northeast Corridor (from CONRAIL) to AMTRAK, and addressed regulatory reform. The purpose of the Act is stated in the Declaration of Policy (Stout, 1977):

"Sec. 101 (a) Purpose - It is the purpose of the Congress in this Act to provide the means to rehabilitate and maintain the physical facilities, improve the operations and structure, and restore the financial stability of the railway system of the United States, and to promote the revitalization of such a railway system, so that this mode of transportation will remain viable in the private sector of the economy and will be able to provide energy-efficient, ecologically compatible transportation services with greater efficiency, effectiveness, and economy, through --

(1) ratemaking and regulatory reform;

(2) the encouragement of efforts to restructure the system on a more economically justified basis, including planning authority in the Secretary of Transportation, an expedited procedure for determining whether merger and consolidation applications are in the public interest, and continuing reorganization authority;

(3) financing mechanism that will assure adequate rehabilitation and improvement of facilities and equipment, implementation of the final system plan, and implementation of the Northeast Corridor project;

(4) transitional continuation of service on light-density rail lines that are necessary to continued employment and community well-being throughout the United States;

(5) auditing, accounting, reporting, and other requirements to protect Federal funds and to assure repayment of loans and financial responsibility; and

(6) necessary studies.

(b) Policy - It is declared to be in the policy of the Congress in this Act to --

(1) balance the needs of carriers, shippers, and the public;

(2) foster competition among all carriers by railroad and other modes of transportation, to promote more adequate and efficient transportation services, and to increase the attractiveness of investing in railroads and rail/service-related enterprises;

(3) permit railroads greater freedom to raise or lower rates for rail services in competitive markets;

(4) promote the establishment of railroad rate structures which are more sensitive to changes in the level of seasonal, regional, and shipper demand;

(5) promote separate pricing of district rail and rail-related services;

(6) formulate standards and guidelines for determining adequate revenue levels for railroads; and

(7) modernize and clarify the function of railroad rate bureaus.

Title II of the 4R Act addresses railroad rate making. Along with other procedural changes, it makes the following major changes in the Interstate Commerce Act:

1. Limits the durations of proceedings to one year in cases arising out of complaint, and two years in cases brought upon by the initiative of the Interstate Commerce Commission (ICC).

2. No rate which covers variable costs shall be found to be unjust or unreasonable unless the ICC first determines that the carrier involved has "market dominance over such service." Market dominance is defined as "... an absence of effective competition from other carriers or modes of transportation, for the traffic or movement to which a rate applies." Furthermore, "a finding that a carrier has market dominance over a service shall not create a presumption that the rate or rates for such service exceeds a just and reasonable maximum." And, "... if the Commission has found that a carrier does not have market dominance over the service to which a rate applies, the Commission may not suspend any increase in such rate on grounds that such rate as increased exceeds a just or reasonable maximum for such service, unless the Commission specifically modifies or sets aside its prior determination concerning market dominance ..."

3. "... the Commission shall establish ... procedures for the establishment of railroad rates based on seasonal, regional, or peak-period demand for rail services. Such ... procedures shall be designed to (a) provide sufficient incentive to shippers to reduce peak period shipments, through rescheduling and advance planning; (b) generate additional revenues for the railroads; and (c) improve the utilization of national supply of freight cars, the movement of goods by rail, level of employment by railroads, and the financial stability of markets served by railroads."

4. "In order to encourage competition, to promote increased reinvestment by railroads, and to encourage and facilitate increased non-railroad investment in the production of rail services, a carrier by railroad ... may, upon its own initiative or upon the request of any shipper or receiver of freight, file separate rates for distinct rail services..."

5. Whenever a new rate schedule is filed with the Commission by a common carrier railroad, and that rate schedule is contested either by complaint, or on initiative of the Commission, a final decision shall be rendered by the Commission not later than seven months after such rate was scheduled to become effective unless "the Commission reports in writing to the Congress that it is unable to render a decision within such period, together with a full explanation of the reason for the delay." Nevertheless, if the decision is not made within ten months, the rate shall go into effect. The rate may be set aside thereafter only if, "upon complaint of an interested party, the Commission finds it to be unlawful."

6. "No rate of a common carrier by railroad shall be held up to a particular level to protect the traffic of any other carrier or mode of transportation, unless the Commission finds that such rates reduces or would reduce the going concern value of the carrier charging the rate."

7. Any rate change involving a capital investment of $1 million or more which the Commission, after hearing, finds to be lawful may not be set aside for a period of five years except that the Commission may order the rate to be raised if the rate is found to reduce the going concern value of the carrier.

8. The Commission may exempt common carriers by railroad from the provisions of the Interstate Commerce Act where their activities are limited in scope, and where their inclusion would "serve little or no useful public purpose."

9. The Commission may set intrastate rates if a state regulatory body has failed to act upon a requested rate change after 120 days have elapsed, and if the carrier applies to the Commission for such a determination.

10. The Act directs the ICC to establish demurrage charges and rules which shall "... fulfill the national needs with respect to (a) freight car utilization and distribution, and (b) maintenance of an adequate freight car supply available for transportation of property."

11. The Commission may establish car service rules, and is directed to establish per-diem charges which will provide an incentive for the acquisition of freight cars which are in short supply. The Commission is directed to revise its car service rules within 18 months following the enactment of the 4R Act.

Title III of the 4R Act authorized reform in the Interstate Commerce Commission. Many of the changes authorized by the Act are procedural. The highlights of Title III are (Stout, 1977):

(1) Upon request, the Commission must deliver any requested document (except those containing trade secrets) to the Committee on Interstate and Foreign Commerce or to the Committee on Commerce within ten days, or state in writing why it cannot comply.

(2) Establishes time limits for the rendering of Commission decisions involving railroads.

(3) Limits investigations by the Commission to three years.

(4) Directs the Commission to formulate new rules of practice before the Commission, and provides for Congressional review of those rules.

(5) Prohibits state and local government discrimination against railroad property in taxation. In particular, the Act prohibits assessment of railroad property "... at a value which bears a higher ratio to the true market value of such transportation property than the ratio which the assessed value of all other commercial and industrial property in the same assessment jurisdiction bears to the true market value of all such other commercial and industrial property." This prohibition is to take effect three years after enactment.

(6) Directs the Commission to establish uniform accounting procedures for the railroads which conform to generally accepted accounting principles, and further directs the ICC to review these procedures periodically, but not less frequently than once every five years.

Title IV of the 4R Act promotes rationalization of the railroad network in the United States. Congress recognized that if railroads are to respond to geographical and structural shifts in the economy, and if they are to overcome some of the disadvantages of their regionally limited rail system structure, additional cooperation, joint use of facilities, and merger and/or consolidation may be necessary. Title IV attempts to assist in the rationalization of the railroad network by (Stout, 1977):

(1) Permitting the Secretary of Transportation to develop "... plans, proposals, and recommendations for mergers, consolidation, reorganizations, and other unification or coordination projects for rail services ..."

(2) Permitting the Secretary of Transportation, at the request of a railroad, to "... assist in planning, negotiating and effecting a unification or coordination of operations and facilities with respect to two or more railroads."

(3) Permitting the Secretary of Transportation to conduct studies "... to determine the potential cost savings and possible improvements in quality of rail services which are likely to result from unification or coordination ..."

(4) Permitting the Secretary of Transportation, at the request of one or more railroads, to hold conferences on unifications or coordination, and to mediate disputes which may arise in connection with such unification or coordination projects.

(5) Allowing the Secretary of Transportation to study mergers proposed by any railroad and to make recommendations to the Interstate Commerce Commission.

(6) Establishes merger procedures, and sets time limits for certain procedural requirements in an effort to speed up the merger process.

Until passage of the 4R Act, railroads could dispose of their abandoned rights-of-way any time after the ICC gave its approval of their abandonment petition. In addition, the ICC could require the railroads to sell all or part of their abandoned rights-of-way to any responsible person, firm, or corporation at a price of not less than the net salvage value of the properties. A provision in the 4R Act required the ICC, upon accepting a petition for abandonment, to determine whether such properties are suitable for use by and for other public purposes, including roads or highways, other forms of mass transportation, conservation, energy production or transmission, or recreation. If the ICC finds that the properties proposed to be abandoned are suitable for other public purposes, it must order that such rail properties not be disposed of for a period not to exceed 180 days, unless the properties have been offered upon reasonable terms as prescribed by the Act.

Energy Policy and Conservation Act of 1975

The Energy Policy and Conservation Act authorizes development and implementation of state energy conservation plans.

Federal Water Pollution Control Act, As Amended by the Clean Water Act of 1977

The Federal Water Pollution Control Act, as amended by the Clean Water Act, sets limits on pollutants discharged in international waterways and requires safeguard against spills from oil storage facilities.

Local Rail Service Assistance Act of 1978

The Local Rail Service Assistance Act of 1978 (LRSAA), passed at the close of the 95th Congress (P.L. 95-607), amended the Section 803 Local Rail Service provisions of the 4R Act. The new legislation created an assistance program with emphasis shifted from operating subsidies to capital assistance. Essentially, the new law changed the focus from post-abandonment operating subsidies towards a pre-abandonment rehabilitation and reflects Congressional concern to save lines before abandonment has been recognized, instead of "picking up the pieces" after abandonment applications have already been processed and granted. LRSAA permits and encourages a concentration on light density lines not formally designated as candidates for abandonment. These lines may be of particular importance to the state and require one-time short-term financial assistance of some sort if abandonment is to be avoided in the long term. An alternative is defined as a rail assistance project that is designed to avoid or alleviate the expected adverse public impacts of abandonment and that makes use of funds available under the 4R Act or Local Rail Service Assistance Act of 1978.

The Staggers Rail Act of 1980

The Stagger Rail Act of 1980 (Public Law 96-448) was signed into law by President Carter on October 4, 1980. This law, while short of total deregulation, substantially eased the regulatory burden experienced by railroads since 1887. The Stagger Act of 1980 further liberalized abandonment proceedings by speeding up the time limit for abandonment decisions. Non-protested abandonments are permitted 75 days after application. Protested but uninvestigated abandonments, are permitted 120 days after application and the final decision on protested and investigated applications must be made within 255 days of filing. According to the Yearbook of Railroad Facts, 1981, the most extensive change provided by the Staggers Act are in provisions for ratemaking. While protection for shippers was retained, the Congress clearly intended that the railroads should be given greater freedom to compete in the marketplace. Thus the majority of all railroad rates were to be freed from regulatory review (the ICC would retain jurisdiction only where the railroads have market dominance) and in the remaining instances, railroads would have more flexibility to price their services in accordance with free market interplay.

The Interstate Commerce Commission set a 17.7 percent composite cost of capital for the nation's railroad industry for 1982. The figure reflects a 7 percent increase in the cost of capital from the 1981 mark of 16.5 percent. Cost of capital is the standard used by the ICC in determining whether a railroad earned adequate revenues in a given year. Railroads are judged to be revenue adequate if they earn a rate of return equal to or greater than the cost of capital.

The revenue adequacy test is a key factor in determining the amount of pricing flexibility permitted under the Staggers Rail Act. The Commission noted that the current cost of railroad debt was 14 percent, the cost of equity capital was 19.8 percent in 1980, and the capital structure is 37 percent debt and 63 percent equity.

Other important provisions of this Act are (Yearbook of Railroad Facts, 1981):

1. ICC service orders will be restricted to emergencies having regional or national significance;

2. A merger application of two Class 2 carriers may be expected without changing current substantive standards. However, the ICC must consider whether the transaction would have an adverse effect on competition among rail carriers in the region. Standards for mergers involving Class 1 railroads are also reduced;

3. The Standard for granting a permit for construction or operations of extensions or additions of railroad lines is eased; and,

4. For three years following enactment, any "financially responsible person" (except Class 1 and Class 2 carriers) can acquire a rail line with a density of less than 3 million gross ton-miles per year subject to certain conditions to be determined by the ICC.

Since the passage of the Staggers Act several large mergers have taken place. It is anticipated that other mergers will occur which could provide much needed right-of-way in urban areas for rail transit.

<u>Surface Transportation Act of 1982</u>

The Surface Transportation Act of 1982, effective January 6, 1983, makes significant changes to the programs of the UMTA. The Act provides the funding formulas to be used in establishing the Mass Transit Account from the Highway Trust Fund. The Act raised the federal motor-fuels tax by five cents per gallon, increasing funding for highways and transit; one cent out of the five cents is dedicated for transit purposes.

The most significant impact of the 1982 Act is the appropriation of earmarked funds for public transit including rail construction. The Urban Mass Transportation Act of 1964, as amended, authorized federal capital and operating assistance funding for transit but derived its monies from the

General Fund. The one penny of the highway user fee dedicated to mass transit is expected to bring $1.1 billion each year into the Mass Transit Account of the Highway Trust Fund. This will be used to fund the Section 3 discretionary grants program for fiscal years 1984 through 1986. In 1983, the trust fund revenues will help to fund the urban formula grant program. (Norman, 1983).

Table A-2 shows the total authorized funding levels for discretionary grants (Section 3), urban formula grants (Sections 5 and 9), and small urban-rural grants (Section 18).

Table A-2. Total Funding Levels FY 1983-1986 (Dollars in Thousands)*

	1983	1984	1985	1986
Section 3	1,606,000	1,250,000(a)	1,100,000(a)	1,100,000(a)
Section 5: Total	1,200,000	0	0	0
Tier I	680,000	0	0	0
Tier II	125,000	0	0	0
Tier III	70,000	0	0	0
Tier IV	325,000	0	0	0
Sections 9 and 18: Total	779,000(a)	2,750,000	2,950,000	3,050,000
Small Urban and Rural (Section 18)	22,825	80,575	86,435	89,365
50,000 to 200,000 Population	67,306	237,600	254,880	263,520
200,000 to 1,000,000 Population Bus Basic	122,225	391,971	420,375	434,625
1,000,000 and Above Population Bus Basic	337,307	1,081,050	1,159,645	1,198,555
200,000 and Above Population Bus Incentive	0	149,249	160,185	165,615
Rail Basic	229,338	774,015	830,425	858,575
Rail Incentive	0	35,539	38,055	39,345
Section 18 (1983 Appropriations Only)	68,500	0	0	0
Program Total	$3,653,500	$4,000,000	$4,050,000	$4,150,000

(a) Funds from the Mass Transit Account of the Highway Trust Fund
*Estimated by APTA. Total excludes all Sections not listed
Source: ITE Journal, April 1983

Section 3 -- Discretionary Program

For this program, the funds from the trust fund in fiscal years 1984 through 1986 will be available as contract authority instead of the usual budget authority. Contract authority permits obligations in advance of the appropriation actions, whereas budget authority is created by appropriation actions each year. In addition, the federal share for this program has been reduced from 80% to 75% (Norman, 1983).

Urban Formula Grants

A new formula block grant program (Section 9) is authorized to replace the old Section 5 program starting in fiscal year 1984. Section 5 funds for fiscal year 1983 and previous year's sums will remain available until September 30, 1985, after which unobligated funds will be added to the Section 9 program. There will be no new Section 5 authorizations after fiscal year 1983 (Norman, 1983).

Eligible expenses under the Section 9 program will include planning, acquisition, construction, improvement, and operating costs of: facilities, equipment and associated capital maintenance. Distribution formula factors include population, population-density factor, fixed guideway revenue vehicle miles, fixed guideway route miles, and bus revenue vehicle miles. Urbanized areas of 750,000 population or more and with commuter rail systems will be guaranteed a minimum amount (Norman, 1983).

Operating Assistance Limitations

In general, an area is limited in using federal funds for operating assistance to a percentage of its federal operating assistance for fiscal year 1982. That percentage is 80% if the area has a population of 1,000,000 or more; 90% if its population is between 200,000 and 1,000,000; and 95% if its population is less than 200,000. In cases where the area became eligible with the 1980 census, it may not use more than 40% of its apportionment for operating assistance (Norman, 1983).

Notwithstanding the limitations on operating assistance described above, an area may transfer additional grant funds from capital programs to operating assistance. However, for each $2 so transferred, $1 will be forfeited. Under this "3-for-2" provision, the amount forfeited will revert to the Secretary of Transportation for discretionary grants. These transfers of capital funds to operating assistance will not be allowed after fiscal year 1984 (Norman, 1983).

Buy America Requirements

Section 165 of the Surface Transportation Act of 1982 contains the "Buy America Requirements" and requires that steel, cement and manufactured products procured under UMTA funded contracts of a certain size be of domestic manufacture or origin (with the following exceptions):

1. No bid received from a U.S. Supplier.
2. Foreign bid meets specifications and are a specified percent less than a U.S. bid.
3. It is shown that foreign bidder intends to supply a significantly superior product.
4. Foreign bidder intends to provide more than 50% of the manufacturing or assembly in the United States.

Elderly and Handicapped Provisions

In Section 317(c) of the Surface Transportation Assistance Act of 1982, Congress directed the Department of Transportation (DOT) to publish a new regulation (to replace Section 504 regulations) that includes "minimum criteria for the provision of transportation services" to handicapped and elderly individuals. In addition, the statute requires that the rule provide for public participation in the establishment of programs to provide services for handicapped persons and for DOT monitoring of recipients' compliance. On

September 8, 1983, the Department of Transportation published a notice of proposed rulemaking (NPRM) in the Federal Register proposing new rules to ensure the provision of transportation services to handicapped persons in federally-assisted mass transit programs. The proposed rules carry out Section 504 of the Rehabilitation Act of 1973 and Section 317(c) of the 1982 Act.

How to ensure the provision of adequate public transportation for handicapped persons at a reasonable cost has long been a difficult problem. DOT has required recipients of Urban Mass Transportation Administration (UMTA) assistance to make "special efforts" to provide transportation services for handicapped persons. The September 1983 NPRM proposes regulatory provisions that would ensure adequate transit service for handicapped persons without imposing undue cost burdens on recipients.

Under the 1983 NPRM, a recipient could meet its obligations for service to handicapped persons in three basic ways: 1) It could make 50 percent of its buses accessible (e.g., through the use of lifts); 2) it could establish a paratransit or special services system (e.g., a "dial-a-ride" van system); or, 3) it could establish a mixed system that would combine elements of accessible bus and paratransit service. The NPRM does not require existing subway systems to be made accessible.

In order to avoid imposing undue financial demands on recipients, the 1983 NPRM proposes a "cost cap." This cost cap is a ceiling on expenditures that a recipient is not required to exceed. If the recipient cannot meet the service criteria without exceeding the cost cap, then the recipient is required to meet the criteria only to the extent possible within the cost cap. Decisions on the service tradeoffs that are made in order to keep costs within the cost cap must be made through the "public participation process."

The NPRM request comment on two alternative approaches to setting the cost cap. One alternative is 7.1 percent of the recipient's UMTA assistance; the other is 3.0 percent of the recipient's total operating budget.

Whatever kind of system the recipient establishes, the system must, subject to the "cost cap," meet six service criteria. The system must serve the same geographic area as the recipient's service for the general public, at the same times, and at comparable fares. There cannot be waiting lists for eligibility or restrictions or priorities based on trip purpose. Finally, the waiting time for service must be reasonable. Within nine months of the effective date of the final rule, each recipient would be required to have a program for providing transportation services to handicapped persons. During that time, the recipient would plan its service in consultation with handicapped persons and groups representing them. A public hearing would be required. In addition, there would be a 60-day public comment period. The recipient would have to respond to the comments it received. The recipient's program, and information concerning the public participation process, would be sent to UMTA. UMTA could reject the program or require it to be changed. In addition to sending this material to UMTA, each recipient would have to give UMTA an annual report on how it was carrying out its program.

Federal Agencies and Regulations

The key to which agencies may be involved in any public transit project is if federal funds are obtained and which agencies contribute. Commuter rail service, normally operating under Federal Railroad Administration (FRA) safety and operating standards, if providing service on railroad track that is used for interstate freight movements, may have to comply with the Interstate Commerce Commission (ICC) regulations (particularly if the commuter service crosses state lines). Federal agencies are responsible for carrying out the intent of laws passed by Congress. The agencies have great powers through the regulations they promulgate. A description of these agencies and the regulations that impact Rail Transit Planning follows.

Department of Transportation-Federal Railroad Administration

The Federal Railroad Administration (FRA) is responsible for rail safety. This involves the establishment of track safety standards as required by the Federal Railroad Safety Act of 1970. These standards set forth specified train speeds over certain tracks as well as setting forth inspection criteria used by the railroads. Table A-2 presents the operating speeds of both freight and passenger trains as determined by the 6 classes of track. To operate at the allowable speeds, a railroad must maintain it's track to the required standards for this speed.

Table A-3: TRACK CLASSES AND MAXIMUM ALLOWABLE OPERATING SPEEDS IN MILES PER HOUR

Track Class	Maximum Allowable Operating Speeds	
	Freight Trains	Passenger Trains
1	10	15
2	25	30
3	40	60
4	60	80
5	80	90
6	110	110

Source: Federal Register, Vol. 38, No. 3 P. 873, 1508
Friday, Jan. 5, 1973 and Monday, Jan. 15, 1973

In addition to track classification for maintenance and operation, the 4R Act of 1976 required a classification and designation of all Class I Railroad lines in the United States by standards established by the Secretary of Transportation. These standards and classifications are as follows (Final Standards, Classifications and Designations of Lines of Class Railroads in the U.S.):

1. Class A Mainlines - The designation is based upon three standards; any line that meets one of the standards qualifies as Class A Mainline.

    1) A traffic density of 20 million or more gross tons annually.
    2) Required to serve a market generating more than 75,000 carloads annually.
    3) Required to provide a through-rail route in corridors designated as essential in The Strategic Rail Corridor Network (STRACNET) for National Defense.

2. Class B Mainlines - The Rail line will qualify as a Class B Mainline if it is a through or feeder route which carries less than 20 million gross tons per year -- but at least 5 million gross tons annually and does not qualify for Class A mainline status (does not serve major markets or part of the Strategic Rail Corridor Network).

3. Class A Branchline - The line is designated as a Class A Branchline if it handles at least one million but less than 5 million gross tons annually and is not otherwise designated as a Class A mainline.

4. The Class B Branchline - The line is designated a Class B Branchline if it handles less than one million gross tons annually and is not otherwise designated as mainline track.

Four types of line segments are not assigned a designation but are included in the sector maps for structural connectivity and are given a line identification code. These line types are as follows:

1. Line segments that connect urban and complex junctions.
2. Switching and Terminal lines.
3. Lines owned by independent Class 1F Railroads.
4. Reported line abandonments.

Due to operating speed constraints and level of service needed, rail passenger service will usually be found on Class 4, 5 or 6, A or B Mainlines. Generally because of low volume of freight traffic, it would not be economically feasible to maintain the Branchlines to the Class level required to move passengers.

Other Federal Agencies

Depending upon the type of transit project and its size, numerous federal agencies may be involved. The Code of Federal Regulations (CFR) should be consulted for which agencies have jurisdiction and/or interplay with any given project phase. Some of the agencies are:

U.S. DOT - Federal Highway Administration (FHWA)
U.S. DOT - Urban Mass Transportation Administration (UMTA)
U.S. DOT - Federal Railroad Administration (FRA)
Interstate Commerce Commission
Advisory Council on Historic Preservation
Department of Treasury
Environmental Protection Agency (EPA)
Department of Labor (DOL)
Office of Management and Budget (OMB)

Federal Regulations Found in the Code of Federal Regulations (CFR)

49 C.F.R. Part 600 are regulations promulgated by the Urban Mass Transportation Administration.

49 C.F.R. Parts 21, 23, 25 and 27 are regulations promulgated by the Department of Transportation governing Title VI of the Civil Rights Act of 1964, Minority Business Enterprise, Relocation and Land Acquisition, and Non-discrimination on the Basis of Handicap.

36 C.F.R. Part 800 are regulations promulgated by the Advisory Council on Historic Preservation.

46 C.F.R. Part 381 gives regulations promulgated by the Maritime Administration governing cargo preference requirements.

31 C.F.R. Part 205 provides regulations promulgated by the Department of Treasury governing letter of credit.

40 C.F.R. Part 15 provides regulations issued by the Environmental Protection Agency pertaining to administration of clean air and water pollution requirements for UMTA grantees.

29 C.F.R. Parts 5 and 215 provide regulations promulgated by the Department of Labor pertaining to construction labor and transit employee protections. New requirements are currently being implemented.

23 C.F.R. Part 203 provides regulations promulgated by the Federal Highway Administration in regard to reimbursement of railroads for items such as labor, equipment, materials, supplies and transportation costs the railroad incurs while implementing Federal-Aid highway projects.

Administrative Requirements: Office of Management and Budget (OMB)

Office of Management and Budget (OMB) Circular A-87 provides cost principles applicable to grants and contracts with state and local governments. OMB Circular A-95 provides that state and local elected officials, not the Federal Government, will determine within the scope of the order, which Federal programs and activities to review and the procedures by which the review will take place. OMB Circular A-102 provides uniform requirements for assistance to state and local governments.

State Agencies, Regulations and Agreements

Railroad Commission

The regulation of railroads by the State of Texas was authorized by a 1890 amendment to the Texas Constitution. The Texas Legislature created the Railroad Commission in 1891 with the following powers (Stout, 1977):

1. To prescribe fares, freight rates and express rates and rules.
2. To prescribe a classification.
3. To prescribe divisions when railroads could not agree.
4. To make different rates for different roads and for different lines under the same management or for different parts of the same line, if found necessary to do justice.
5. To regulate the supply of equipment and the interchange of cars between connecting lines.
6. To require at least one train a day (Sundays excepted) for passengers and it was prohibited from relaxing this provision.
7. To see that "all laws of this State concerning railroads are enforced and obeyed."
8. To investigate interstate rates, and to seek relief from the Interstate Commerce Commission when the railroads failed to make proper adjustment.
9. To prevent extortion and discrimination.
10. To regulate free transportation of persons and property.

Since the passage of the Act, the Railroad Commission has been given additional powers with regard to railroads. In addition, intrastate regulatory authority has been given the Commission over truck lines, buses and pipelines plus the regulation of oil and gas production.

The Railroad Commission of Texas is the principal agency acting on behalf of the state in railroad matters. While direct power to influence a privately owned industry that is regulated by the Federal Government is limited, the Texas Railroad Commission has two roles:

1. It approves rates on intrastate shipments (Regulatory Role).
2. It represents the State of Texas in all matters related to railroad planning and Federal grants administered by the Federal Railroad Administration (Designated Agency Role).

Through the Designated Agency Role, the Texas Railroad Commission is the planning and grant administering arm for federal funds to assist the railroads of Texas. As a planning function it oversees federal study grants to a number of Metropolitan Planning Organizations (MPO's) to address specific local rail issues (i.e., rail line relocation, rail crossing problems, and rail yard relocation).

An indirect authority possessed by the Railroad Commission is its ability to exercise considerable influence. It can recommend and support State policy and legislation pertaining to railroad matters. It can also represent state interests in federal determination on matters that affect rail service in Texas.

The Railroad Commission promulgates rules and regulations in accordance with a 1925 General Law requiring all Railway Companies and all persons to place nothing over the tracks less than twenty-two feet from the top of the rails, or not less than eight and one-half feet from the center of a main line, spur, switch or siding. Variances to the clearance law must be granted by the Railroad Commission.

State Department of Highway and Public Transportation

The State Department of Highways and Public Transportation (SDHPT) is frequently involved with railroad problems when the highway system and the railroad meet (conflict points commonly known as a highway-railroad grade crossings). Since 1972 the Federal Highway Administration (FHWA) has funded grade crossing improvement projects through Section 203 of the Highway Trust Fund. Grade crossing surfaces can be replaced using Section 230 funds on the state system.

As reported by Mr. Dodson (SDHPT Bridge Division), the SDHPT Bridge Division has responsibility for the selection of grade crossing improvement projects. The crossings selected are from a priority list developed from hazard indices, calculated from the state inventory of railroad crossings.

The SDHPT also interacts with the railroads in areas other than grade crossing improvements. Among these situations are when:

1. The highway crosses railroad property.
2. The railroad crosses a State highway.
3. The railroad crosses above a State highway.
4. The State highway crosses above railroad property.
5. The railroad runs spur track across a State highway.
6. Drainage ditches run parallel between a State highway and railroad tracks.
7. Re-surfacing or re-planking of grade crossings on the State highway system.

The cost of the crossing is borne by the State when the highway crosses a railroad. The railroad bears all the cost of the crossing when the railroad crosses a State highway. A general agreement between the railroads and the SDHPT exists regarding drainage ditches: when a highway parallels a railroad track, rather than maintaining two drainage ditches, the railroad allows the State to use its rights-of-way for drainage ditches.

To accomplish the legal paperwork, license agreements or permits (depending on the situation) are executed between a railroad and the State to accomplish a specific task. A Railroad License and Planking Agreement is used when the State Department of Highways and Public Transportation (SDHPT) crosses a railroad track. Agreements between the SDHPT and a railroad are executed when an overpass is built crossing a railroad, when a highway-railroad grade crossing project is implemented, or to allow a railroad to construct a spur across SDHPT right-of-way to serve an industrial site. Some of the principal parts of these general agreements are included for ready reference by the interested reader.

Railroad License and Planking Agreement

NOW, THEREFORE, in consideration of the premises and of the mutual convenants and agreements of the parties hereto to be by them respectively kept and performed, as hereinafter set forth, it is agreed as follows:

1. LICENSE.

a. The RAILROAD hereby gives to the STATE license and permission to construct and maintain the highway across its property at the intersection of the railroad and highway as shown on EXHIBIT A.

b. The license is given subject to the rights of utility companies to maintain and operate pole and wire lines thereon and thereover, and the STATE will make its own arrangements with the utility companies for any necessary relocation or alteration of said pole and wire lines.

c. No legal right which the RAILROAD now has to reconstruct, maintain and operate its existing track and appurtenances or to connances upon and across said property shall in any way be affected by the giving of this license.

2. SCOPE OF WORK.

a. The RAILROAD agrees to perform the work as outlined in the attached EXHIBIT A. This work will generally consist of removing existing crossing and installing ________ feet of new full depth creosoted heavy timber pavement as thick as the rails and tie plates. It shall be the RAILROAD'S responsibility to order and assemble a high quality grade.

b. If subgrade stabilization improvement work is required such work shall be detailed on said EXHIBIT A. In that event, the RAILROAD shall remove the existing rails and crossties within the crossing limits, and the

STATE shall excavate the existing material and furnish and install the stabilized subgrade. The RAILROAD shall place the necessary ballast, if required, and install the new ties and relay the rail and install the new timber crossing pavement.

c. The RAILROAD shall submit a cost estimate detailed in accordance with EXHIBIT A, upon request by the STATE.

3. <u>CONSTRUCTION AND MAINTENANCE</u>.

a. The RAILROAD shall commence the work to be done within thirty (30) days after having been issued a "Work Order" by the STATE and shall proceed without delay to completion. Payment will not be made for work done by the RAILROAD which is performed at the project site prior to the "Work Order" date. Materials used on the project should be assembled sufficiently in advance to assure prompt delivery but reimbursement for any materials or handling charges will be contingent upon the issuance of the "Work Order."

b. The RAILROAD shall remove the existing crossing material including crossties within the crossing limits. The RAILROAD shall...

c. It is understood that the STATE will not pay for replacement of rails, crossties, track spikes or other material or labor related to the improvement or maintenance of the railroad tracks at this location. The RAILROAD agrees that upon completion of the crossing improvement, it will assume future responsibility for maintaining a smooth crossing to the satisfaction of the STATE.

4. <u>PAYMENT</u>. Upon completion of the work, the RAILROAD shall bill the STATE, which will pay to the RAILROAD the cost of labor, material and expenses incurred. Reimbursement to the RAILROAD will be made for work performed and materials furnished, including but not limited to, ...

5. <u>CONDITIONS</u>.

a. The STATE reserves the right to cancel this agreement for any reason and at any time prior to the issuance of a "Work Order" by the STATE to the RAILROAD to proceed with any part of the work outlined herein. The STATE will not be responsible for any expense incident to any cost incurred in the event of the cancellation of this contract.

b. The RAILROAD shall retain adequate cost accounting records for auditing purposes for a period of three years after payment of the final bill.

c. It will be necessary that the RAILROAD contact the District Engineer, State Department of Highways and Public Transportation, a minimum of seven days prior to actual commencement of work in order that STATE forces may provide inspection during the installation of the planking.

6. Compliance with Title VI of the Civil Rights Act of 1964.

During the performance of this contract, the RAILROAD (referred to as the "contractor" in the following paragraphs numbered 1 through 6), for itself, its assignees and successors in interest, agrees to comply with the following six paragraphs except in those instances where work undertaken under this agreement is performed by its own forces.

(1) Compliance with Regulations: The contractor will comply with the Regulations of the Department of Commerce relative to nondiscrimination...

(2) Nondiscrimination: The contractor, with regard to the work performed by it after award and prior to completion of the contract work, will not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including...

(3) Solicitations for Subcontracts, Including Procurements of Materials and Equipment: In all solicitations either by competitive bidding or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials or equipment, each potential subcontractor or supplier shall...

(4) Information and Reports: The contractor will provide all information and reports required by the Regulations, or orders and instructions issued pursuant thereto, and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the STATE or the Federal Highway Administration to be pertinent to ascertain compliance with such Regulations, orders and instructions. Where any information required of a contractor is...

(5) Sanctions for Noncompliance: In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, the STATE shall impose such contract sanctions as it or the Federal Highway Administration may determine to be appropriate, including, but not limited to,

(a) withholding of payments to the contractor under the contract until the contractor complies, and/or

(b) cancellation, termination or suspension of the contract, in whole or in part.

(6) Incorporation of Provisions: The contractor will include the provisions of paragraphs (1) through (6) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations, orders, or instructions issued pursuant...

Overpass Construction Agreement

WHEREAS, ______________________________ crosses the railroad line of the company at ______________________________

______________________________ County, Texas, and the State proposes to separate the grades of the railroad and highway by the construction of an overpass over the company's track, as shown on print marked "Exhibit A," attached hereto and made a part hereof.

AGREEMENT

NOW THEREFORE, in consideration of the premises and of mutual...

1. The company hereby gives to the State license and permission for the construction, maintenance and use of the aforesaid overpass and highway across its property and over its track at the intersection of the railroad and highway, as shown on Exhibit "A."

2. The State agrees to and will prepare plans and specifications, subject to approval by the company, for the proposed overpass structure. Said plans and specifications, after having been approved in writing by the State and the company, are hereby adopted as plans and specifications covering the construction of said overpass, and...

3. Cost of preliminary engineering ineligible for reimbursement with Federal funds due to being incurred prior to date of program approval will be reimbursed with State funds if incurred after the State's request for preparation of estimates.

4. The company, unless otherwise provided, shall make such changes or alterations in the tracks, communication and signal, pole and wire lines, pipe sewer and drainage or other facilities or buildings located upon the company's right-of-way, which may be displaced or required by the construction of the project, as may be necessary to maintain continuous service and conform them to said construction and restore them to former condition for service either prior to, during or following subject to approval by the State, for the adjustment of such facilities. Such estimates shall be attached hereto. Any known work to be done, not shown in the estimates, will not be paid for.

5. The company shall commence the work to be done by it herein within thirty (30) days after receipt of written notice from the State that the work may proceed and shall proceed diligently to the conclusion of its obligations herein. Reimbursement will not be made for work undertaken by the company which is performed at the site of the project prior to the issuance of such work order by the State. This does not apply to...

6. Reimbursement to the company will be made for work performed and materials furnished, including, but not limited to, ...

7. Railroads and utility company bills.

a. The company may submit monthly bills prepared in satisfactory form for work performed in compliance with this agreement provided the cost to be billed exceeds $500.00. Upon receipt of said montly bills, the State will make payment to the company. The amount of such payment may...

b. In the event that the company does not desire monthly payments, then upon satisfactory completion of the work performed by the company under this agreement and receipt of a statement in proper form, the State shall make payment to the company. The amount of said payment may...

8. The State expects to be reimbursed for its expenditures hereunder from funds provided by the United States Government. Such reimbursement can only be obtained by the State by compliance with the statutes, rules and regulations from time to time enacted and promulgated by the United States Government and its Federal Highway Administration. In case such statutes, rules or regulations shall hereafter be altered or amended in such manner as to affect the State's right to such reimbursement or funds...

9. In the event that construction is not undertaken, or in the absence of a work order being issued by the State to the company, the State will not be responsible for any expenses incident to any cost incurred in connection with any provision of this contract.

10. It is agreed that should the property licensed hereunder or any portion thereof cease to be used for public road purposes, this license, as to portion so abandoned, shall immediately cease and terminate.

11. The State shall furnish material for and perform the work to be done by it hereunder in accordance with approved plans and specifications referred to in paragraph 2 hereof. ...

12. If provided by the plans and specifications, the company shall furnish and install materials for the inner guard rail, of the company's standard design through the overpass structure. The rail, angle bars, tie plates and frog point, for the guard rail, shall be secondhand.

13. The State assumes the entire responsibility for the construction, maintenance and use of said highway upon the company's property at the location herein described; and nothing contained herein shall ever be construed to place upon the company any manner of liability for injury to or death of persons, or for damage to or loss of property, arising from or in any manner connected with the construction, maintenance or use of the portion of said highway located upon the company's said property.

14. The license, given hereby, shall not in any way prevent the company from operating its trains or multiplying or changing its tracks across the land over which license has been given, or under the overpass contemplated hereby.

15. The contract or contracts to be let by the State for the construction of the work to be undertaken by it hereunder shall provide:

A. Standard Manufacturers' and Contractors' Liability Insurance. The Contractor shall furnish evidence to the State that, with respect to the operations he performs, he carries regular Contractors' Liability Insurance providing...

B. Contractors' Protective Liability Insurance. The Contractor shall furnish evidence to the State that, with respect to the operations performed for him by subcontractors, he carries in his own behalf regular Contractor's Protective Liability Insurance providing for a limit of not less than...

C. Railroads' Protective Liability and Property Damage and Physical Damage to Property Insurance. The Contractor shall furnish an original policy to the State for and in behalf of the company which, with respect to the operations he or any of his subcontractors perform, provides the Standard Railroad Protective Liability Policy, with coverage outlined in...

D. General. The insurance, as specified in paragraphs a. and b. above, shall be carried until...

16. Compliance with Title VI of the Civil Rights Act of 1964.

During the performance of this contract, the company (referred to as the "contractor" in the following paragraphs numbered 1 through 6), for itself, its assignees and successors in interest, agrees to comply with the following six paragraphs except in those instances where work undertaken under this agreement is performed by its own forces.

(1) Compliance with Regulations: The contractor will comply with the...

(2) Nondiscrimination: The contractor, with regard to the work...

(3) Solicitations for Subcontracts, Including Procurements of Materials and Equipment: In all solicitations either by competitive bidding or...

(4) Information and Reports: The contractor will provide all information and reports required by the Regulations, or orders and...

(5) Sanctions for Noncompliance: In the event of the contractor's noncompliance with the nondiscrimination provisions of this contract, ...

(6) Incorporation of Provisions: The contractor will include the provisions of paragraphs (1) through (6) in every subcontract, including...

17. The company shall retain adequate cost accounting records for auditing purposes for a period of three years after payment of the final bill.

Highway-Railroad Grade Crossing Agreement

WHEREAS, the STATE proposes to engage in certain projects for the reconstruction or other changes of portions of the State Highway System which will cross at-grade the right-of-way and tracks of the RAILROAD, said projects listed and attached hereto and hereinafter referred to as EXHIBIT L;

AND WHEREAS, the plans for said reconstruction or other changes are to be reviewed by the STATE and RAILROAD;

NOW, THEREFORE, in consideration of the premises as herein set forth, the parties hereto agree as follows:

1. When the STATE has furnished "PROJECT NOTICES" and plans to the RAILROAD regarding crossing of the RAILROAD'S right-of-way and tracks for the projects listed on EXHIBIT L, the RAILROAD will provide detailed estimates clearly showing the work to be performed; furnish or have furnished all necessary materials required; and construct at STATE expense, crossing pavements and other work as shown on EXHIBIT A. Any or all such work shall be performed in accordance with railroad standards and specifications, AAR and/or AREA standards and specifications, and to the satisfaction of the STATE.

2. a. When crossing surface pavements are proposed, it shall be the RAILROAD'S responsibility to order and assemble a high quality grade of timber or other specified material, including ballast for track adjustments if specified, and as shown on EXHIBIT A. Any timber assembled for the project shall be...

b. If subgrade stabilization improvement work is required, such work shall be detailed on said EXHIBIT A. In that event, the RAILROAD shall remove the existing rails, and crossties within the crossing limits, and the STATE shall excavate the existing material and furnish ballast if required, install new ties, relay the rail and install the new crossing surface pavement.

c. It is understood that the STATE will not pay for replacement of rails, crossties, track spikes or other material or labor related to the improvement or maintenance of the railroad tracks at this location. Crosstie replacements for the individual projects are considered intrinsic to railroad maintenance and therefore...

3. a. The WORK ORDER should be requested from the applicable State Department of Highways and Public Transportation District Office at the time that materials for each individual project have been assembled and crews scheduled. The RAILROAD shall begin the installation of the individual projects within seven (7) days after receipt of WORK ORDER from the STATE for...

4. The STATE will normally follow Federal requirements and guidelines regarding reimbursement on various crossing projects. Therefore, the RAILROAD hereby agrees to install and adjust the necessary parts of its facilities in accordance with the applicable method described in the following:

(1) Federal Highway Administration, Federal Highway Program Manual (FHPM), Volume 1, Chapter 4, Section 3 (Reimbursement).

(2) State Department of Highways and Public Transportation current policies and practice on submission of plans, estimates and billings and any supplements to the above revisions thereof, which, by reference hereto, are made a part hereof.

for any reason it is necessary that the flow of traffic be stopped for other than a normal period of time, the Industry shall notify the State in writing as to the necessity and circumstances, prior to such stoppage.

4. There is to be no general switching across the roadway.

5. The Railroad, at Industry expense, will perform or have performed the work described herein and incident thereto. The State will not be responsible for any cost or charges in connection with this spur track crossing.

6. All work to be done hereunder, as well as the maintenance thereof, shall be done at no cost to the State and to the satisfaction of the State.

7. The Railroad, at Industry expense, shall furnish, install and thereafter maintain flashing light signals, Type E (AAR 1746), as shown on the attached Exhibits A and B. Plans for the flashing light signal installation shall meet the approval of the State. If at any time the State determines that the flashing light signals are operating excessively or improperly, then the Railroad, at Industry expense, shall promptly eliminate the objectionable operation of the signals. The Railroad shall not commence operations over the aforesaid spur track until the flashing light signals and other facilities described herein have been installed and approved by the State.

8. The Railroad, at Industry expense, shall furnish, install and thereafter maintain a new 96 foot rubber crossing. All rail joints within the limits of the crossing area shall be welded at no expense to the State.

9. The Railroad, at Industry expense, will perform or have performed the stabilized subgrade work, perforated underdrain pipe and new ballast.

10. The Railroad, at Industry expense, will perform or have performed the hot-mix asphalt overlay for the 700 feet of roadway as shown on the Exhibit A.

11. The Railroad, at Industry expense, shall furnish, install and maintain two 18" x 48" Reinforced Concrete Pipe (Class III, Wall B). Said pipes are required to have 6:1 sloped-end treatments on each end.

12. The Railroad, at Industry expense, will perform or have performed the roadway approaches on each side of the crossing to the satisfaction of the State.

13. The State, at Industry expense, shall furnish and install the pavement markings as shown on Exhibit C and advance warning signs as shown on Exhibit D.

14. The State agrees to maintain the pavement markings and advance warning signs at no expense to the Industry and/or Railroad.

15. The Railroad, at Industry expense, will perform or have performed the detour and traffic control during the installation of the crossing as

approved by the State and as indicated on Exhibit E attached hereto and made a part of. After completion of the spur track, the barricades shall be satisfactorily disposed of.

16. It is understood and agreed that any engineering, inspection, labor, material, right-of-way or other costs borne by the State in connection with this spur crossing shall be promptly reimbursed by the Industry upon presentation of an itemized bill.

17. If the State elects to modify the highway as to its width and/or grade and/or alignment or make any other changes in the highway which will affect the grade crossing, then the State shall have the right to make such modifications and the Railroad will make adjustments of the spur track, grade crossing, highway ditch drainage structures, crossing pavement and flashing light signals promptly and without expense to the State to make them conform to the modified highway location or design. If the highway is modified and additional drainage structures, crossing pavements and/or flashing light signals are needed, the Railroad shall, at Industry expense, install and maintain these additional items to the satisfaction of the State.

18. In the construction and operation of the spur track upon and across the highway, the Industry and/or Railroad agree to use reasonable care and/or require its contractor to use reasonable care to protect the travelling public. The State does not assume any liability for suits, claims or damage of whatever kind or nature arising out of or incident to the construction, maintenance and operation of the spur track and flashing light signals.

19. The Railroad shall not revise, change, alter or add to the crossing installation after it has been accepted by the State except with written approval of the State. This shall be further construed to mean that the Railroad's maintenance crews shall not erect obstacles, posts, or barriers around the signal bases.

20. Obligations and/or rights specified under terms of this permit may not be assigned to others without the prior written approval of the State.

21. The Industry agrees that it will remove the crossing or bear the entire cost of a grade separation of the railroad and highway grade when the combination of train movements and traffic volumes equal or exceed the following values:

Daily Train Movements	Annual Average Daily Traffic (vpd)
2	4,500
4	2,500
6	2,000

22. It is mutually understood and agreed between the parties hereto that if and when Industry and/or Railroad shall abandon this spur track crossing or cease operations thereover, the permission and authority granted herein for the spur track shall expire and terminate; whereupon the Railroad shall, at Industry expense, promptly remove from the highway and highway right-of-way the abandoned spur track and other facilities as provided herein

for the spur track and will replace and rebuild the highway pavement to the same design existing at the time of the removal of the tracks and to the satisfaction of the State.

Local Agencies and Authorities

Metropolitan Planning Organizations (MPO)

The establishment of a Metropolitan Planning Organization (MPO) is a promulgation of the Urban Mass Transportation Act of 1964 and subsequent amendments. Through the MPO, a mechanism was created to funnel federal funds directly to larger metropolitan areas without having to go through the state.

The Governor of the State established MPO regions. North Central Texas Council of Governments, (consisting of 16 counties), and Houston-Galveston Area Council of Governments, (consisting of 13 counties), are examples of MPO's in Texas. The MPO is not a government agency but is a voluntary organization of, by, and for local governments (Peat, Marwich, Mitchell & Co., 1980). The MPO serves a valuable and viable purpose of addressing area-wide problems through the promotion of intergovernmental cooperation and coordination, the conduct of comprehensive regional planning, and the provision of a forum through which regional problems can be studied and resolved.

Membership in the MPO is open to all governments in the MPO region. This includes counties, cities, school districts and special districts. The North Central Texas Council of Governments organization is an excellent example of a very active Council of Governments. It consists of an MPO staff for administrative functions and an MPO policy board (Council) for making policy and decisions. The planning work efforts are funded by member dues, plus financial assistance from the State, and Federal governments. The MPO policy board (Council) is responsible for all areas of regional planning including transportation, energy, criminal justice, housing environment, and human resources. UMTA requires that the urbanized area planning process shall be carried on by local officials acting through a Metropolitan Planning Organization (MPO) in cooperation with the state.

Creation of Regional Transit Authorities

The Texas Legislature passed enabling acts to allow urban regions to consider establishing Regional Transit Authorities. The first of these acts was Article 1118X. The Metropolitan Transit Authority of Harris County and VIA in Bexar County were established under this Act.

Article 1118X gives the authority very broad powers rights (i.e., rights to own property, acquire property by right of eminent domain, to acquire lands in fee simple and any interest less than fee simple in, on, under and above lands, including without limitation, easements, rights-of-way, rights of use of air space or subsurface space or any combination thereof) provided that such right shall not be exercised in a manner which would unduly interfere with interstate commerce or which would authorize the authority to run its vehicles on railroad tracks which are used to transport property.

Additional enabling articles have been passed by the State Legislature for cities of different populations. Article 1118Y pertains to the Dallas/Fort Worth Area. Voters in Dallas approved on August 13, 1983 the establishment of the Dallas Area Rapid Transit (DART) Authority. Article 1118Y differs from 1118X in that it does not have as broad powers in the right of eminent domain. Article 1118Y allows right of eminent domain through the city powers rather than the authority powers.

Taxation of Railroads

The Texas Constitution, ratified in 1876, authorized the taxation of every railroad property by state, county, and muncipal governments. It established the taxation method and what is to be rendered for tax. To further clarify procedures, the State Property Tax Board has developed a State appraisal technique. The railroad company annually submits a valuation of their railroad corridor properties to the local taxing authority. An example of a prelude that most railroads will attach to their valuation statements was furnished by Mr. Ed. L. Kayser, former regional tax commissioner with the Southern Pacific Transportation Company. The prelude covers constitutional background, Laws of the State of Texas, court cases and methodology used in valuation computations.

It should be pointed out that appraisal offices of various entities collecting railroad taxes may disagree with the railroads' evaluation of value or method used. At the present time, the City of Houston and the Dallas Appraisal District are in litigation on railroad tax valuations, because of differences of opinion as to the computed values of railroad property.

The following "Appraisal of Railroad Property" was prepared by one of the State's railroad companies (Southern Pacific) and is taken from the prelude furnished by Mr. Kayser:

Appraisal of Railroad Property

The railroads of Texas are unique properties for ad valorem taxation purposes. They are, by the very nature of the enterprise, different from any other entity in the state. A railroad is a composite of many varied and diverse parts and types of property. Some parts have a fixed situs and, some parts are heavily regulated by the ICC and Texas Railroad Commission, while other parts are not burdened at all by governmental regulations.

The constitution of the State of Texas, Article 10, Section 2, set the railroads apart from all other property in the State by stating "Railroads heretofore constructed or which may hereafter be constructed in this state are hereby declared public highways and railroad companies common carriers." The purpose of this article, as explained by the courts, was to devote railroad property to limited public use and to subject the companies and roads to the control of the State.

Article 8, Section 1 of the Texas Constitution required property to be taxed in proportion to its value, which "shall be ascertained as may be provided by law." The legislature, in response to this constitutional mandate did provide a logical plan and system of laws for the determination of situs and taxable value of the various types of property owned by the railroads as follows:

1. The rolling stock, which has no actual situs, is to be valued by the chief appraiser of the domiciliary county and the situs established at the county level in the counties through which the road runs. (24.31 thru 24.40 TEXAS PROPERTY TAX CODE)

2. The intangible assets, which have no actual situs, are to be valued by the State Property Tax Board and this valuation distributed at the county level in the counties through which the road runs. (Sec. 24.01 thru 24.14 TEXAS PROPERTY TAX CODE)

3. The localized property. Having made provisions for the establishment of the situs of and the responsibility for the valuing of two parts of a railroad's property, the legislature made further provision for the rendition and taxation of the remaining railroad property, the localized property (or rights-of-way). The law does not say simply that all other property of the railroads would be assessed and taxed where located, but rather the legislature provided a detailed plan for the rendition and assessment of these various types of localized property so that each type could be valued correctly and independently of the other.

The law of the State of Texas provides that every railroad corporation in the State shall deliver on or before the 1st day of May of each year, to the Chief Appraiser of each Appraisal District, a rendition of all property owned by or in possession of said corporation as of the 1st day of January of each year. The rendition shall:

1. List of all real property;

2. List of the number of miles of railroad together with the market value per mile (includes right-of-way, roadbed, superstructure, and all buildings and improvements) and,

3. List of all personal property.

The legislature determined that real property and personal property should be treated as all other real estate and personal property in the jurisdiction. But, the legislature recognized that railroad operating property, referred to as Subdivision (2) above, is peculiar and specialized and should be rendered and taxed in a special way.

The operating property of a railroad consists of several parts:

1. Shops, building and fixtures of every kind used in the operation of the railroad. Their valuation poses no problem and since they are localized, only the situs jurisdiction can assess and tax them.

2. The railroad corridor consists of the track and rights-of-way, whether owned in fee or held under an easement. Every mile of railroad corridor is integrated and dependent upon every mile for its value. Its operation is heavily regulated by both the ICC and the Texas Railroad Commission. This regulated property must be used for railroad purposes. In order to arrive at the true market value of this peculiar type of property a valuation method which recognizes these facts must be used. The courts of the State of Texas and of the United States have addressed how this type of railroad property should be appraised and assessed in order to arrive at a true market value.

The Court of Civil Appeals in State v. St. Louis Southwestern Railway Company of Texas (1906) 43 Tex. Cv. A. 533, 96 SW 70, stated "The law providing that the whole length of a railroad through a county may be assessed for taxes by giving the length thereof and placing a value thereon per mile, in effect, provides for a valuation according to the average value of the entire length of the road through the county; and hence the road is assessed as an entirety and not as so many separate and distinct miles of road nor as separate and distinct parts of the surveys over which is passes....

The Supreme Court of Texas stated in State v. Austin & N. W. Railroad Company (1901) 94 Tex. 53, 62 SW 1050, "The value of a railroad is not the mere value of its right-of-way, roadbed, and superstructure, its depot grounds and structures thereon, considered by themselves, but the value of all these, as an operating, 'going concern'; this value being in general determinable by the profits which result from its operation." "Persons proposing to sell or buy a railroad, in forming their opinion as to its value, would doubtless consider the condition of its physical properties, but would ultimately reach their conclusion upon the question by a careful estimate of the probable net income which its operation will produce."

The United States Supreme Court stated in Columbus Southern R. Company V. Wright, 151, U. S. 470, 481-482, 38 L. Ed., 238, 243 "The roadway itself of a railroad depends for its value upon the traffic of the company, and not merely upon the narrow strip of land appropriated for the use of the road, and the original cost, its ultimate cost after years of expenditure in repairs and improvements. On the other hand, its value cannot be determined by ascertaining the value of the land included in the road assessed at the market price of adjacent lands, and adding the value of crossties, rails and spikes. The value of land depends largely upon the use to which it can be put, and the character of the improvements upon it. The assessable value, for taxation, of a railroad track can only be determined by looking at the elements on which the financial condition of the company depends...."

Three Appraisal Approaches

In order to comply with the Statute and the rationale of these decisions the railroad corridor of the Southern Pacific Transportation Company as an operating entity by considering the three commonly accepted indicators of value for this type of property: Investment, capitalized income and the market value of stock and debt. The new General Appraisal Manual, Section 14, published by the State Property Tax Board recognizes the corridor approach for valuing railroads.

1. Cost Approach: Although much of the professional literature in recent years emphasizes that cost is an unreliable evidence of market value for railroads, some tax administrators insist that cost be given consideration in the appraisal process. However, the courts have often stated that cost of construction is not a good criterion of value and is a very unreliable evidence of market value.

It should also be pointed out that included in railway company accounts are the cost of facilities which do not contribute to carrier earnings or to the efficiency of their operation. These facilities are constructed solely for benefit of the public and do not in any way enhance the market value of the railroads. Some obvious examples are the costs of viaducts, underpasses and elevated structures necessitated by the construction of public highways; the costs of public improvements such as special assessments levied for the construction of drainage ditches, street paving, curbs and gutters, etc.; the costs of elevated track for highway grade crossings; and the costs of highway signal devices.

It is generally recognized that the most serious deficiency in using cost as a value indicator is the fact that it does not give credit for the presence of a large amount of function and economic obsolescence. Although it is difficult to accurately measure the obsolescence of rail properties the most commonly used methods are known as (1) "income deficiency" whereby the net railway operating income is mathematically related to an acceptable rate of income and (2) "the best of the best" which compares various operating factors of the subject road to the best operating factors of several top class one railroads which assumes the best railroad has no obsolescence.

2. Market (Stock & Debt) Approach: This is the market approach universally used for railroads which in theory parallels the principle that market value equals the equity in a property plus the debt for which it is liable. The equity of a railroad is value to the stockholder of the railroad portion of the equity of the holding company. The market (stockholder) purchases equity for a return. The contribution of the income of railroad to the income of the holding company determines that part of stock price the stockholder is paying for the railroad. The debt is made up of funded debt (debt on all types of property), equipment trust certificates and conditional sales contracts which are largely debt secured by rolling stock equipment. The value of the equity and the debt includes both operating and non-operating property.

3. Capitalized Income Approach: It is suggested that net railway operating income be capitalized by a rate calculated by the "band of investment" or "cost of capital" method. The "band of investment" method

calls for a computation of a single capitalization rate by weighting the component rates applicable to the debt and equity portions of the capital structure. In valuing a railroad, Texas assessing authorities have generally used "Net Railway Operating Income" as the unit of income to be capitalized. This concept allows deduction for all operating expenses, including depreciation charges and all taxes, and is considered to be a net operating stream in perpetuity.

Correlation: Upon completion of a thorough study of values indicated by each of the three approaches, an appraiser must use professional judgement to determine the value of a railroad. It is not uncommon for the cost approach to be ignored completely, but when it is used it is normally given less weight than the income and market approaches. Weight given these approaches are: cost 10%, stock and debt 40%, and income 50%.

After the total corridor value has been determined, it is divided between mainline, branchline and side track in direct relationship to investment therein. The per-mile market values for the Mainline, Branchline, and Side Track mileage can be obtained by using the guidelines of the Railroad Section of the General Appraisal Manual. This section of the Manual was compiled and recommended by the State Property Tax Board as a viable method of appraising the Railroad Transportation Corridor.

APPENDIX B

SURVEY INSTRUMENTS AND ADDRESSES FOR TRANSIT AGENCIES
AND PLANNING ORGANIZATIONS

Contents:

Utilization of Railroad Right-Of-Way for Transit

Undertaken by the Texas Transportation Institute, Texas A&M University System in cooperation with the Texas State Department of Highways and Public Transportation, the U.S. Department of Transportation, and the Urban Mass Transportation Administration

This survey is intended to collect only basic information on your use of railroad right-of-way for public transportation purposes. Please supplement the questionnaire with any relevant contracts, agreements, plans, reports, etc., if such documents are readily available. If requested, the information supplied by your agency will be treated as confidential. Thank you for your assistance and participation in this survey.

---

1. Does your agency currently operate transit service within any portion of railroad right-of-way? ☐ Yes* ☐ No

   1.a. If YES, please indicate the type of service operated and the approximate mileage.

   ☐ Light Rail Service Miles on RR ROW________ Total Miles________

   ☐ Heavy Rail Service Miles on RR ROW________ Total Miles________

   ☐ Commuter Rail Service Miles on RR ROW________ Total Miles________

   ☐ Busways or Exclusive HOV Lanes Miles on RR ROW________ Total Miles________

   ☐ Other (specify):__________ Miles on RR ROW________ Total Miles________

   1.b. If NO, has the use of RR ROW for transit purposes been investigated?

   ☐ Yes* ☐ No

   1.c. If NO, does your agency have plans to utilize RR ROW for transit in the future?

   ☐ Yes* ☐ No

2. If transit service is currently operated or planned on RR ROW:

   2.a. Who operates the transit service?

   ☐ Transit Agency ☐ Railroad Company ☐ Other (specify)__________

   2.b. Is any RR trackage jointly shared by passenger and freight service?

   ☐ Yes ☐ No If YES, about what percentage of RR ROW miles?________%

   2.c. How was/is RR ROW obtained by the public agency for transit use?

   ☐ Abandonment ☐ Condemnation ☐ Purchase** ☐ Service Contract

   ☐ Lease* ☐ Other (specify):__________

   2.d. What RR Company or Companies is/are involved with the provision of RR ROW or the operation?__________

(over please)

2.e. Which governmental agencies were (or will be) involved in acquiring the RR ROW?

____

3. If both public passenger service and private freight service are operated on shared right-of-way or trackage, how are the fees or assessments calculated?

____

____

4. What are the approximate population densities (persons per square mile) within your rail corridors?

Low:__________persons/sq. mile High:__________persons/sq. mile

Overall Average:__________persons/sq. mile

*5. Please provide copies of any lease agreements, contracts, studies, investigations, system maps, and/or comments which relate to the research project.

____

____

**6. If you have purchased RR ROW, what was the approximate cost and year of acquisition?

Cost per acre:$__________ Cost per mile:$__________ Year Acquired:__________

7. May we reference all or part of the information supplied by your agency?

☐ Yes (all) ☐ Yes (part) ☐ No If PART, please indicate material to be held confidential:____

____

8. If your agency does not operate transit service within any portion of railroad right-of-way, then what do you consider the major problem to the railroad for joint use of the right-of-way?

____

____

Please return questionnaire to:

Texas Transportation Institute
Attention: Richard L. Peterson
Texas A&M University
College Station, TX 77843

THANK YOU FOR YOUR COOPERATION.

APPENDIX B

Mailing addresses used in the: Survey of Transit Agencies, Cities and Planning Organizations. (Mailed to 63 Agencies; returned by 35.)

Atlanta Regional Commission (ID #1)
230 Peachtree Street, N.W.
Suite 200
Atlanta, GA 30303

Regional Planning Council (ID #2)
2225 N. Charles Street
Baltimore, Maryland 21218

Maryland Department of Transportation (ID #3)
P.O. Box 8755
Baltimore Washington Int'l Airport
Baltimore, Maryland 21246

Metropolitan Planning Org. (ID #4)
c/o SubSignatory Committee
27 School Street
Boston, Massachusetts 02108

Joint Regional Transportation Committee (ID #5)
27 School Street
Boston, Massachusetts 02108

New York State DOT (ID #6)
1220 Washington Avenue
State Campus
Albany, New York

Chicago Area Transportation (ID #7)
Study Policy Commission
300 West Adams
Chicago, Illinois 60606

Northwest Ohio Areawide
Coordinating Agency (ID #8)
1501 Euclid Avenue
Buckley Building
Cleveland, Ohio 44115

Southwest Michigan Council of
Governments (ID #97)
800 Book Building
1249 Washington Blvd.
Detroit, Michigan 48226

Miami Urban Area Metropolitan
Planning Organization (ID #10)
242 Courthouse
Miami, Florida 33130

Metropolitan Dade County Planning
Department (ID #11)
Suite 900
909 S.E. First Ave.
Miami, Florida 33134

Delaware Valley Regional
Planning Commission (ID #12)
1819 J.F. Kennedy Blvd.
Philadelphia, PA 19103

Southwestern Pennsylvania
Regional Planning Commission (ID #13)
564 Forbes Avenue
Pittsburgh, Pennsylvania 15219

Banfield Light Rail Project (ID #14)
4012 S.E. 17th Ave.
Portland, OR 97204

Metropolitan Service District (ID #15)
525 S.W. Hall
Portland, OR 97201

Public Utilities Commission (ID #16)
Room 287 City Hall
San Francisco, CA 94102

Metropolitan Transportation
Commission (ID #17)
Hotel Claremont
Berkley, CA 94705

San Diego Comprehensive
Planning Organization (ID #18)
Security Pacific Plaza
1200 Third Avenue, Suite 524
San Diego, CA 92101

Pudget Sound Council of Governments (ID #19)
216-1st Avenue South
Seattle, Washington 98164

Transportation Planning Brd. (ID #20)
c/o Metro. Washington Council of Governments
1875 EYE Street, N.W.
Suite 100
Washington, D.C. 20006

North Central Texas Council of
Governments (ID #21)
P.O. Drawer COG
Arlington, Texas 76011

Houston-Galveston Area Council
of Governments (ID #22)
P.O. Box 22777
Houston, Texas 77027

Massachusetts Dept. of Transportation (ID #23)
ATTN: Transportation Planning Dept.
One Ashburton Place
Boston, Massachusetts 02108

State Dept. of Transportation (ID #24)
ATTN: Director of Transportation
Planning and Research
1035 Parkway Avenue
Trenton, N.J. 08635

New York Dept. of Transportation (ID #25)
ATTN: Director of Program Planning
and Management Group
1220 Washington Avenue
Albany, N.Y. 12232

Department of Transportation (ID #26)
ATTN: Office of Transportation
Presidential Building
415-12th Street, N.W.
Washington, D.C. 20004

Maryland Department of
Transportation (ID #27)
ATTN: Division of Transportation
Planning and Development
P.O. Box 8755
Baltimore, Maryland 21240

Pennsylvania Department of Transportation
and Safety Building (ID #28)
ATTN: Deputy Secretary for Planning
Commonwealth and Foster Street
Harrisburg, PA 17120

Florida Dept. of Transportation (ID #29)
ATTN: Director of Planning
Haydon Burns Building
605 Swannee Street
Tallahassee, Florida 32301

Georgia Dept. of Transportation (ID #30)
ATTN: Director Planning and Programming
2 Capital Square
Atlanta, GA 30334

Illinois Dept. of Transportation (ID #31)
ATTN: Planning Division
2300 South Dirksen Parkway
Springfield, Illinois 62764

Ohio Dept. of Transportation (ID #32)
ATTN: Transportation Planning
25 South Front Street
Columbus, Ohio 43216

California Dept. of Transportation (ID #33)
ATTN: Deputy Director for Planning
and Programing
1120 N. Street
Sacramento, CA 95814

Oregon Dept. of Transportation (ID #34)
ATTN: Assistant Director for
Policy and Planning
Transportation Building
Salem, Oregon 97310

Washington Dept. of Transportation (ID #35)
ATTN: Director of Planning
Highway Administration Building
Olympia, Washington 98504

Metropolitan Washington Council
of Governments (ID #37)
1895 EYE Street N.W.
Washington, D.C. 20006

Michigan Dept. of Transportation (ID #36)
ATTN: Deputy Director Transportation
Planning
State Highway Building
P.O. Box 30050
Lansing, Michigan 48909

Metropolitan Atlanta Rapid Transit
Authority (ID #38)
401 W. Peachtree
Atlanta, Georgia 30808

The Mass Transit Administration of
Maryland (ID #39)
109 E. Redwood St.
Baltimore, Maryland 21202

The Massachusetts Bay Transportation
Authority (ID #40)
50 High Street
Boston, MA 02110

The Niagara Frontier Transportation
Authority (ID #41)
P.O. Box 5008
Buffalo, N.Y. 14205

Port Authority Trans-Hudson (ID #48)
1 World Trade Center
New York, NY 10048

Metropolitan Transportation Authority (ID #49)
347 Madison Avenue
New York, NY 10017

New York City Transit Authority (ID #50)
370 Jay Street
Brooklyn, NY 11201

The Southeastern Pennsylvania
Transportation Authority (ID #52)
200 W. Wyoming Avenue
Philadelphia, PA 19140

Washington Metro. Area Transit
Authority (ID #60)
600 Fifth St. N.W.
Washington, D.C. 20001

The Regional Transp. Auth. (ID #42)
300 North State Street
Chicago, IL 60610

The Chicago Transit Auth. (ID #43)
Box 3555 Merch Mart
Chicago, IL 60654

The Greater Cleveland Regional
Transit Authority (ID #44)
615 West Superior
Cleveland, OH 44115

The Southeastern Michigan
Transportation Authority (ID #45)
P.O. Box 33
Detroit, Michigan 48226

Metrorail (ID #46)
Metropolitan Dade Cty. Transit Agency
911 Courthouse
Miami, FL 33130

New Jersey Transit Corp. (ID #47)
95 Orange Street
P.O. Box 720
Newark, NJ 07102

The Tri-County Metro. Transportation
District (ID #55)
4012 SE 17th Avenue
Portland, OR 97202

Metropolitan Transit Develop. Board (ID #56)
620 C Street
San Diego, CA 92101

Staten Island Rapid Transit Operating
Authority (ID #51)
25 Hyait Street
Staten Island, NY 10301

San Francisco-Bay Area Rapid
Transit District (ID #57)
300 Madison Street
Oakland, CA 94607

Seattle Municipal Transit Dept. (ID #59)
821 Second Avenue
Seattle, Washington 98164

Delaware River Port Authority (ID #53)
Franklin Br Plaza
Camden, N.J. 08102

The Port Authority of Allegheny County (ID #54)
Beavers and Island Avenue
Pittsburgh, PA 15219

Toronto Transit Commission (ID #63)
1900 Yonge Street
Toronto Ontario, Canada M4S 1Z2

City of Calgary, Transportation Dept. (ID #61)
LRT Division
Box 2100
Calgary Alberta, Canada T2P 2M5

City of Edmonton, Transportation Planning Board (ID #62)
10th Floor
Center Plaza 9803-102A Avenue
Edmonton Alberta, Canada J5J 3A3

San Francisco Municipal Railway (ID #58)
949 Presidio Avenue
San Francisco, CA 94114

Listing of Contacted Organizations by State or Province and Agency Type.

State or Province:	Urbanized Area:	Agency Type:	ID No.
California	Oakland	Transit Agency or Operator	57
California	San Diego	Transit Agency or Operator	56
		City Planning Org. or Adm.	18
California	San Francisco	Transit Agency or Operator	58
		Regional Council or Comm.	17
		City Planning Org. or Admin.	16
		State DOT or Admin.	33
Canada (Alberta)	Calgary	Transit Agency or Operator	61
Canada (Alberta)	Edmonton	City Planning Org. or Admin.	62
Canada (Ontario)	Toronto	City Planning Org. or Admin.	63
D.C.	Washington	Transit Agency or Operator	60
		Regional Council or Comm.	20
		Regional Council or Comm.	37
		Other	26
Florida	Miami	Transit Agency or Operator	46
		Regional Council or Comm.	10
		City Planning Org. or Admin.	11
Florida	Tallahassee	State DOT or Admin.	29
Georgia	Atlanta	Transit Agency or Operator	38
		Regional Council or Comm.	1
		State DOT or Admin.	30
Illinois	Chicago	Transit Agency or Operator	42
		Transit Agency or Operator	43
		Regional Council or Comm.	7
Illinois	Springfield	State DOT or Admin.	31
Massachusetts	Boston	Transit Agency or Operator	40
		Regional Council or Comm.	4
		Regional Council or Comm.	5
		State DOT or Admin.	23
Maryland	Baltimore	Regional Council or Comm.	2
		Other	39
		State DOT or Admin.	3
		State DOT or Admin.	27
Michigan	Detroit	Transit Agency or Operator	45
		Regional Council or Comm.	9
Michigan	Lansing	State DOT or Admin.	36
New Jersey	Newark	Transit Agency or Operator	47
New Jersey	Trenton	State DOT or Admin.	24
New York	Albany	State DOT or Admin.	6
New York	Buffalo	Transit Agency or Operator	41
New York	New York	Transit Agency or Operator	48
			49
			50
			51
			25
Ohio	Cleveland	Transit Agency or Operator	44
			8
Ohio	Columbus	State DOT or Admin.	32
Oregon	Portland	Transit Agency or Operator	14
			55
			15

Listing of Contacted Organizations by State or Province and Agency Type (Cont'd).

State or Province:	Urbanized Area:	Agency Type:	ID No.
Oregon	Salem	State DOT or Admin.	34
Pennsylvania	Harrisburg	State DOT or Admin.	28
Pennsylvania	Philadelphia	Transit Agency or Operator	52
			53
			12
Pennsylvania	Pittsburgh	Transit Agency or Operator	54
			13
Texas	Arlington	Regional Council or Comm.	21
Texas	Houston	Regional Council or Comm.	22
Washington	Seattle	Regional Council or Comm.	19
			59
			35

Listing of Contacted Organizations by City or Urbanized Area and Agency Type.

Urbanized Area:	State or Province:	Agency Type:	ID No.
Albany	New York	State DOT or Admin.	6
Arlington	Texas	Regional Council or Comm.	21
Atlanta	Georgia	Transit Agency or Operator	38
			1
			30
Baltimore	Maryland	Regional Council or Comm.	2
			39
			3
			27
Boston	Massachusetts	Transit Agency or Operator	40
			4
			5
			23
Buffalo	New York	Transit Agency or Operator	41
Calgary	Canada (Alberta)	Transit Agency or Operator	61
Chicago	Illinois	Transit Agency or Operator	42
			43
			7
Cleveland	Ohio	Transit Agency or Operator	44
			8
Columbus	Ohio	State DOT or Admin.	32
Detroit	Michigan	Transit Agency or Operator	45
			9
Edmonton	Canada (Alberta)	City Planning Org. or Admin.	62
Harrisburg	Pennsylvania	State DOT or Admin.	28
Houston	Texas	Regional Council or Comm.	22
Lansing	Michigan	State DOT or Admin.	36
Miami	Florida	Transit Agency or Operator	46
			10
			11
Newark	New Jersey	Transit Agency or Operator	47
New York	New York	Transit Agency or Operator	48
			49
			50
			51
			25
Oakland	California	Transit Agency or Operator	57
Philadelphia	Pennsylvania	Transit Agency or Operator	52
			53
			12
Pittsburgh	Pennsylvania	Transit Agency or Operator	54
Portland	Oregon	Transit Agency or Operator	14
			55
			15
Salem	Oregon	State DOT or Admin.	34
San Diego	California	Transit Agency or Operator	56
			18

Listing of Contacted Organizations by City or Urbanized Area and Agency Type (Cont'd).

Urbanized Area:	State or Province:	Agency Type:	ID No.
San Francisco	California	Transit Agency or Operator	58
			17
			16
			33
Seattle	Washington	Regional Council or Comm.	19
			59
			35
Springfield	Illinois	State DOT or Admin.	31
Tallahassee	Florida	State DOT or Admin.	29
Toronto	Canada (Ontario)	City Planning Org. or Admin.	63
Trenton	New Jersey	State DOT or Admin.	24
Washington	D.C.	Transit Agency or Operator	60
			20
			37
			26

APPENDIX C

TELEPHONE SURVEY OF RAILROAD COMPANIES

Contents:

APPENDIX C--TELEPHONE SURVEY OF RAILROAD COMPANIES

General

In order to gather information for this report, officials of 21 United States railroads, two Canadian railroads, and 5 passenger transportation agencies were contacted by telephone. Depending upon the railroad's involvement with public transportation, questions in Tables C-1 and C-2 were asked, and responses were tabulated. The actual survey inquiries were tailored to each situation; not all questions were applicable for each railroad. Many railroads followed up the survey by mail with additional information. Responses of some officials were more complete than those of others, due to unavailability of concise information and/or caution about releasing the information for publication. In these cases, the information was derived from other sources such as timetables and responses of the surveyed transit agencies. In some cases, conflicting information was obtained from different agencies, and were checked out and resolved when and where possible. The authors take full responsibility for any remaining inaccuracies or omissions.

Some omissions were intentional. For example, a number of transit guideways cross over freight railroads; some cross at a gentle angle and remain on the railroad right-of-way for a thousand feet or more. Nevertheless, these crossings were omitted from the survey of joint right-of-way usage since they were considered to be grade-separated crossings. Grade-separated crossings would not normally be handled in the same manner as parallel joint right-of-way use and were considered to be outside the purpose or intent of this study. Transit projects which were parallel to existing railroads but outside the right-of-way were also excluded from the telephone survey.

Results are summarized in Table C-3. Note: In the Freight RR use column, "Light" is defined as 4 or fewer freight trains per day total (both ways), "Medium" is defined as 5 to 8 freight trains per day, and "Heavy" is defined as 9 or more freight trains per day.

Table C-1: Telephone Survey Questions for Railroads with Joint Transit Usage on Rights-of-Way

I. LAND QUESTIONS:

A. Width of original and remaining right-of-way?
B. How was land obtained by transit agency?
C. Was compensation fair?
D. Required clearances (please be specific)?
E. Were any grade crossings separated and/or closed as a result of the new transit operation?

II. OPERATIONAL QUESTIONS:

A. Problems during construction?
B. Were railroad tracks moved?
C. Are/were any interchange tracks present? How operated? How are they protected?
D. Are there any joining sidings/operations? Problems?
E. Effects of transit on railroad signal system? Who paid to fix?
F. Railroad dispatching problems due to transit?
G. Any safety problems existing/possible?
H. Did the presence of transit "block off" need for present or future railroad expansion?
I. Was any railroad traffic diverted due to transit construction temporarily or permanently?
J. Has there been any increase in vandalism or other public problems due to the presence of the transit system?
K. Have there been any positive/negative effects on operating speed?
L. Do any main lines cross transit? If so, how protected?
M. Do industrial spurs cross transit? If so, how switched?

III. COOPERATION QUESTIONS:

A. Was acquisition of land by the transit agency friendly?
B. Did the transit operation cost the railroad? Was reimbursment fair?
C. Is liasion maintained between the transit agency & the railroad?
D. Does transit bureaucracy interfere with railroad interests?

Table C-2: Telephone Survey Questions for Commuter Operations over Existing Freight Railroads.

I. LAND and EQUIPMENT ACQUISITION QUESTIONS:

A. Was the commuter line purchased or leased? Is service purchased?
B. How obtained from the railroad?
C. How was funding obtained by the transit agency?
D. Was compensation fair?
E. Were freight operating rights retained by the railroad?
F. What rehabilitation/new facilities were needed? What were the costs?
G. Were any grade crossings separated/closed as a result of the new commuter operation?

II. OPERATIONAL QUESTIONS:

A. Any problems during operating changeover?
B. Are any interchange tracks present? How are they operated? How are they protected?
C. How is the line now dispatched, and by whom? Any problems?
D. Any special safety problems existing/possible?
E. Was any railroad traffic diverted due to commuter operations either temporarily or permanently?
F. What problems exist concerning vandalism and other public problems due to the commuter service? How are these problems handled?
G. Do any railroad main lines cross commuter lines? How are these protected?
H. How are industries switched, and when?
I. To which public agencies (FRA, ICC, etc.) does the railroad report?

III. GENERAL QUESTIONS:

Are there any railroad commuter lines which have parallel public transit lines or are any joining right-of-way uses planned?

Table C-3: Summary of Telephone Survey of Railroad Companies

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Owned by	Operated by	Other Comments/ Clearances
AMTRAK	Baltimore	CR	B&O	45	Subsidy	FRA/Congress	-	Std-Pass	Amtrak	B&O	By Contract with Maryland.
	Martinsburg	CR	B&O	70	Special	FRA/Congress	-	Std-Pass	Amtrak	B&O	Sunset Commuter (Special Legislation).
	Philadelphia	RRT	AMTRAK	252	Trk Rigts	FRA	-	RRT	SEPTA	SEPTA	SEPTA operates over AMTRAK trks.
AT&SF	San Francisco	RRT	BART	0	Purchase	-	None	RRT	BART	BART	Lite-use line now abandoned; Row Sold. 23.5' vert
	S. Cal.	-	-	-	-	-	-	-	-	-	Contacted due to San-Diego to LA High Speed Rail Proposal. AT&SF does not favor.
BALTIMORE & OHIO	Baltimore Wash.	CR	B&O	37	Service	MD DOT FRA	Heavy	CR	MD B&O	B&O	
	Washington DC. to Martinsburg	CR	B&O	70	Service	MD DOT ICC	Heavy	CR	B&O	B&O	MD portion subsidized, W. Va. unfunded & ICC Regulated.
	Pittsburg	CR	B&O	18	Service	FRA PAAC	Heavy	CR	B&O	B&O	Push-pull, funded by Port Authority of Allegheny County.
	Wash DC	RRT	WMATA	6.2	*	-	Heavy	RRT	WMATA	WMSTA	2 main tracks spread; METRO in center.
BOSTON & MAINE	Boston	CR	MBTA	242	Sale Serv	FRA MBTA	Med	Std. Comm	MBTA	B&MRR	Sold to MBTA; operated by B&M.
	Boston	RRT	MBTA	5	Sale	-	Med	RRT	MBTA	MBTA	RRT line reduced clearances; new Hi-wide route built. RR changed to single track.

Table C-3: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Owned by	Operated by	Other Comments/ Clearances.
BURLINGTON NORTHERN	Chicago	CR	BN	37.7	Service	FRA RTA	Heavy	CR	Dist	BN	3 track (CTC Main Line, Freight is Time-Restricted.
	Seattle	LRT	BN	2	Trk Rights	FRA	Light	LRT	City	Cty	Tourists-Time separated. 23' to catenary.
CANADIAN NATIONAL	Montreal	CR	CN	20	Service	Ministry of Transport/ Province/ Local Govt.	Light	CR	City	CN	3 yrs Negotiation
	Toronto	CR	CP	180.7	Service		Heavy	CR	GOTRANS	CN	Model of cooperation.
	Edmonton	LRT	City	3.5	Lease		Med	LRT	City	City	CN did rail installation. Tunnel under track. Fence at stations.
CANADIAN PACIFIC	Montreal	CR	CP	40	Service	Ministry of Transport Province/ Local Govt.	Heavy	CR	City	CP	
	Toronto	CR	CP	31.2	Service		Heavy	CR	City	CP	Freight Time-Restricted.
	Vancouver	LRT	City	1	Lease		Heavy	LRT	City	City	Under CP-owned Buildings already on columns. 84" Horiz, 26' vertical clearance. Fence, signal changes.
	Calgary	LRT	Calgary	11	Lease		Light	LRT	City	City	14' Horizontal. Grade xing signal changes.
CHICAGO RTA	Chicago	CR	NIRC	46.9	Owned	FRA	Light	CR	NIRC	NIRC	Refers to purchase of Rock Island only - see also BN, C&NW, CSS&SB, ICG, Milw, N&W.

Table C-3: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Owned by	Operated by	Other Comments/ Clearances
CHICAGO & NORTHWESTERN	Chicago	CR	CNW	150.2	Service	FRA RTA	Heavy	CR	RTA	C&NW	Freight time restricted.
CHICAGO, SOUTH SHORE & SOUTH BEND	CHICAGO	CR	CSS&SB	90	Service	FRA RTA ICC North Indiana Comm Trans	Med	CR	RTA &	CSS&SB	Once Interurban - 2 miles of street running. Freight time restricted.
CONRAIL	None	-	Govt's	0	Purchase	-	-	-	-	-	All operations and track sold to MBTA, SEPTA, NJ Transit, Conn TA, New York, Del. DOT, MD DOT. Trackage rights retained.
	Philadelphia	RRT	SEPTA	36	Purchase	Govt's	Heavy	RRT	SEPTA	SEPTA	
FAMILY LINES	Atlanta	RRT	MARTA	4	Purchase	MARTA	Heavy	RRT	MARTA	MARTA	SCL Relocated. 20'Horizontal.
FLORIDA EAST COAST	Miami	RRT	Dade Co.	9.2	Purchase	Dade Co.	Light	RRT	County	County	12' Horizontal, 23' vertical
GO TRANSIT	Toronto	CR	GOTRANS	211.9	Service	Province/Min of Transport	Heavy	CR	GOTRANS	GOTRANS	31.2 miles on CP; 180.7 miles on CN
GRAND TRUNK WESTERN	Detroit	CR	GTW	25.5	Service	FRA SEMTA	Med	CR	SEMTA	GTW	
ILLINOIS CENTRAL GULF	Chicago	CR	ICG	77.8	Service	FRA RTA	None	CR	RTA & Distr	ICG	Special Commuter tracks not shared with freight on 3 Electric Lines. One diesel Line.
LONG ISLAND RR	New York Long Island	CR	LIRR	320	Subsidy	FRA NY ICC METRO		CR	LIRR	LIRR	Owned by NY State. Passenger service is first. Common Carrier. Problems include Vandalism & Suicides.

Table C-3: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Owned by	Operated by	Other Comments/ Clearances
MILWAUKEE	Chicago	CR	Milw	80.7	Service	FRA RTA	Light	CR	NIRC	NIRC	No Switching during rush hour.
NORFOLK & WESTERN	Chicago	CR	N&W	23	Service	FRA RTA	Light	CR	RTA	N&W	Freight Time Restricted.
PITTSBURG & LAKE ERIE	Pittsburg	CR	P&LE	40	Subsidy	FRA ICC	Heavy	CR	P&LE	P&LE	Subsidy from State of PA & Beaver County run at a loss, but provides good will.
SAN DIEGO & ARIZONA EASTERN	San Diego	LRT	METRO	17	RR TRK Rights	FRA CAL PUC	Med	LRT	City	City	Only LRT/FRT RR Joint Operations. See special RR Listings.
SEMTA	Detroit	CR	GTW	25.5	Contract	FRA SEMTA	Med	CR	SEMTA	SEMTA	
SE.PA.TRANS. AUTHORITY	Philadelphia	CR	AMTRAK	252	Trk Rights	ICC	Light	CR	SEPTA	SEPTA	90 MPH Max. Portion operates over AMTRAK tracks.
SOUTHERN	Atlanta	RRT	MARTA	12.5	Purchased	MARTA	Heavy	RRT	MARTA	MARTA	One corridor lost 1 track. Tracks shifted. Shoo-fly needed during construction. 19.5' Horiz., 23' Vert. clearance.
	Washington DC	RRT	WMATA	2	Purchased	WMATA	Heavy	RRT	WMATA	WMATA	
SOUTHERN PACIFIC	San Francisco	CR	SP	47	Contract	FRA CALDOT	Heavy	CR	SP	SP	
	Portland	LRT	ODOT	3	Purchase	FRA CALDOT	None	LRT	City	City	Portland Traction (jointly owned by SP & UP). 3 miles closed & sold for LRT line.

Table C-3: Summary of Telephone Survey of Railroad Companies (Cont'd.)

Railroad	Location City	Transit Type	Transit Trk Owned	Route Miles	Type of Contract	Regulatory Agencies	Freight RR Use	Equipment (Transit)	Owned by	Operated by	Other Comments/ Clearances
UNION PACIFIC	Portland	LRT	ODOT	5	Purchase	FRA ODOT	Med	LRT	City	City	Between RR & Freeway. Special Drainage. 21' horiz. clearance.
WESTERN PACIFIC	Oakland	RRT	BART	30	Purchase	FRA CALDOT	Med	BART	BART	BART	Slow orders, shoo-flys, spur track removed. 22.5 vert.
YAKIMA VALLEY TRANSPORTATION	Yakima	LRT	YVT	10+	Track rts.	FRA	Light	Trolleys	City	City	Tourist Attraction Trolley-time separated.

Special Situations by Railroads

While general information about each railroad contacted is summarized in Table C-3, some railroads reported special situations or features of their involvement with public transit which could not be adequately presented in the table. The special situations are summarized below and presented by responding railroad.

AMTRAK Legislation does not allow Amtrak to operate commuter trains unless 100% reimbursed for losses. (Special legislation was needed to enable operation of a commuter run between Washington, D.C. and Martinsburg, West Virginia.) The commuter run between Washington D.C. and Baltimore is subsidized by the State of Maryland. Amtrak now owns the Northeast Corridor tracks; SEPTA has trackage rights over a portion of this corridor.

B&O operates a Washington, D.C. to Martinsburg, West Virginia commuter run. The portion in Maryland is subsidized by the State of Maryland; the West Virginia portion, 21 miles, is operated at partial B&O expense under ICC regulations. West Virginia and UMTA matching funds are currently providing some subsidy; losses may be recovered in 1983 by revenues. During construction of 6.2 miles of the Washington D.C. Metro, a portion of the two B&O main tracks were spread to put Metro between, causing "slow orders" and B&O tracks being out of service during construction. Four more miles of B&O tracks are planned for use by Metro.

Boston & Maine sold trackage and equipment to the MBTA and now operates multiple lines totaling 242 miles under contract. Trackage is owned by the B&M over the state lines. Construction of 5 miles of parallel subway required single-tracking the main line and moving track 10 to 20 feet to obtain adequate ROW width. Clearances for high-wide loads were reduced to such a degree that the MBTA had to reconstruct an alternative B&M main line to allow high-wide loads continued movement in and out of Boston. Construction took track out of service and necessitated a 1-mile shuttle. One portion of the Southwest Corridor passes through a cut, with a park built over the cut in a high-crime area which, it is feared by the railroad officials, may attract bored youths resulting in vandalism and accidents.

Burlington Northern has a 2-mile Tourist Trolley streetcar operating over a lightly-used branch on the waterfront in Seattle, Washington. LRT operates only during the day, while BN operates at night, once or twice per month. Nevertheless, the overhead catenary causes problems with high-wide load clearances.

Canadian Pacific has leased its right-of-way for use by Vancouver for a UTDC Linear Induction Advanced LRT, including land under CP-owned buildings already on columns. LRT elevated structures must clear 26' above top of CP rail. Due to tight horizontal clearances, 8' 4 1/4" horizontal clearances (from track centerline) are allowed; widened clearances are required on curves.

Chicago RTA has taken over responsibility for Chicago area commuter operations (436.3 route miles total) in association with the following agencies:

> NIRC (Northeastern Illinois Railroads Corporation), which is a publicly-owned commuter railroad agency, providing service over the Milwaukee and owning the old Rock Island. Freight service over the old Rock Island is provided under agreement with the Chessie System and the La Salle Bureau County railroad.
>
> CSSMTD (Chicago South Suburban Mass Transit District), which owns some of the equipment used on the Illinois Central Gulf (ICG).
>
> NWSMTD (North West Suburban Mass Transit District), which owns some of the equipment used on the Milwaukee.

WSTD (West Suburban Transit District), which owns the equipment used on the Burlington Northern (BN).

Indiana District which owns some of the equipment used on the Chicago South Shore & South Bend (CSS & SB).

Railroads involved with the Chicago RTA include the Burlington Northern (37.7 miles), Chicago and Northwestern or C&NW (148.7 miles), Chicago South Shore & South Bend (20.9 miles to Indiana border), Illinois Central Gulf (77.8 miles), Milwaukee (80.7 miles), Norfolk & Western (23.6 miles) and the old Rock Island, now the Northeastern Illinois Railroads Corporation (80.7 miles). A rush-hour curfew is imposed on freight operations, within the commuter time windows of approximately 6:30-8:30 a.m. and 4:00-6:00 p.m.

The Northeastern Illinois Railroads Corporation (NIRC) operates the Rock Island and the Milwaukee commuter services. The RTA has negotiated purchase of service from ICG and C&NW, which have cost-plus contracts with N&W and BN. In addition, the RTA subsidizes the Chicago Transit Authority (CTA) and bus companies.

Conrail has sold all commuter rail operations to MBTA (Boston), SEPTA (Philadelphia), New Jersey Transit, CTA (Connecticut), Delaware DOT, New York MTA, and Maryland DOT. They retain trackage rights, but no longer perform commuter services.

GO TRANSIT, in Toronto, has six commuter rail lines under contract; five are with Canadian National. GO TRANSIT owns the trains. The operation has been considered a model for government/railroad negotiations.

Long Island Railroad is a common carrier which puts passenger service ahead of freight service. Wholly-owned by the State of New York since 1956, the

Long Island has 715 revenue passenger runs daily during the week. Both electric and diesel propulsion are used.

Pittsburgh & Lake Erie operates a commuter run, 40 miles from Beaver Falls to Pittsburgh, at a loss over the entire length of the run under ICC regulations. The State of Pennsylvania and Beaver County provide a partial subsidy for the operation.

San Diego and Arizona Eastern is in a unique position in that it operates over trackage owned by San Diego METRO (Light Rail Transit). In 1975 the Southern Pacific wanted to abandon two San Diego lines. The abandonment was denied, and in 1979 the San Diego METRO Transportation Development Board purchased these two lines for 18 million dollars and restored the track for use by Light Rail Vehicles. The Light Rail Vehicles also operate in the street through downtown San Diego. The San Diego and Arizona Eastern Transportation Company (Kyle) operates freight service over these lines on a contract basis, which requires them to give precedence to LRT operation. They do not operate at all during the day, but operate through-freights and switching service to 20+ industries between 10:00 p.m. and 5:50 a.m. The California Public Utilities Commission (PUC) would allow joint operations at the same time - freight on one track, LRT on the other - if railroad crews were qualified on both railroad and LRT rules; but this had not been done at the time of the interview.

Joint use of trackage for freight and passenger service identified a number of problems. The railroad interlocking signals are placed low for the LRT operation. The freight railroad crosses the LRT line at three locations, under control of the METRO traffic controller who grants verbal clearance. The catenary wire must clear the top of rail by 22 feet to allow for freight operation, which is higher than that used for most LRT operations. Side clearance problems precluded high platform passenger loading of the narrower DuWag LRT vehicles. Industrial spur switches are equipped with a five minute time delay, which increases LRT safety but hinders freight switching. The line must operate under two different theories: public service vs. freight movement. Careful planning and excellent cooperation have minimized joint operational conflicts, but a number of problems still exist, as listed above.

Yakima Valley Transportation Company, in the State of Washington, allows operation of two lightweight 2-axle street cars over approximately ten miles of its electrified line on mornings, weekends, and holidays when freights are not operating. Operations are totally time-separated for safety.

Other Railroads, in addition to the railroads listed in Table C-3 which are directly involved in joint right-of-way use, the following companies, railroads and agencies were contacted and provided additional information:

Advanced Monorail Systems, Inc.
Association of American Railroads
Houston METRO
Missouri-Kansas-Texas Railroad Company
Western Maryland Railway Company

Summary of Survey

Results of this study are presented in the Section entitled "Data Collection Survey of Railroad Companies" within the text, and in Table C-3 above. The majority, 19 of the organizations, are involved in Commuter Rail Operations; 8 organizations are involved with RRT; and 4 organizations are involved with parallel LRT (without joint trackage). Three railroads operate over the same track as LRT vehicles, but two of these are "tourist trolleys." The total is different from the total of contacted agencies because some organizations are involved with more than one mode, while others are not involved with any.

From this study, the following generalizations and trends can be drawn from the responses:

1. During negotiations, railroads insist upon being "kept whole" (not being harmed financially or operationally, or being compensated fairly if harm is unavoidable - See Technical Feasibility Section of text).

2. Most railroads will cooperate with local Public Transit Authorities, provided the proposals are reasonable and compensation is fair.

3. To date, freight trains have not shared the same track at the same time with light rail vehicles. Only one identified United States railroad has this possibility, the San Diego and Arizona Eastern but safety considerations so far have kept operations time-separated, with freight trains running only at night. The San Diego and Arizona Eastern railroad waits until transit operations have ceased before running their trains and switching industries. While it would be possible to run freight trains simultaneously with the LRT vehicles (provided the California PUC requirement is met that train crews be qualified under both railroad and transit rules), this has not been done as of this date.

4. Rail Rapid Transit trains share track with railroads only in the New York City area. Some Long Island and some South Shore electrified trains use transit couplers and powered cars; while some might consider these to be RRT trains, for this report they are classed as commuter trains.

5. Railroads prefer to sell land outright for parallel transit operations, insisting upon minimum horizontal clearances (from centerline of the nearest track) of 15 feet or more and preferring other measures such as fences to protect the railroad. The Canadian Pacific right-of-way in Vancouver required clearance of only 8 feet, 4-1/4 inches on tangents but the railroad retained the land and leased to the operating agency.

6. An adjacent transitway will generally disrupt railroad operations during construction, requiring expensive slow orders and possibly construction of shoo-fly tracks to carry freight trains around the construction site. Construction may even require temporary closure of the line. The adjacent transit guideway may also require permanent signal changes. In extreme cases, existing railroad tracks may be permanently removed and/or relocated.

7. Commuter rail operations are increasingly being provided by regional transit authorities, which often purchase the rolling stock and sometimes the tracks, and then contract with the railroad to operate the service. Only the Pittsburgh and Lake Erie Railroad still operate a commuter train at a loss under ICC regulations over the complete route; even this operation is subsidized by public funds. The Baltimore and Ohio's West Virginia end of the Washington - Martinsburg run is still operated in this manner, but the east portion is operated under a service contract.

8. Currently there are no "high technology" transit modes sharing right-of-way or tracks. The most advanced parallel transit system is a linear induction LRT System which is under construction in Vancouver.

9. Negotiations usually take a number of years, requiring approvals of many railroad officials. Rapid approval of plans by local railroad officials is generally not possible.

10. Care must be taken to avoid harming local industry by restricting clearances or hindering future freight traffic growth.

11. Some railroad officials expressed concern about crime, vandalism, and public safety, especially in the northeast. These problems should be properly addressed during the rail transit planning phase.

12. While transit guideways cross over or under freight railroad tracks, no United States example currently exists of "piggybacking" a parallel guideway directly over or under railroad tracks. This design alternative, although costly, may be a viable approach to shared right-of-way usage providing that adequate clearances are maintained.

Results of this survey suggest that increased joint use of railroad right-of-way for a separate transit guideway or for a commuter operation is quite possible for some lines, provided the railroad's interests and good engineering practice are provided for, and the agreement assures that the railroad be kept whole. Shared trackage is possible but less desirable and little-used in the United States as of this writing.

APPENDIX D

LISTING OF SURVEYED TRANSPORTATION ASSOCIATIONS AND ORGANIZATIONS

APPENDIX D

Mailing addresses used in the : Survey of Transportation Associations and Organizations. (Mailed to 26 groups; returned by 12).

Air Transport Association of America
1709 New York Avenue, N.W.
Washington, D.C. 20006
Attention: Paul R. Ignatius, President

American Association of Motor Vehicle Administrators
1201 Connecticut Avenue, N.W.
Washington, D.C. 20036
Attention: Donald J. Bardell, Executive Director

American Association of State Highway and Transportation Officials
444 N. Capital Street, N.W., Suite 225
Washington, D.C. 20001
Attention: Francis B. Francois, Executive Director

American Institute for Shippers' Association
1100 17th Street, N.W.
Suite 309
Washington, D.C. 20036
Attention: Jean V. Murphy, Executive Vice President

American Public Transit Association
1225 Connecticut Avenue, N.W., Suite 200
Washington, D.C. 20036
Attention: Molly Kuntz, Planning and Policy

American Short Line Railroad Association
2000 Massachusetts Avenue, N.W.
Washington, D.C. 20036
Attention: P.H. Croft, President

American Society of Traffic and Transportation
P.O. Box 33095
Louisville, Kentucky 40232
Attention: Carter M. Harrison, Executive Director

American Trucking Association
1616 P Street, N.W.
Washington, D.C. 20036
Attention: Bennett C. Whitlock, Jr., President

Association of American Railroads
1920 L Street, N.W.
Washington, D.C. 20036
Attention: William H. Dempsey, President

Association of Interstate Motor Carriers
P.O. Box 225
Webster, New York 14580
Attention: S. Michael Richards, Executive Officer

Commuter Airline Association of America
1101 Connecticut Avenue, N.W.
Washington, D.C. 20036
Attention: Duane Ekedahl, President

Equipment Interchange Association
1616 P Street N.W.
Washington, D.C. 20036
Attention: Kenneth R. Hauck, Managing Director

Freight Forwarders Institute
1055 Thomas Jefferson St., N.W.
Washington, D.C. 20007
Attention: Robert J. Frulla, Executive Vice President

Highway Users Federation for Safety and Mobility
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036
Attention: Peter G. Koltnow, President

Institute of Transportation Engineers
525 School Street, S.W. Suite 410
Washington, D.C. 20024
Attention: Thomas W. Brahms, Executive Director

National Association of Regulatory Utility Commissioners
12th Street and Constitution Avenue, N.W.
Suite 1102, P.O. Box 684
Washington, D.C. 20044
Attention: Paul Rodgers, Administrative Director and General Council

National Association of Shippers Advisory Boards
1920 L Street N.W. Rm 321
Washington, D.C. 20036
Attention: Martha McManus Kappel
Director, Shipper Relations

National Association of Women Highway Safety Leaders
7206 Robin Hood Drive
Upper Marlboro, Maryland 20870
Attention: Agnes Beaton, Executive Director

North American Trackless Trolley Association
2125 Bashford Manor Lane
Louisville, Kentucky 40218
Attention: Harry R. Porter, President

Railway Progress Institute
700 N. Fairfax Street
Alexandria, Virginia 22314
Attention: Robert W. Smith, President

Slurry Transport Association
490 L'Enfant Plaza E. S.W., Suite 3210
Washington, D.C. 20024
Attention: David A. Skedgell, President

The National Industrial Traffic League
1090 Vermont Avenue, N.W., Suite 410
Washington, D.C. 20005
Attention: James E. Bartley, Executive Vice President

Traffic Clubs International
1040 Woodcock Road
Orlando, Florida 32803
Attention: Charles T. Harper, Jr., Executive Director

Transportation Association of America
1100 17th St. N.W.
Washington, D.C. 20036
Attention: Paul J. Tierney, President

Transportation Data Coordinating Committee
1101 17th Street N.W., Suite 708
Washington, D.C. 20036
Attention: Edward A. Guilbert, President

Western Highway Institute
1200 Bay Hill Drive
San Bruno, California 94066
Attention: Byron L. Geuy, Executive Director

APPENDIX E

INVENTORY OF TEXAS RAILROAD FACILITIES

Contents:

APPENDIX E: INVENTORY OF TEXAS RAILROAD FACILITIES

Overview of Rail Facilities

The railroad inventory of Texas consists of 30 operating railroads, including the 7 Class I carriers listed below.

1. Atchison, Topeka & Santa Fe Railway Company (ATSF);
2. Burlington Northern Railway Company (BN);
3. Kansas City Southern Railway Company (KCS);
4. Missouri-Kansas-Texas Railroad Company (MKT);
5. Missouri Pacific Railroad Company (MP)*;
6. St. Louis Southwestern Railway Company (SSW); and,
7. Southern Pacific Transportation Company (SP).

*Merged with the Union Pacific and Western Pacific September 1, 1982 and approved by the Interstate Commerce Commission on October 20, 1982.

The above Class I carriers are classified this way because of the Freight Classification Procedure of the Interstate Commerce Commission (ICC). Class I railroads are those having annual operating revenues of $50 million or more. Class II railroads show annual operating revenues of less than $50 million but more than $10 million; Class III railroads have revenues less than $10 million per year.

An interesting note on ownership is that many of the Class II and III railroads are owned by Class I railroads. As an example, Missouri Pacific is the parent company of the Texas and Pacific System which owns Abilene and Southern Railroad, Texas-New Mexico Railroad, and Weatherford, Mineral Wells and Northwestern Railroads.

Class I railroads operate on some 13,081 miles of track within the State of Texas. Table E-1 provides operating characteristics for each of the 7 Class I railroads. The table presents both the 1981 systemwide

Table E-1. Class I Carrier Operating Characteristics

	ATSF			BN*		
	System 1981	Texas 1981	% System In Texas	System 1981	Texas 1981	% System In Texas
Mileage	12,366	3,452	27.9	27,374	1,374	5.0
Total revenue (000)	2,411,314	635,992	26.3	4,294,636	204,710	4.7
Total expense (000)	2,300,747	518,174	22.5	4,009,408	179,471	4.4
Net Income (000)	110,567	117,818	---	285,408	25,239	8.8
Revenue Car Loadings Originating and received from connections	1,745,938	1,124,233	64.3	3,714,084	434,779	11.7
Tons of revenue freight carried	122,597,000	65,283,635	53.2	273,559,208	34,250,846	12.5
Net ton miles (000)	77,325,590	21,395,550	27.6	166,934,083	10,483,486	6.2
Revenue per mile	194,995	184,239	NA	156,887	148,988	NA
Expense per mile	186,054	150,108	NA	146,461	130,619	NA
Net income per mile	8,941	34,130	NA	10,426	18,369	NA

	MP			SSW		
	System 1981	Texas 1981	% System In Texas	System 1981	Texas 1981	% System In Texas
Mileage	11,272	3,322	29.4	2,384	643	26.9
Total revenue (000)	1,957,068	600,721	30.6	440,197	76,376	17.3
Total expense (000)	1,808,745	509,199	28.1	379,196	70,053	18.4
Net Income (000)	148,323	91,522	61.7	61,001	6,323	10.3
Revenue Car Loadings Originating and received from connections	1,898,391	925,058	48.7	492,560	277,525	56.3
Tons of revenue freight carried	132,222,000	57,385,752	43.4	25,615,000	12,854,741	50.1
Net ton miles (000)	62,117,313	18,086,769	29.1	13,282,810	2,409,827	18.1
Revenue per mile	173,622	180,831	NA	184,646	118,781	NA
Expense per mile	160,464	153,281	NA	159,059	108,947	NA
Net income per mile	13,159	27,550	NA	25,588	9,834	NA

*BN includes the Fort Worth and Denver Railroad

Source: Texas Railroads 1982-1983 Update-Transportation Division, Railroad Commission of Texas, (March, 1983)

Table E-1. Class I Carrier Operating Characteristics (page 2 of 2)

	KCS			MKT		
	System 1981	Texas 1981	% System In Texas	System 1981	Texas 1981	% System In Texas
Mileage	1,663	293	17.6	2,174	1,015	46.6
Total revenue (000)	327,531	68,698	20.9	274,413	138,140	50.6
Total expense (000)	300,889	47,139	15.6	273,206	103,140	37.7
Net Income (000)	26,642	21,559	80.9	1,207	35,829	---
Revenue Car Loadings Originating and received from connections	570,396	385,160	67.5	346,657	279,614	80.6
Tons of revenue freight carried	38,385,630	30,157,500	78.5	25,976,108	21,373,913	82.2
Net ton miles (000)	9,979,671	1,417,721	14.2	8,417,190	4,797,414	56.9
Revenue per mile	196,952	234,464	NA	126,244	136,915	NA
Expense per mile	180,931	160,883	NA	125,670	101,616	NA
Net income per mile	16,020	73,580	NA	5,550	35,300	NA

	SP		
	System 1981	Texas 1981	% System In Texas
Mileage	10,962	2,952	26.9
Total revenue (000)	2,399,423	676,904	28.2
Total expense (000)	2,351,579	637,124	27.0
Net Income (000)	47,844	39,780	83.2
Revenue Car Loadings Originating and received from connections	1,882,392	869,158	46.2
Tons of revenue freight carried	117,249,000	53,915,194	45.9
Net ton miles (000)	65,184,678	20,643,893	31.6
Revenue per mile	218,886	229,304	NA
Expense per mile	214,521	215,828	NA
Net income per mile	4,365	13,476	NA

Source: Texas Railroads 1982-1983 Update-Transportation Division, Railroad Commission of Texas, (March 1983) (throughout the U.S.) characteristics and the 1981 Texas only characteristics; the percentage of the railroads' operations occurring in Texas are also shown. The 1981 operating characteristics summarized for the Class I companies include:

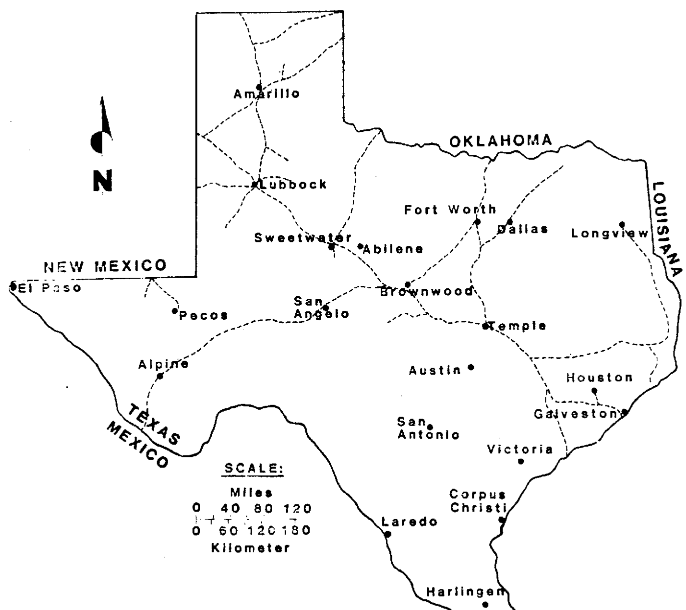
- Route Mileage
- Total Revenue
- Total Expenses
- Net Income
- Revenue Car Loadings
- Tons of Revenue Freight
- Net Ton Miles
- Revenue Per Mile
- Expenses Per Mile
- Net Income Per Mile

Historical Background and Service Areas of Class I Railroads

Atchison, Topeka and Santa Fe Railway (ATSF)

The Atchison, Topeka and Santa Fe Railway is owned by Santa Fe Industries Inc. which was incorporated in Kansas in 1895. The railroad provides services to North, Central, South, East and West Texas. The ten major metropolitan areas (SMSA's) served in Texas are Amarillo; Beaumont-Port Arthur-Orange; El Paso; Dallas-Fort Worth; Galveston-Texas City; Killeen-Temple; Houston; Longview-Marshall; Lubbock; and San Angelo. Figure E-1 shows the Atchison, Topeka and Santa Fe Railway Service areas in Texas.

ATCHISON TOPEKA & SANTA FE RAILWAY COMPANY



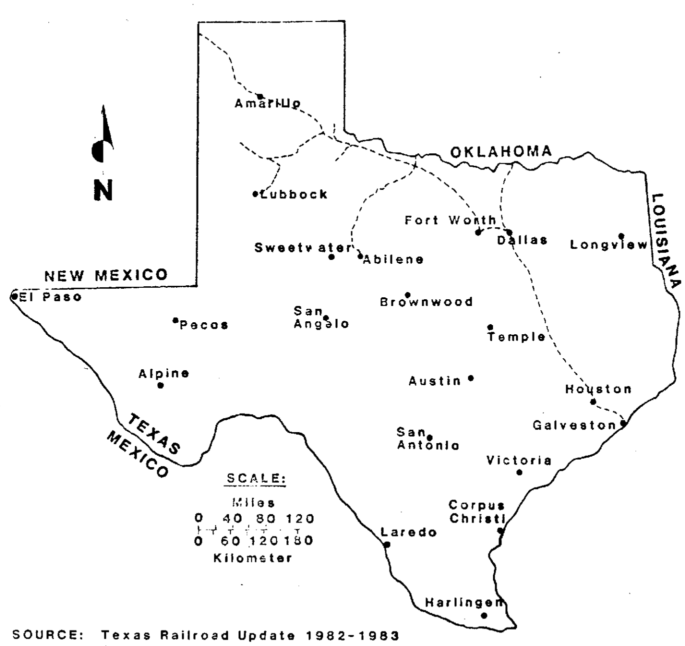
SOURCE: Texas Railroad Update 1982-1983
Transportation Division
Railroad Commission of Texas

Figure E-1: ATSF Rail Service In Texas

Burlington Northern Railway (BN)

The Burlington Northern was formed in 1970 after the Supreme Court approval of the merger of the Great Northern, the Northern Pacific, and the Chicago, Burlington & Quincy Railroads (Ogburn, 1977). The Burlington Northern Railway Operation in Texas is represented by three further rail mergers with the Burlington Northern the St. Louis San Francisco Railway Co (SLSF), the Quannah, Acme and Pacific Railway Company (QA&P) and, on January 1, 1983, the Fort Worth and Denver Railway Company (FWD). The eight SMSA's served by the Burlington Northern are Dallas-Fort Worth; Tyler; Abilene; Amarillo; Galveston-Texas City; Houston; Lubbock; and Wichita Falls. Figure E-2 shows the service area of the Burlington Northern Railway.

BURLINGTON NORTHERN



SOURCE: Texas Railroad Update 1982-1983
Transportation Division
Railroad Commission of Texas

Figure E-2: BN Rail Service in Texas

Missouri Pacific Railroad Company (MP)

The Missouri Pacific Company, often referred to as the "MoPac", received approval from the Interstate Commerce Commission (ICC) on October 20, 1982, to merge with the Union Pacific and the Western Pacific Railroad Companies. The consolidation of these three railroads form the third largest railroad in the United States by track miles (22,800) and the second largest by revenue ($4.2 billion). The new company will be managed by a new entity, Pacific Rail Systems, Inc. headquartered in Omaha, Nebraska.

The Missouri Pacific was originally chartered in Missouri in 1849 as the Pacific Railroad Company to construct a railroad line from St. Louis to the Western border of Missouri (Peat, Marwick, Mitchell & Co., 1980). In 1876, after hard times, the railroad was acquired and reorganized as the Missouri Pacific Railway. It was incorporated in Missouri in 1917, taking over the former Missouri Pacific Railway Company and the St. Louis Iron Mountain & Southern Railway Company.

The Missouri Pacific is the second largest railroad by route miles (3,322 miles) operating in Texas. It provides services to the following 22 SMSA's: Abilene; Austin; Beaumont-Port Arthur-Orange; Brownsville-Harlingen-San Benito; Bryan-College Station; Corpus Christi; El Paso; Dallas-Fort Worth; Galveston-Texas City; Killeen-Temple; Houston; Laredo; Longview-Marshall; McAllen-Pharr-Edinburg; Midland; Odessa; San Antonio; Sherman-Denison; Texarkana; Tyler; Victoria; and Waco. Approximately 29 percent of the Missouri Pacific System route miles are located in Texas.

The "MoPac" also owns several Class III railroads in Texas. Among these are the Texas and Pacific System which includes the Texas and Pacific Railroad, Abilene and Southern Railroad, and Texas-New Mexico Railroad. The other Class III road is the Weatherford, Mineral Wells and Northwestern Railroad.

The Texas & Pacific provides a route from Denison to Fort Worth to El Paso in West Texas, and from Fort Worth to Texarkana and Marshall in East Texas. The Texas-New Mexico provides a link from the Texas and Pacific line at Monahans, which is midway between Pecos and Odessa, to New Mexico. The Weatherford, Mineral Wells and Northwestern is a short-line that connects Mineral Wells and Weatherford. Figure E-3 shows the service area of the Missouri Pacific Railroad Company.

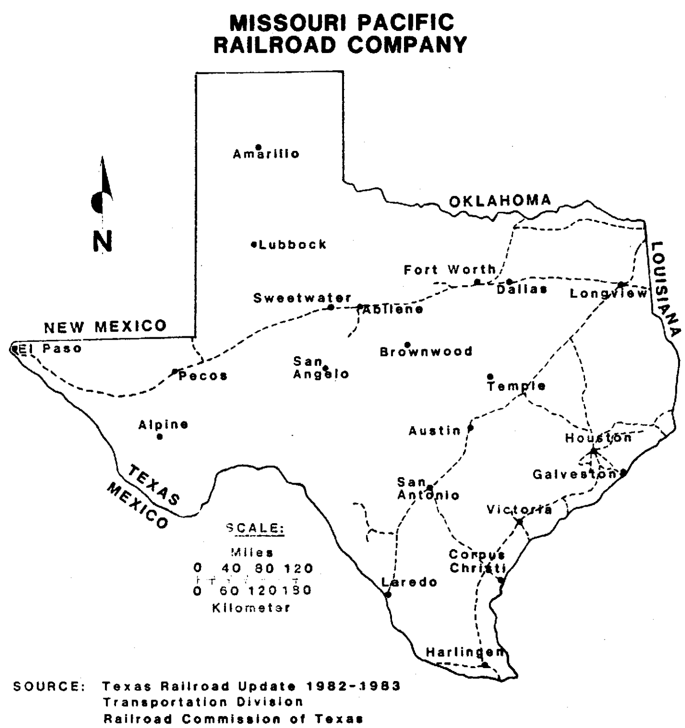


Figure E-3: MP Rail Service In Texas

St. Louis Southwestern Railway Company (SSW)

The St. Louis Southwestern Railway Company is a wholly owned subsidiary of the Southern Pacific Transportation Company. The railway is often called the "Cotton Belt" because of its operation from North Texas, through Arkansas, and Missouri to St. Louis. Figure E-4 shows the service area of the St. Louis Southwestern Railway Company.

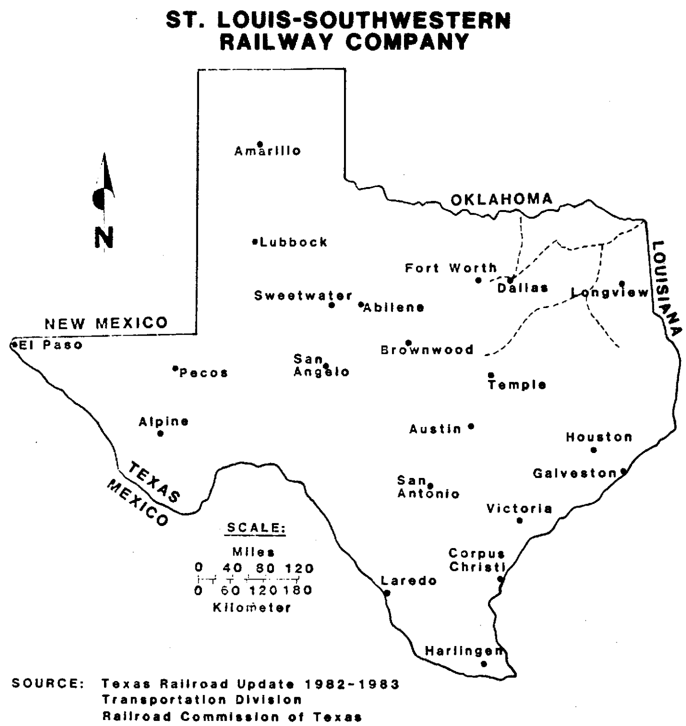


Figure E-4: SSW Rail Service In Texas

The Kansas City Southern Railway (KCS)

The Kansas City Southern Railway is controlled by Kansas City Southern Industries, Inc. It was incorporated in Missouri in 1900 after the Kansas City, Pittsburg & Gulf Railroad failed. The KCS and its subsidiaries have the shortest rail routes from Kansas City to Port Arthur, providing an outlet to the Gulf of Mexico for products produced in middle America and a return route for products produced in the petrochemical industries along the

Texas coast. The three SMSA's served by Kansas City Southern Railroad are: Beaumont-Port Arthur-Orange; Dallas-Fort Worth; and Texarkana. Figure E-5 shows the service area of the Kansas City Southern Railway.

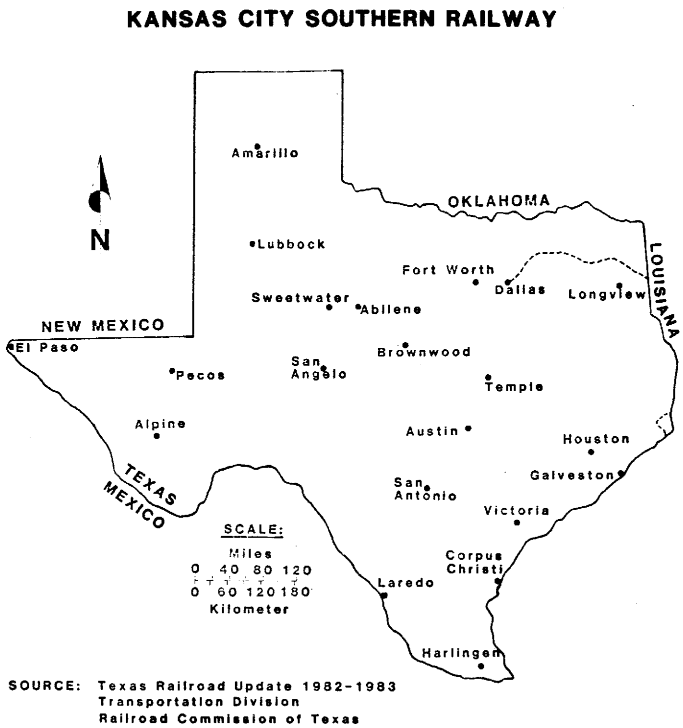


Figure E-5: KCS Rail Service In Texas

Missouri-Kansas-Texas Railroad Company (MKT)

The Missouri-Kansas-Texas Railroad Company is best known as the "Katy" railroad. It was originally incorporated in Kansas in 1865 as the Union Pacific Railway Company, Southern Branch. Of particular interest is the fact that the MKT receives more traffic from its rail connections than it originates. The nine SMSA's served by MKT are Austin; Dallas-Fort Worth; Galveston-Texas City; Killeen-Temple; Houston; San Antonio; Sherman-Denison;

Waco; and Wichita Falls. Figure E-6 shows the service area of the Missouri-Kansas-Texas Railroad Company.

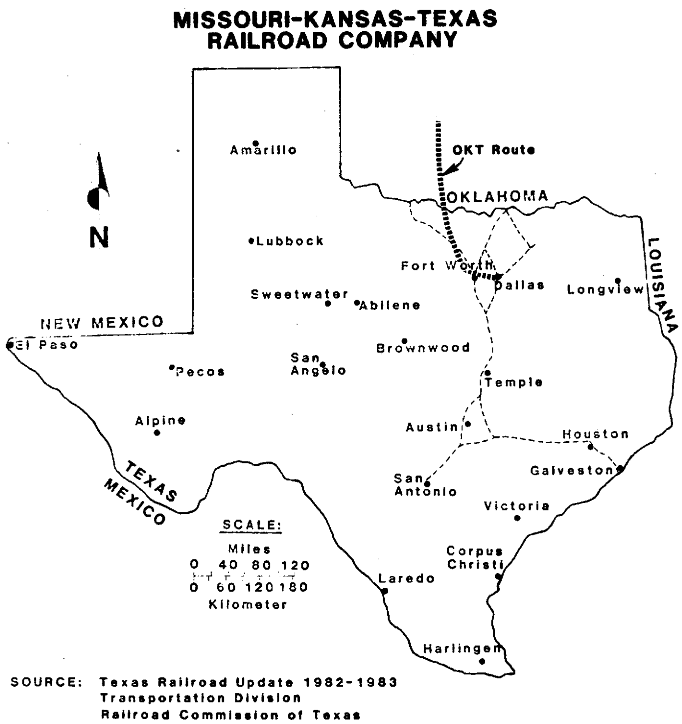


Figure E-6: MKT Rail Service In Texas

Southern Pacific (SP)

Southern Pacific is owned by the Southern Pacific Transportation Company. Southern Pacific was purchased by the Central Pacific Railroad when Southern Pacific was only a name with no tracks; SP had a charter to build to southern California (Ogburn, 1977). The Southern Pacific was incorporated in 1884 in Kentucky with reincorporations in 1947 and 1969 in Delaware. Figure E-7 shows the service area of the Southern Pacific.

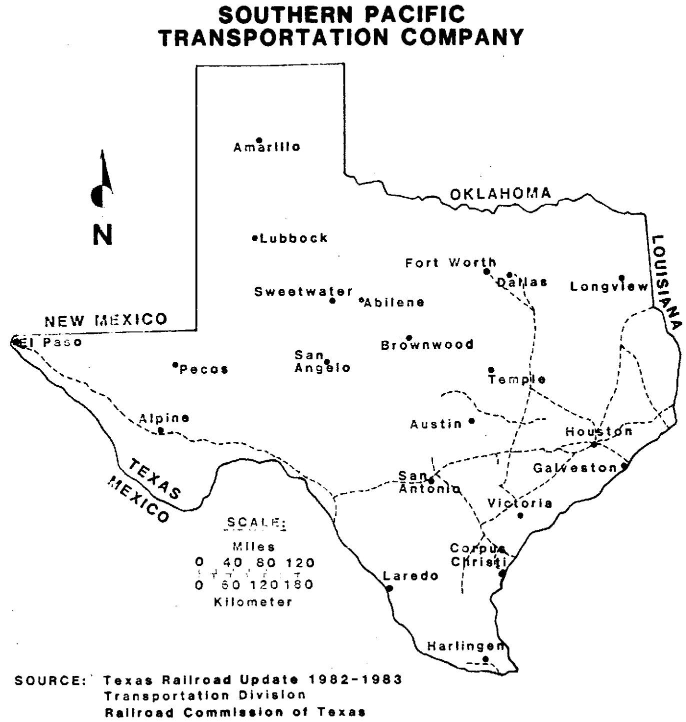


Figure E-7: SP Rail Service In Texas

Class II and III Railroads Operating In Texas

There are 23 Class II and Class III railroads operating in Texas. Class II railroads are those having annual operating revenues less than $50 million but more than $10 million. Class III railroads are those having annual operating revenues of $10 million or less. All switching and terminal railroads are designated as Class III. Class II and III railroads are shown on Figure E-8. Table E-2 shows operating characteristics of these railroads except for the Oklahoma-Kansas-Texas Railroad.

The Oklahoma-Kansas-Texas Railroads (OKT) was formed on June 3, 1982 when the Interstate Commerce Commission (ICC) approved a $40 million agreement for the Oklahoma, Kansas and Texas Rail Users Association to purchase

Table E-2. Operating Characteristics, Class II and Class III Railroads in Texas

Railroad	Length/ Miles	1981 Carloadings	1981 Net Revenue	Primary Commodities Hauled
Angelina & Neches River RR Co. (ANR)	10.0	7,124	$1,719,132	Lumber, wood products
Belton Railroad Company (BAR)	6.2	Not Available	7,423	Nonmetallic minerals, sand, gravel
Galveston, Houston and Henderson RR Co. (GHH)	48.0	Terminal & Switching		
Galveston Wharves (GWF)	45.7	Terminal & Switching		
Georgetown Railroad Company, Inc. (GRR)	7.9	36,426	6,643,534	Crushed stone
Great Southwest Railroad, Inc. (GSW)	22.0	Terminal & Switching		
Houston Belt & Terminal RAilway Co (HBT)	243.0	Terminal & Switching		
Moscow, Camden & San Augustine Railroad (MCSA)	6.5	4,906	835,251	Lumber, wood products
Pecos Valley Southern Railway Co. (PUS)	34.0	3,539	315,416	Non mettallic minerals, food, kindred products
Point Comfort & Northern Railway Co. (PCN)	12.7	10,552	2,762,569	Alunimum, non metallic minerals, chemical products
Rockdale, Sandow & Southern Railroad Co. (RSS)	5.8	13,374	2,468,887	Metallic ores, aluminum, petroleum, coal
Roscoe; Snyder and Pacific Railway Co. (RSP)	30.0		(158,679)	Bridge Traffic from Santa Fe or Missouri Pacific RW
Sabine River & Northern Railroad Co. (SRN)	29.0	13,042	904,862	Lumber, wood, pulp and paper products
Texas & Northern Railway Company (TN)	7.6	64,205	7,355,507	Metallic ores, primary metal products
Texas Central Railroad Company (TEXC)	24.7	2,420	17,016	Farm products primarily peanuts
Texas City Terminal Railway Company (TCT)	5.84	Terminal & Switching	1,558,728	Chemicals, petroleum products
Texas Mexican Railway Company (TM)	157.0	50,725	6,290,000	Farm products, non metallic minerals
Texas North Western Railroad (TNW)	66.0	New Nov. 1982	New Nov. 1982	Grain, carbon black
Texas South Eastern Railroad Company	20.1	Not Available	130,776	Lumber and wood products
Texas Transportation Company	1.0	Switching 2,385	(13,928)	Food products, waste and scrap materials
Weatherford, mineral wells and Northwestern Railway Company (WMWN)	22.7	505	(18,450)	Bricks and food products
Western Railroad Company	3.9	44,045	6,110,040	Coal, crushed stone and other aggregates.

NOTE: New class II not shown on map or table. Oklahoma, Kansas and Texas Railraod (OKT); See MKT map for location of this railroad.

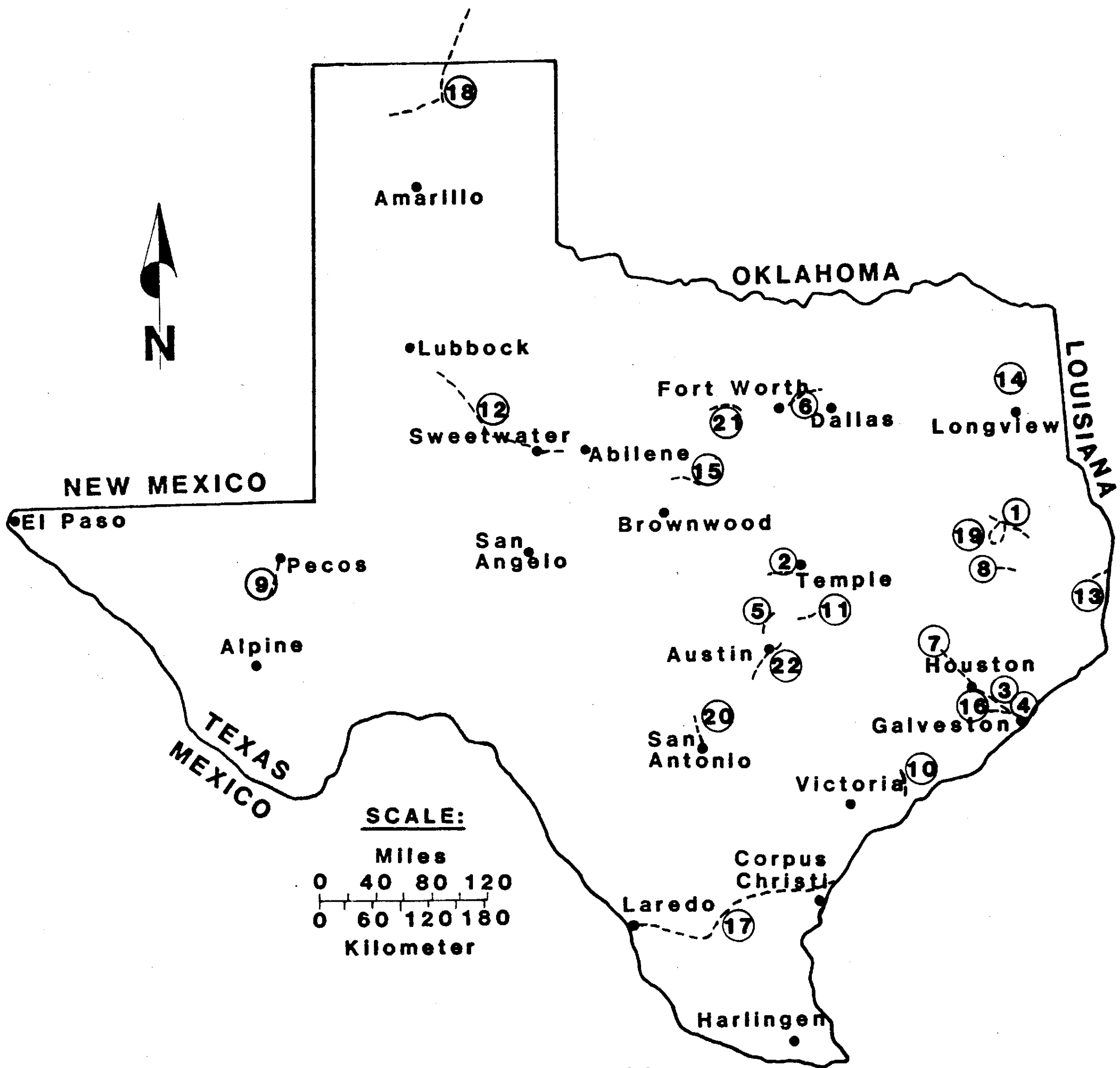
630 miles of the bankrupt Rock Island line from Salina, Kansas to the Dallas/ Fort Worth area. The users group consists of the State of Oklahoma and others. The line has a total of 630 miles with 354 miles in Oklahoma, 156 miles in Kansas, and 120 miles in Texas (See Figure E-6). A subsidiary of the Missouri, Kansas and Texas Railroad (MKT), the Oklahoma-Kansas-Texas Railroad Company (OKT) was formed to operate the $40 million dollar purchase.

Table E-3 provides a list of the 23 Class II and III railroads while Figure E-8 shows their locations within the State of Texas.

Table E-3. Class II and III Railroads Operating in Texas (Numbers Correspond to Figure E-8)

ID No.	Railroad:
(1)	Angelina & Neches River Railroad Company
(2)	Belton Railroad Company
(3)	Galveston, Houston & Henderson Railroad Company
(4)	Galveston Wharves, Board of Trustees of the
(5)	Georgetown Railroad Company, Inc.
(6)	Great Southwest Railroad, Inc.
(7)	Houston Belt and Terminal Railway Company
(8)	Moscow, Camden & San Augustine Railroad
(9)	Pecos Valley Southern Railway Company
(10)	Point Comfort & Northern Railway Company
(11)	Rockdale, Sandow & Southern Railway Company
(12)	Roscoe, Snyder & Pacific Railway Company
(13)	Sabine River & Northern Railroad Company, Inc.
(14)	Texas & Northern Railway Company
(15)	Texas Central Railroad Company
(16)	Texas City Terminal Railway Company
(17)	Texas Mexican Railway Company
(18)	Texas North Western Railroad
(19)	Texas South-Eastern Railroad Company
(20)	Texas Transportation Company
(21)	Weatherford, Mineral Wells & Northwestern Railway Company
(22)	Western Railroad Company
(23)	Oklahoma, Kansas and Texas Railroad Company

CLASS II AND III RAILROADS OPERATING IN TEXAS



SOURCE: Texas Railroad Update 1982-1983
Transportation Division
Railroad Commission of Texas

Figure E-8: Class II and III Rail Service in Texas

NOTE: See Table E-3 for Cross Reference of Numbers Shown to Railroads.

Rail Passenger Service

The Rail Passenger Service Act of 1970 provided the establishment of a non-government, for-profit corporation (AMTRAK) that would operate a national system of rail passenger service. Existing service routes and the proposed Fort Worth to Oklahoma/Kansas extension are shown on Figure E-9.

AMTRAK PASSENGER ROUTES 1983

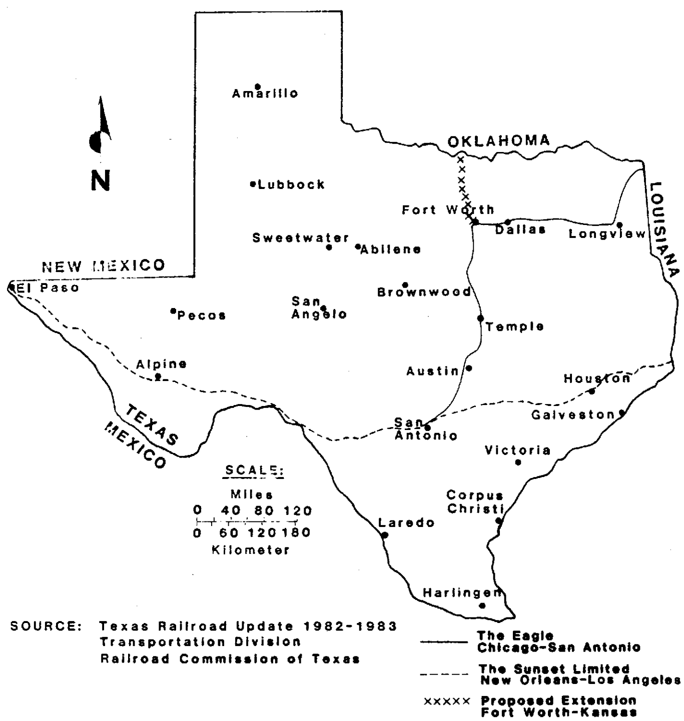


Figure E-9: AMTRAK Rail Service In Texas

AMTRAK assumed operation of all intercity passenger trains in May 1971. Of the four original intercity passenger routes in Texas only two were retained. These two were the "Texas Chief" operated over Santa Fe Railway lines and the "Sunset", operated over Southern Pacific lines. The Santa Fe route was eliminated in 1979 since the AMTRAK Reorganization Act of 1979 set new ridership and revenue criteria for a train's continuation. Passenger routes were given two years to meet the ridership criteria or face demise.

The present system has been in place since 1981 with a route from Chicago to San Antonio (The Eagle) which operates on a tri-weekly schedule. The second route operates from El Paso to Beaumont allowing a route from Texas to the East or West Coast.

The ridership for AMTRAK (on/off) at Texas stations as reported by AMTRAK for Fiscal Year 1981 was 282,353; reported in 1982 was 146,875 riders (a 48% reduction). Since the route structure changed during this period it is difficult to determine the true ridership changes since the 1981 figures covered a large part of the period that AMTRAK operated to Laredo providing an international link. Also, the 1981 service provided more station stops and a connecting train between Temple and Houston. These changes distort a true ridership comparison.

APPENDIX F

INVENTORY OF RAILROAD FACILITIES IN THE HOUSTON AND DALLAS/FORT WORTH REGIONS

Contents:

APPENDIX F: INVENTORY OF RAILROAD FACILITIES IN THE HOUSTON AND DALLAS/FORT WORTH REGIONS

General

The passage of the Regional Rail Reorganization Act (3R Act) of 1973, the Railroad Rehabilitation and Regulatory Reform Act (4R Act) of 1975, and the Local Rail Service Act of 1978 created the opportunity for states to become more involved with rail planning and monitoring. While the initial efforts focused on rail safety, the Acts also provided Federal support and funding of state programs to identify and resolve railroad problems; particularly those that involve abandonment and/or reduction of rail service on branch lines.

Federal funding of state rail programs became contingent upon states preparing and annually updating a State Rail Plan. As part of the Texas planning effort, the Federal Railroad Administration (FRA) funded regional planning studies in five urban areas; North Central Texas Region; Houston-Galveston Area; El Paso; Bryan-College Station; and Brownsville.

The North Central Texas Study (by Peat, Marwick, Mitchell and Co. et al.), and the Houston-Galveston Area Rail Study (by Turner Collie & Braden, Inc., et al.), in 1980 gathered a large amount of inventory data for the two regions, but not necessarily the same data in the two regions. It is from these two principal reports that a general description of the two rail systems serving the Dallas/Fort Worth and the Houston areas is extracted and presented. It is the authors' view that the systems have changed very little (physically) since these reports were completed in 1980. The prime exception is the Chicago, Rock Island and Pacific Railroad Company, which served both urbanized areas, has gone into bankruptcy with various lines of the railroad being sold off to interested buyers.

Rail System Of Dallas-Fort Worth

Currently, all 7 Class I line-haul railroads operating in Texas provide service to the D/FW region. These are:

1) The Atchison, Topeka and Santa Fe Railway Company (ATSF);
2) The Burlington Northern Railway Company (BN);
3) The Kansas City Southern Railway Company (KCS);
4) Missouri-Kansas-Texas Railroad Company (MKT);
5) Missouri Pacific Railway Company (MP);
6) St. Louis-Southwestern Railway Company (SSW); and,
7) Southern Pacific Transportation Company (SP).

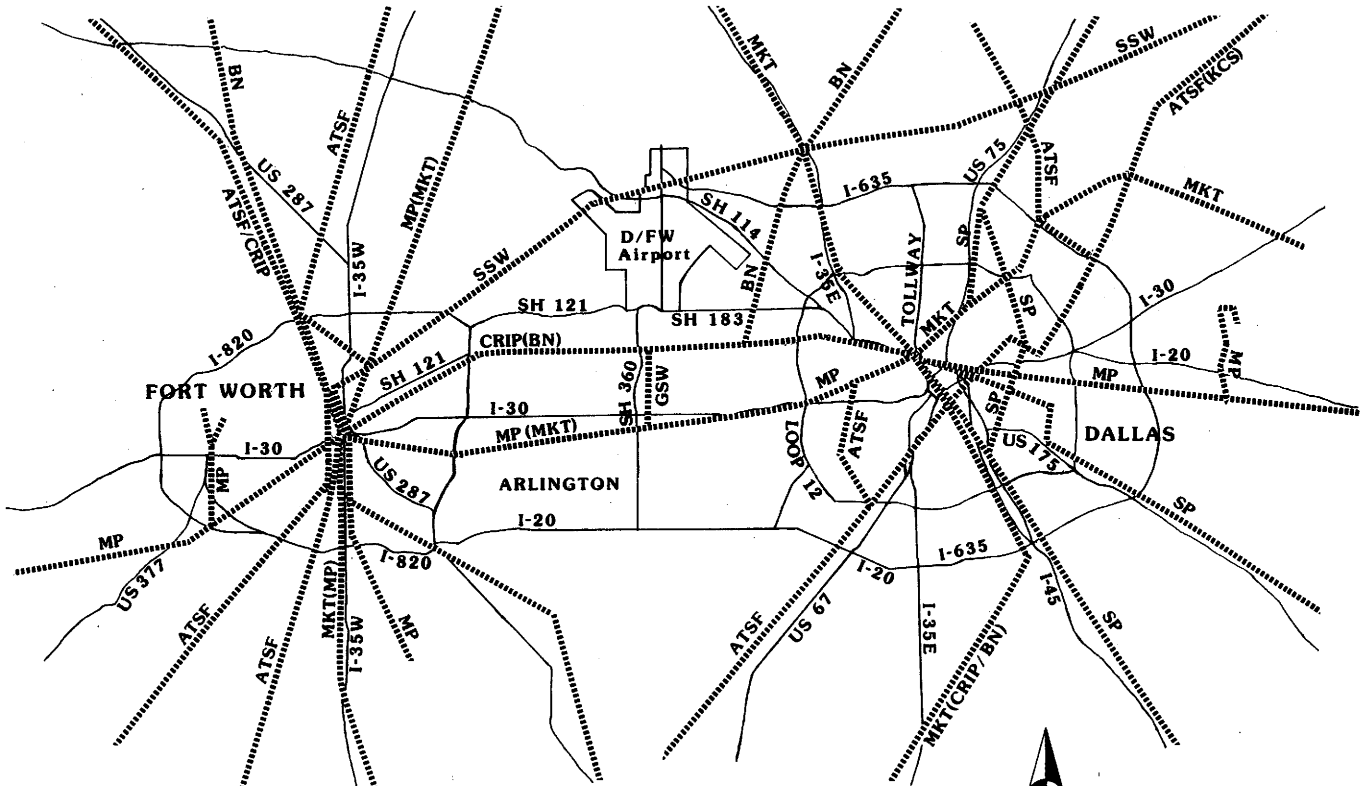
Rail passenger service is currently provided to the region by the National Rail Passenger Corporation (AMTRAK). This service is provided over track owned by the Missouri Pacific and Santa Fe Railroads.

The Dallas-Fort Worth area contains an extensive rail network having some 514.3 line miles within the two principal counties (Dallas and Tarrant). Tarrant County contains 267.9 miles of main and branch line track (Peat, Marwick, Mitchell & Company, 1980). Dallas County contains 246.4 miles of main and branch line track (Dallas County Tax Appraisal District, 1983). Figure F-1 shows the rail network within the Dallas-Fort Worth area. (Note: The figure also shows the bankrupt Chicago Rock Island and Pacific Railroad).

The Cities of Dallas and Fort Worth, in cooperation with the Urban Mass Transportation Administration and the State Department of Highways and Public Transportation, are pursuing the purchase, of 34 miles of the Chicago Rock Island and Pacific Railroad from the trustees of the Railroad. The purchase will give the two cities a link between each central business district (CBD) for future rail mass transportation uses plus the continuation of freight service in the interim.

Railroad rights-of-way in Dallas County generally range from 100 feet to 250 feet in width. Rights-of-way of this magnitude should provide adequate horizontal clearance for both freight and transit movements. Rights-of-way

DALLAS-FORT WORTH RAIL SYSTEM



LEGEND:

ATSF -Atchison, Topeka & Santa Fe Railway
BN -Burlington Northern
CRIP -Chicago, Rock Island & Pacific Railroad
GSW -Great Southwestern Railroad
KCS -Kansas City Southern Railway
MKT -Missouri-Kansas-Texas Railroad
MP -Missouri Pacific Railroad
SP -Southern Pacific Transportation Company
SSW -St. Louis-Southwestern Railway

SCALE:
0 1 2 3 4
MILES

Figure F-1: Class I Rail Service In Dallas/Fort Worth Area.

in Tarrant County are presumed to be of similar width, also providing the necessary clearances for passenger rail system development.

Houston-Galveston Area Rail System

The railroads operating in the 13-county area include 5 Class I railroads:

1) Atchison, Topeka and Santa Fe Railway Company (ATSF);
2) Burlington Northern (BN);
3) Missouri-Kansas-Texas (MKT);
4) Missouri Pacific Railroad (MP); and,
5) Southern Pacific Railroad (SP).

Four terminal railroads operate in the area due to the high amount of shipping activity common to major sea ports such as Houston. These four terminal railroads are:

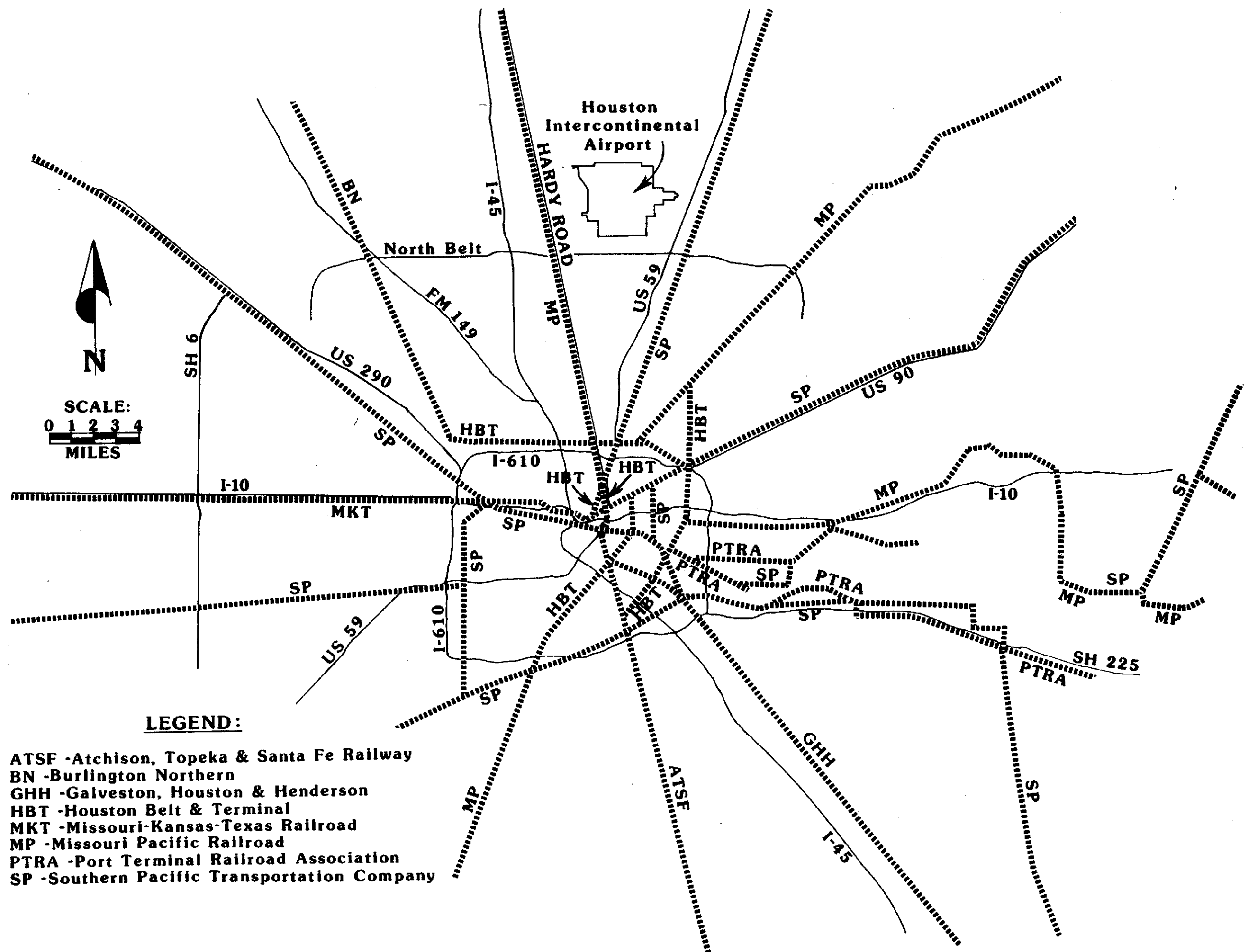
1) Houston Belt and Terminal (HBT);
2) Port Terminal Railroad Association (PTRA);
3) Texas City Terminal Railroad; and,
4) Galveston Wharves.

In addition to the above, the Galveston, Houston & Henderson Railroad (GHH), a non-operating railroad company, owns one rail route between Houston and Galveston. Throughout the Houston-Galveston area, there exists a total of 1,106 miles of track for all classes of railroads.

The rail system network totals 841.6 route miles in Harris County of which 97.5% is single track and 2.5% is double track (Buffington, 1977). Joint operations or trackage rights agreements exist on portions of the 15 rail routes entering or leaving Harris County (City of Houston). Multiple rail routes are owned by Missouri Pacific Railroad (4 routes) and Southern Pacific (7 routes). Figure F-2 shows the rail network of the Houston area.

Railroad right-of-way in the Houston area is of varied widths. However, from a conversation with Mr. Ed Keyser, former Regional Tax Commission of the Southern Pacific Railroad, "minimum" width of rights-of-way for most

HOUSTON AREA RAIL SYSTEM



NOTE: The "Texas City Terminal Railroad" and "Galveston Whaves" Railroad are not shown on the map.

Figure F-2: Rail Service In the Houston Area.

railroads is estimated to be generally 100 feet-wide; exceptions to the 100 foot width occur in the parts of the urbanized area.

Grade Crossings

Railroad-highway grade crossings in recent years have become a major focal point for national, state and local research and analysis. Grade crossing accidents, due to their typical severity, are banner news items in newspaper and other public media. Therefore, from a safety perspective, grade crossing consideration will be very important in determining the feasibility of transit routes and modes of transit (Light Rail, Heavy Rail, Commuter Rail, Monorail, etc.). Table F-1 gives a comparison of the number of grade crossings in the two study areas as well as grade crossing data for Texas and the United States.

Table F-1: Railroad-Highway Grade Crossing Inventory Data

Location	Number of Public At-Grade Crossings[1]	Miles of Track (All Classes)[2]	Crossing Per Mile of Track[3]
Texas	14,600	13,794	1.06
Dallas-Tarrant Counties	894	514	1.74
Houston-Galveston Area	1,601	1,106	1.45
United States	210,000	179,800	1.17

Sources: [1]Federal Railroad Administration, 1983
[2]Regional Rail Study, Houston-Galveston Area, 1980
[3]Rail Planning Program for the North Central Texas Region, 1980

As shown in Table F-1, Dallas and Tarrant Counties have a higher number of grade crossings per mile (1.74) than does the Houston-Galveston area (1.45). Both of the major urbanized areas exceed the national average of 1.17 crossings per mile by some 24% to 49%.

Rail Transit Planning

General

Both of the major Texas urbanized areas of Dallas/Fort Worth and Houston are in the process of planning rail transit systems to meet their mobility needs in the 21st century. Twenty-one local political jurisdictions plus unincorporated areas of Dallas County voted on the establishment of a regional transit authority and approval of a service plan on Saturday, August 13, 1983. The proposed service plan contained some 160 miles of new rail transit to serve the citizens of the area.

The Metropolitan Transit Authority of Houston, known as METRO, presented a $2.35 billion referendum for revenue bonds to their citizens on Saturday, June 11, 1983. The bond package was intended to help finance some 18.5 miles of heavy rail passenger service plus other transportation improvements within the authorities service area.

A transit authority (VIA) approved by San Antonio voters under the provisions of Texas Law 1118X, V.C.S., has yet to pursue rail transit. The City of Fort Worth and the City of Arlington (both in Tarrant County) are developing service plans for transportation authorities within their respective areas; neither plan includes rail transit in the short to medium time period. However, as previously mentioned, the City of Fort Worth in cooperation with the City of Dallas has obtained funding for the acquisition of the Rock Island right-of-way for future rail transit implementation.

Dallas Rail Transit

Voters in 14 municipalities approved the creation of the Dallas Area Rapid Transit (DART) authority on Saturday, August 13, 1983. The service area, receiving a favorable vote in the referendum, includes portions of four Texas Counties and some 1,416,658 persons:

City	County/Counties	*1980 Population
Addison	Collin/Dallas	5,553
Carrollton	Dallas/Denton	40,591
Coppell	Dallas/Denton	3,826
Dallas	Dallas	904,078
Farmers Branch	Dallas	24,863
Flower Mound	Denton	4,402
Garland	Dallas	138,857
Glenn Heights	Dallas	1,033
Highland Park	Dallas	8,909
Irving	Dallas	109,943
Plano	Collin	72,331
Richardson	Dallas/Collin	72,496
Rowlett	Dallas/Rockwall	7,522
University Park	Dallas	22,254

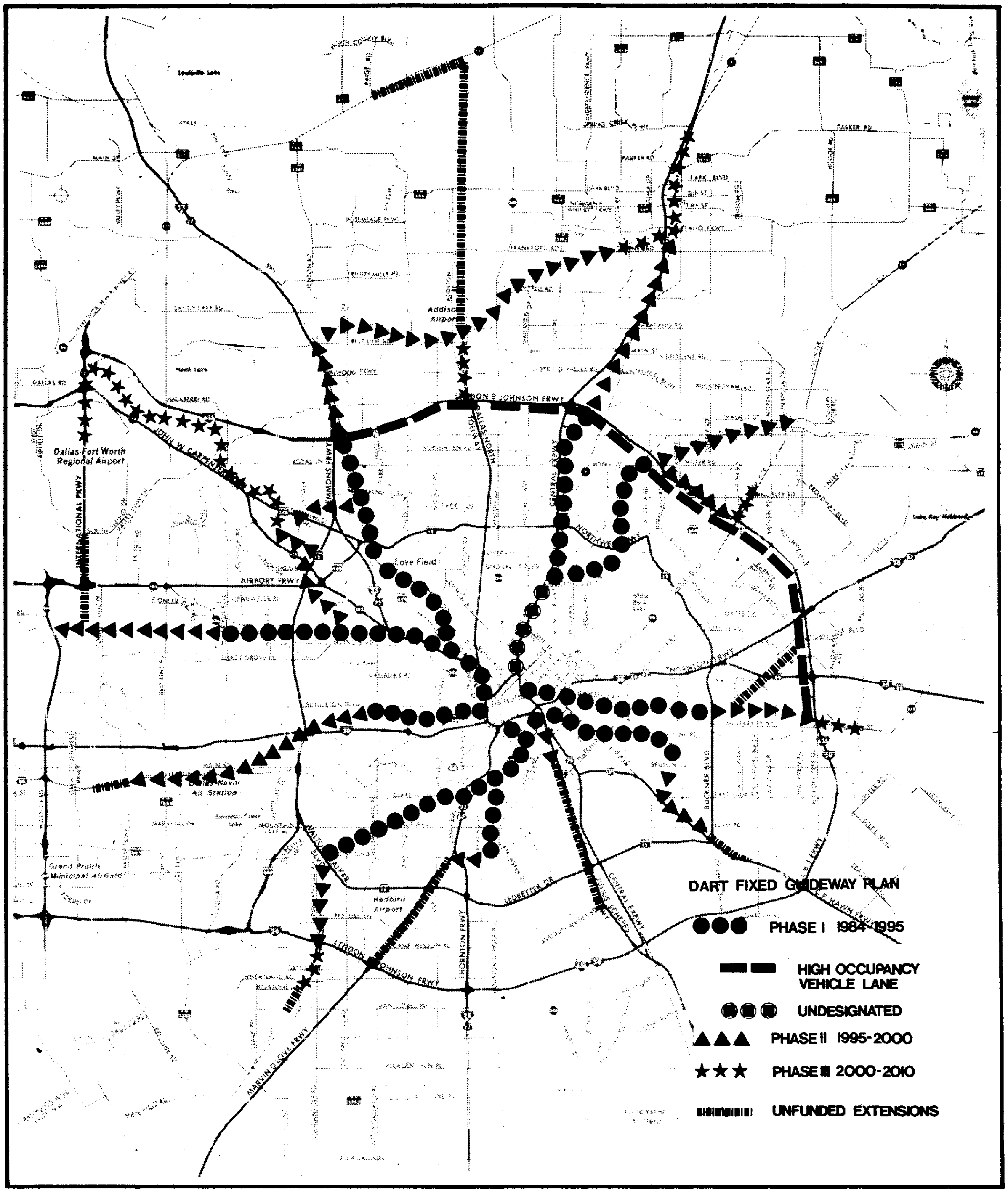
*Source: 1982-1983 Texas Almanac, the Dallas Morning News, A.H. Belo Corporation, 1981.

The creation of the DART Authority authorizes the collection of a one-percent limited sales tax from retail activity occurring within the 14 municipalities. Revenues derived from the local sales tax along with state and federal funding will be used to implement the adopted service plan which contains some 160 miles of rail service and 98 transit stations by the year 2010. Figure F-3 shows the proposed rail services network within the Dallas area.

In addition to required operating expenses, the DART financial plan includes some $4 billion (1982 adjusted) for capital improvements. Some 89% of the capital program is associated with the rail (fixed guideway) system as shown below:

ITEM	ESTIMATED 1984-2010 Cost:	PERCENT Of Total
Buses and Related Facilities	$350,000,000	8.7%
HOV Lanes	$ 94,000,000	2.3%
Fixed Guideway System	$3,583,000,000	89.0%
Total	$4,027,000,000	100.0%

Rail Services 1984-2010



- **Rail construction between1984-2010**
  - 69 miles by 1995
  - 131 miles by 2000
  - 160 miles by 2010
  - 98 transit stations

Figure F-3: Proposed Dallas Rail Services Network

Of the $3.6 billion for the 160 mile rail system, the majority (58.3%) goes toward track and public works types of improvments. A breakdown of the fixed guideway system expenditures follows:

FIXED GUIDEWAY Element	ESTIMATED 1984-2010 Cost:	PERCENT Of Total
Track and Civil Work	$2,088,000,000	58.3%
Stations	636,000,000	17.7%
Vehicles	680,000,000	19.0%
Maintenance/Operating Fac.	179,000,000	5.0%
Total	$3,583,000,000	100.0%

Preliminary estimates, derived from the DART service plan, indicate that approximately 78% of all planned rail transit milage will be on or adjacent to railroad rights-of-way. In addition to the now bankrupt Rock Island Railroad, 5 of the 7 Class I Companies will be directly involved in implementation of the rail system including:

- Atchison, Topeka and Santa Fe (ATSF);
- Missouri-Kansas-Texas (MKT);
- Missouri-Pacific Railway (MP);
- St. Louis-Southwestern Railway (SSW); and,
- Southern Pacific Transportation (SP).

Due to joint trackage agreements and interlining of freight, more than the above listing companies will probably be involved in the final planning and contractual arrangements.

<u>Houston Rail Transit</u>

The Houston Metropolitan Transit Authority presented a $2.35 billion revenue bond issue to their voters on Saturday, June 11, 1983. The bond issue was to have provided an 8-year bus and rail capital improvement program; unfortunately, the issue was defeated by those casting a ballot in the election (12% of the elligible voters).

Some 89% or $2.125 billion of the capital funding (same percentage as Dallas) was to have gone toward the construction of an 18.5 mile heavy rail system with 17 stations. Figure F-4 shows the proposed alignment of the Houston rail services plan while Figure F-5 presents the 6 major activity/employment centers within the service area. It is assumed that if and when rail service becomes a reality for the Houston area, a significant portion of the rail construction will be considered on or adjacent to railroad rights-of-way.

HOUSTON RRT: Stage One Employment / Activity Centers

Sourse: Draft Enviromental Impact Statement,
Houston Rail Rapid Transit Project,
March 1983

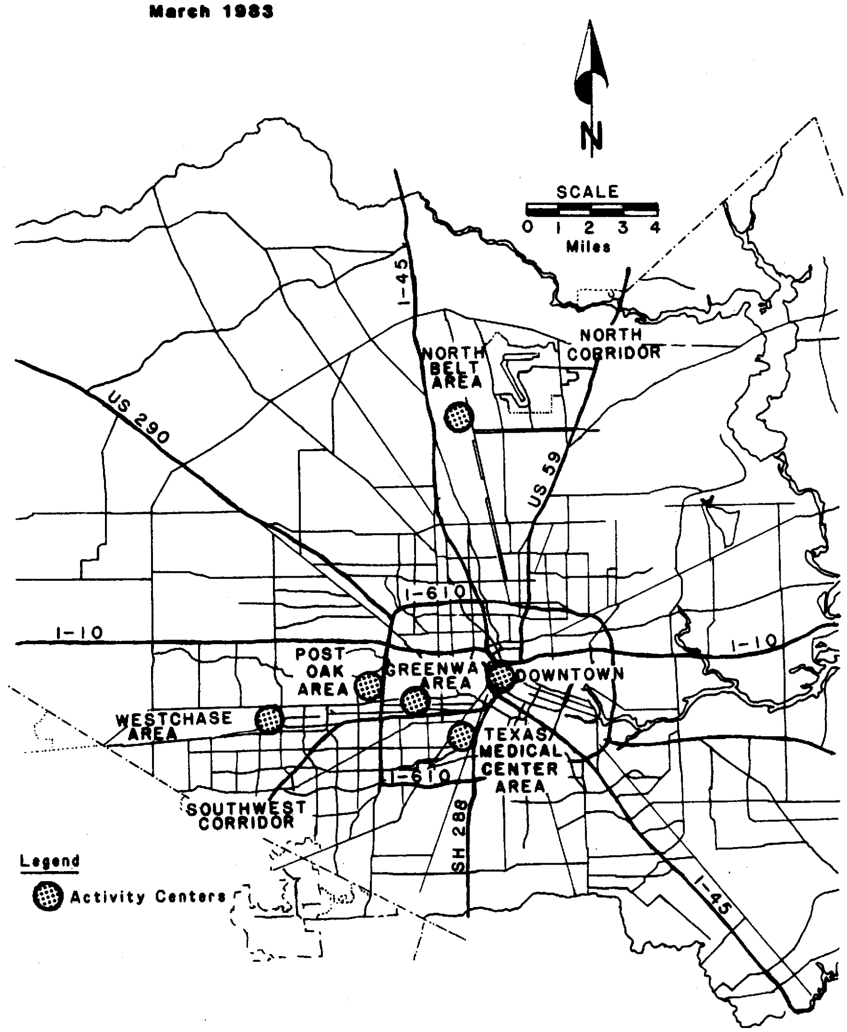
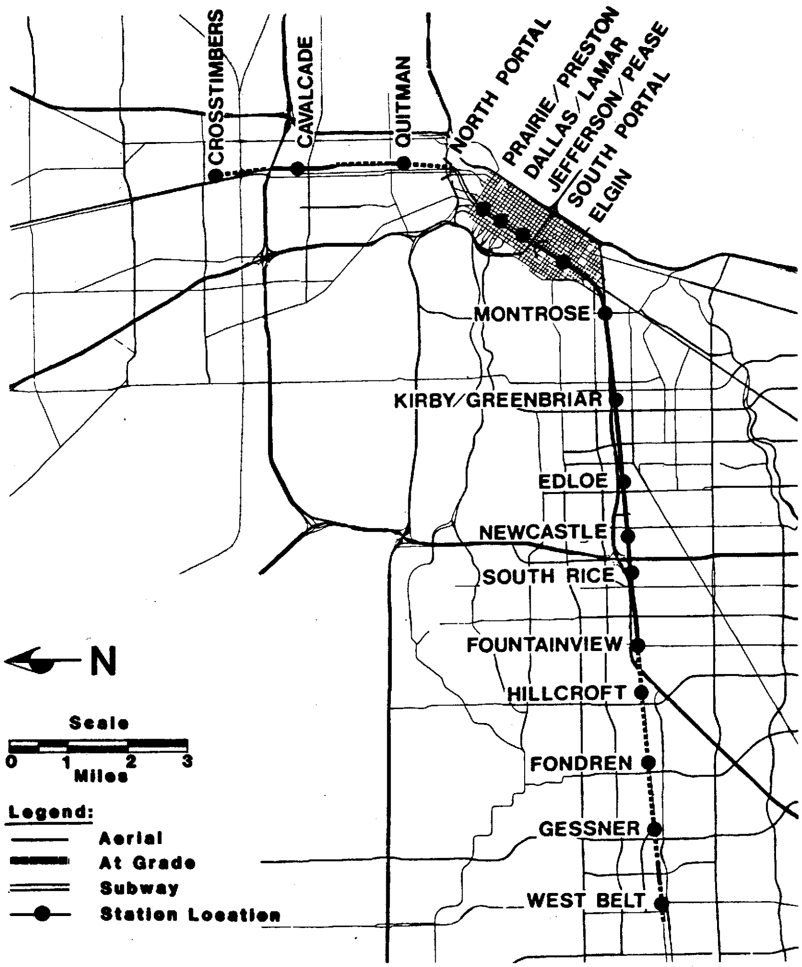


Figure F-4. Proposed 1983 Houston Rail Services Plan



Houston RRT: Stage One

Source : Draft Environment Impact Statement, Houston Rail Rapid Transit Project, March 1983

Figure F-5: Major Activity/Employment Centers in METRO Service Area

APPENDIX G

FIXED-GUIDEWAY TRANSIT TECHNOLOGY AND OPERATIONS

Contents:

APPENDIX G: FIXED-GUIDEWAY TRANSIT TECHNOLOGY AND OPERATIONS

Introduction

Fixed guideway systems are those systems in which the guideway steers the vehicle or vehicles, as opposed to driver-steered vehicles such as buses. Transit systems which used fixed guideways include: (1) Personal Rapid Transit (PRT - or larger vehicles which have sometimes been called Group Rapid Transit); (2) Concept 21 (a side-supported elevated transit system); (3) monorails of all types; (4) Light Rail Transit (LRT); (5) Hybrid Rail Transit (transit systems which combine LRT and RRT features - sometimes called Pre-Metro, Light Rail Rapid Transit, Light Rail Transit on exclusive right-of-way, etc.); (6) Rail Rapid Transit (RRT - heavier rail vehicles than LRT, sometimes called Heavy Rail); and, (7) Commuter Rail Transit (CRT - trains of passenger cars built to freight railroad standards, and often run on existing freight railroad tracks - sometimes called Regional Rail Transit or RRT). While each mode is somewhat different, and the different types of guideways provide somewhat different operating characteristics, there are strong similarities in operation due to the fixed-guideway principle. Thus much of this section is not broken down by mode, but combines modes and addresses their operational similarities.

This section presents only an introductory overview. For further information the reader is directed to the references, especially Vuchic 1981, Hay 1982, and the Dallas Fixed Guideway Rapid Transit Mode Analysis (Lea, et al., 1983).

Classification and Operation

While there are obvious differences in designs between modes, from an operational standpoint there are strong similarities. Thus, this section is not broken down by mode, but by similarities, types of service, differences by guide-way type, types of vehicle control (operation), scheduling, and safety/human factors. Vehicle differences are addressed where appropriate.

Similarities

The use of the fixed-guideway provides many similarities between all transit modes, although they may appear different to the eye. Important common features include the following:

Vehicle Control

As driver-steered vehicles require more maneuvering clearance than fixed guideway vehicles, fixed-guideway systems can operate safely on considerably narrower rights-of-way. Such systems require less land at-grade, narrower elevated structures, and smaller subway tunnels for a given size of vehicle. There is less lateral wander and accidents caused by improper driver steering. However, the fact that the driver is unable in most cases to steer around an obstruction in an emergency, fixed guideways increase the possibility of end-on collision between vehicles which cannot avoid each other. This collision possibility makes safety provisions mandatory for multiple-vehicle, fixed-guideway systems. Such provisions may range from simple rules (such as single-directional running with protection provided by the driver's vision or assignment of a single block to a single train by means of block keys or train orders) to highly sophisticated computerized traffic control systems with at least partial automatic train control. A commonly used railroad type signal system used with steel-wheeled vehicles on steel rails involves detecting the presence of the vehicle by allowing the wheels to short-out a signal current flowing through the rails, which causes a relay or electronic system to respond. This electrical response which may also trigger grade crossing warning signals changes the aspect (appearance or color of light) on a signal located along the right-of-way and/or in the operator's cab, indicating to the driver the proper action he should take; also it can trigger automatic devices to control the train speed or to stop the train if the driver takes inappropriate action. Many signal systems will also warn of a broken rail or improperly thrown switch. Vehicle detection systems not only increase safety, but they make it possible to provide some level of automatic control.

Propulsion

Fixed-guideway systems can easily use electrical pickups; thus it is relatively easy to power the vehicles by electricity. Metal rails can serve as an electrical return, further reducing the cost of electrifying the system. Thus, most fixed-guideway systems operate on electric power except for some commuter trains and a few other isolated systems. Electric operation generally allows for strong acceleration limited primarily by passenger comfort, electric braking sometimes with regeneration (the motor feeds power back into the system during deceleration), smooth and quiet operation, and elimination of pollution by the vehicle, though there may still be pollution at the power generation plant. While electric power lends itself to automatic control and reduced maintenance, a number of problems exist. The electrical distribution system is quite expensive, and may prove hazardous to pedestrians on the right-of-way. Some transit systems mount the electrical conductors low to save construction costs (such as RRT third rails), but then must protect against electrocution by providing a nonconductive cover over the third rail and/or by carefully fencing off the right-of-way. To reduce these hazards, the electrical contactor may be hung high above the vehicle with power collected by means of a pantograph or a trolley pole. This overhead wire not only greatly reduces the hazards of contact, but it allows the tracks to be embedded in streets and grade crossings, and also makes it feasible to substantially increase the voltage from the commonly used 600 volts D.C. (both third rail and overhead systems often used 600 volts D.C.) to more efficient high voltage A.C. (as high as 27,000 volts). Electric propulsion currents can affect signal systems not only on the transit system, but also on adjacent railroad systems through leakage and induced currents; more-expensive signaling equipment may be required to allow the signals to continue to function safely.

Switching

Fixed-guideway systems require some form of switch (turnout) mechanism to enable the vehicles to take diverging routes or to pass one another. While a system such as the Seattle monorail simply shuttles two vehicles back and forth, one on each parallel beam, most transit systems are not built this simply. Various guideways have various types of switches, but all have one shortcoming in common: vehicles cannot diverge from the guideway safely except at a switch. A vehicle can pass another vehicle on the same track only where switches or turnouts make this possible. This means that the location of switches must be carefully planned to maximize operational abilities.

Flexibility

Unlike driver-steered vehicles, fixed-guideway vehicles cannot leave the guideway to bypass obstructions or to change to a new route where no guideway exists, making them much more subject to delay or service disruption in case of breakdown of vehicle or guideway. Route changes are difficult and costly, and must be carefully pre-planned, often years in advance.

Capacity

Most fixed-guideway vehicles can be coupled together into trains to increase productivity and capacity. Use of exclusive guideways can increase speed and reduce congestion, further increasing capacity. Higher capacity guideways systems, such as RRT and Commuter Rail, can have capacities in excess of 40,000 passengers per hour.

Types of Service

The type of service to be provided by the transit system will generally tend to favor some modes over others. The differences in suitability of various modes for different types of service may be so great as to suggest the use of two or more different types of modes. For example, the flexibility of feeder buses may be used to collect commuters in a suburban city and transport them to a rail station. Here the commuters would transfer to a hybrid LRT, RRT, or commuter system for transportation to the outskirts of the central business district, where they would again transfer to a people-mover or monorail to reach their places of work. This multi-modal concept must be used with caution, however, as passengers prefer to ride a single vehicle from origin to destination, and the multiple transfer system could result in reduced ridership. One approach which has met with considerable success is the use of Park-and-Ride or Park-and-Pool lots (where the commuter drives to a parking lot at the transit station and transfers to a train), with provision for Kiss-and-Ride passengers (where a family member drives the commuter to the station). The train, by means of subway, elevated structure, or street operation often passes through the central business district to distribute the riders downtown. Some passengers may not consider this type of arrangement to require any transfers.

Types of service may be loosely classified according to commute distance, as follows:

1. Short-distance shuttle (downtown);
2. Intermediate service (station spacing of 1 to 2 miles); and,
3. Commuter/express service.

Right-of-way categories for the various service types can be classified as:

A. Fully-controlled, with no crossing or street running (exclusive);
B. Primarily separated, but with some grade crossings and/or street running; or
C. Surface streets with mixed traffic operation (Vuchic, 1981).

Short-Distance Shuttle

High-density areas, such as downtown central business districts, may require a transit stop every two or three blocks, to minimize walking distance for riders. This type of service requires frequent starts and stops of the transit vehicle, with little opportunity to achieve much operating speed (at the maximum comfort acceleration of three miles per hour per second) before deceleration for the next stop. Electric propulsion is desirable in this case due to the lack of vehicle pollution, the capability of electric motors to produce higher horse power for short periods of time (short-term ratings), and the possible savings in brakes and electric power through regenerative braking. While the generated power is often simply wasted in heat in a resistance grid, it is technically possible to feed the generated power back into the power system. If the transit vehicles operate in mixed-flow (Right-of-Way Category C), traffic congestion will increase as the length of trains or vehicles increase. Consequently, vehicles which can be grade-separated (Category A) are often preferable for use in downtown areas.

Where the grade separation involves elevated structures, the public will naturally desire attractive or at least unobtrusive guideways. The old-fashioned, bulky type of structure used by the Chicago Loop will no longer be an acceptable alternative for new systems.

While all transit modes, except commuter rail, can be used for street service, diesel buses are more flexible, and also least desirable from a noise and pollution standpoint; buses create nearly as much traffic congestion as LRT vehicles in the street. LRT vehicles are subject to delays caused by other traffic unless they are operated in transit malls, within the central business district. Many cities have subway systems with rail transit such as hybrid LRT and/or rapid rail operating beneath the streets. The cost of Category A subway systems may be enormous (especially for a city such as Houston which has clay soil and a high water table), and the ride is unpleasantly dark and "mole-like". However, a subway transit system is completely separated from the traffic above.

Because of the potential unsightliness of an elevated structure, and the tendancy of designers to plan excessively large elevated stations, elevating a transit system above city streets has not been fully considered in many cases. The least obstrusive elevated transit modes are monorails and Project 21-type systems, which are capable of lightweight construction with long spans between pillars. PRT and hybrid LRT systems are not particularly large or obtrusive if single-tracked, and modern construction techniques make it possible to construct RRT elevated tracks which are far less obtrusive than the common public perception. An interesting concept would be to run these elevated structures over an extra-wide city sidewalk, which would allow stations to be placed inside adjacent buildings (See Figure G-1). In some cases the station space might be donated by a department store or office complex. The Tandy Center in Fort Worth attracts many potential customers by

Figure G-1: Concept of Elevated Structure With Stations Internal to Adjacent Buildings operating a free two-mile Hybrid LRT subway between a parking lot on the Trinity River and a subway station within the Tandy Center; economic benefits accrue to department stores and shops leasing space near the Tandy transit station. As elevated guideways cost much less than subways, and as negotiations could greatly reduce the cost of stations, this type of construction could allow grade-separated distribution in a central business district at a fraction of the cost to build subways.

Intermediate Service

Surrounding high density business districts will often be areas where station spacing of one to two miles will prove to be most economical. Such distances are generally too great for many riders to walk to the stations. However, transit patrons may be served by feeder buses or, for patrons living some distance from the station, by private transportation facility accommodations such as Park-and-Ride, Park-and-Pool, or Kiss-and-Ride. Some transit stations provide bicycle lockers for those commuters using the bike mode. The areas around these stations frequently, become more built up with high density development, providing more walk-in patrons.

Increased station spacing generally occurs when demand for stops in between stations is relatively low, making the expense of more closely spaced stations impractical. As distance between station stops increases, it becomes more advantageous to use higher-speed vehicles on Category A or B guideways which allow for higher operating speed. Full Category A grade-separation can often facilitate operation by avoiding traffic conflicts which interfere with the operation of the vehicle. In some cases, separation from surrounding traffic and pedestrians is accomplished by constructing the guideway at-grade, but by fencing the guideway.

Guideways in this range may benefit from locating along side an existing freight railway. The presence of the railway line may have already resulted in parallel access roads with only a few grade crossings. Stations may be located at the more major grade crossings. If all trains stop at a station adjacent to a grade crossing, the Category B guideway allows for street crossings at-grade (i.e., standard railroad-type track), and electrical pick-up from overhead wire. Trains will be moving slowly as they approach or leave the station, greatly minimizing hazards.

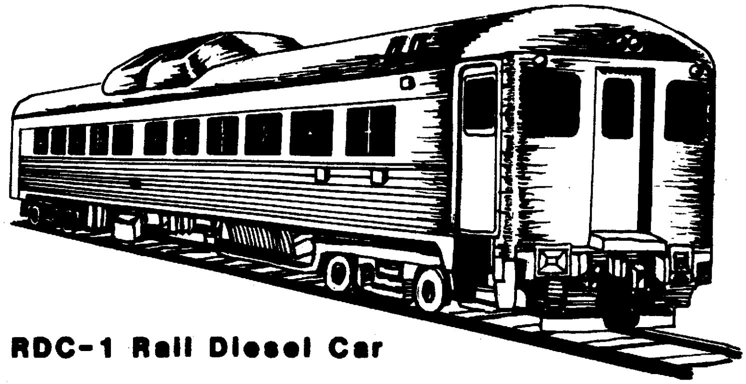
While the least expensive type of construction is at-grade, avoiding the expense of overhead structures or subway tunnels, if the surrounding area has been built up and/or if the route parallels a street instead of a freight railroad, there may be severe community opposition to street closings. In this case, the guideway can best achieve reasonable operating speeds if it is completely grade-separated. The Seattle monorail (which shuttles back and forth between two stations spaced 1.2 miles apart) fits into this category, and is capable of achieving quite high (60 miles per hour) speeds, (Brackett, 1982).

Commuter/Express Service

There are areas where station spacings of two miles or less are not economically justified by the number of potential riders. Large numbers of urban employees may live in outlying suburban communities with fairly long stretches of intervening low population density areas. Some commuter runs may exceed 100 miles; the ride would take too much time if stops were made every two miles or less. With adequate guideway design, it is possible to have express runs which bypass close-in stations at full operating speed.

As station spacing increases beyond two miles, it may became desirable to use an exclusive Category A guideway, whether grade-separated or fenced at-grade, with vehicles capable of high operating speeds (sometimes in excess of 90 miles per hour). Due to the distances required to stop from a high speed of heavily loaded transit vehicles, safe signalling becomes important; especially as stopping distances often exceed sight distances. In order to allow vehicles to switch from track to track without a significant speed decrease (especially when express trains are bypassing local stations), high-speed turnouts (switches) may be needed to realize full line capacity potential. These switches will usually be automatically operated from a remote location, such as a railroad interlocking plant or a centralized traffic control center. Thus operation of turnouts must be completely reliable and foolproof, with a warning transmitted in a timely manner in case of malfunction. If speed exceeds 79 miles per hour, either Automatic Train Stop (ATS) or Centralized Traffic Control (CTC) may be required. (Shaw, 1978).

Many transit systems use Rapid Rail Transit or commuter trains in longer distance suburban commuter service, preferring to run fewer rush-hour trains with high capacity per train rather than running more frequent, lower capacity service which normally requires more operators. While many commuter trains are electrified, longer run commuter trains are often diesel powered (See Figure G-2). While acceleration of diesel trains may be less than that of electrically powered trains, there is very little additional running time involved, due to the fact that the long station spacing allows considerable running time at top speed between stations. In some cases a single track may be used at the far end of the commuter line, further reducing transit expense. In many cases commuter trains share freight railroad tracks, usually on Category B type of right-of-way, but interposing passenger traffic on heavily used freight track may require improvements on the line at the transportation agency's expense (PRC Voorhees, 1981).



Budd RDC-1 Rail Diesel Car

Source: Illustrated History of BUDD Railway Passenger Cars, J.W. Kerr

Figure G-2. Example of a 1950 Diesel Powered Commuter Car

Difference By Guideway Type

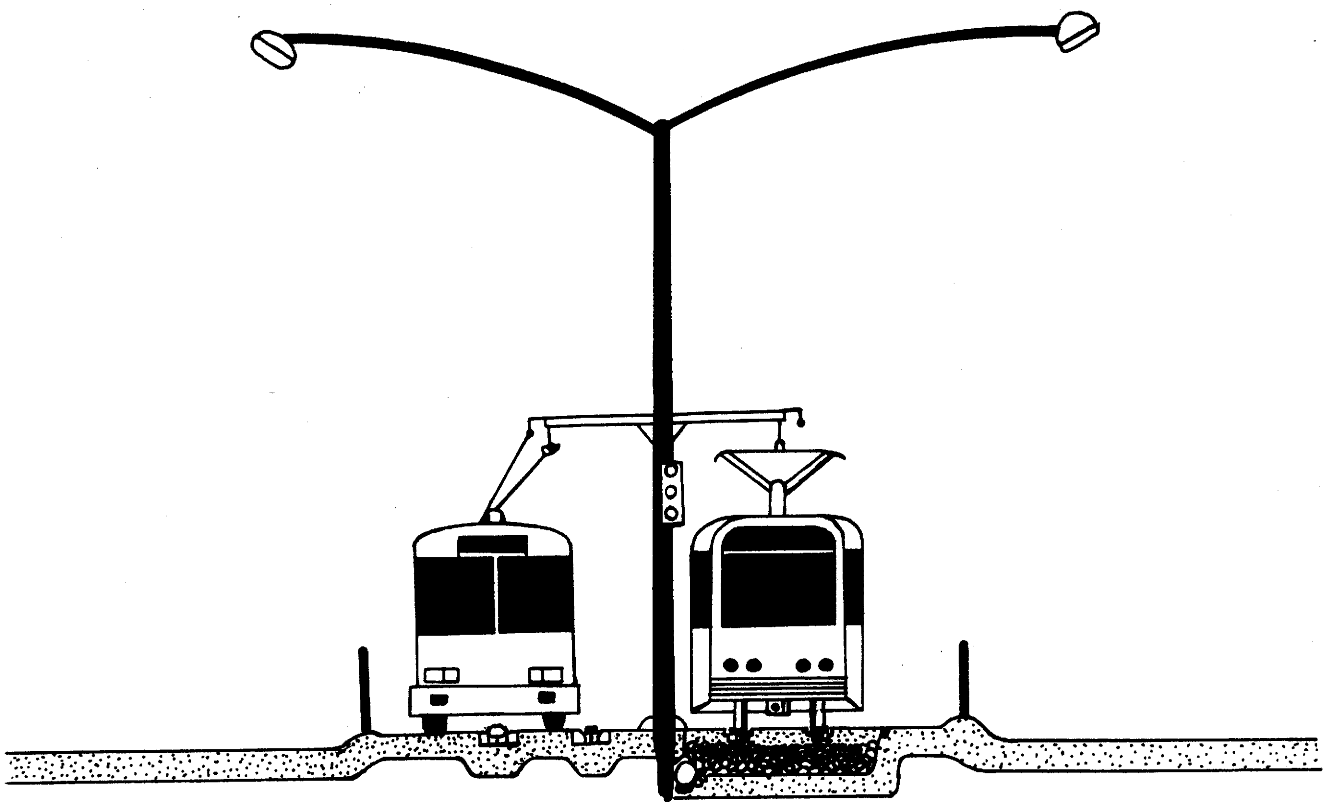
The method of supporting and steering the transit vehicles on the guideway can effect the overall economics and feasibility of utilizing adjacent railroad right-of-way at-grade. Provided that vertical clearance is adequate, overhanging elevated guideways should not interfere in a major way with railroad operation, nor the railroad with transit operation. One problem with at-grade guideways is the width required. In many cases, the right-of-way width may not be available, even if the railroad track is shifted to one side. A two-directional busway will probably require the widest guideway, while at-grade construction of a monorail or Light Rail Transit single track will probably require the least width and railroad land. Another consideration is the ability to cross lightly traveled streets at-grade. The transit system can become very expensive if all street crossings must be grade-separated. It is not recommended that busways cross streets at-grade, unless barrier gates which allow access only to authorized vehicles are provided.

Steered Rubber Tires on Flat Running Surface

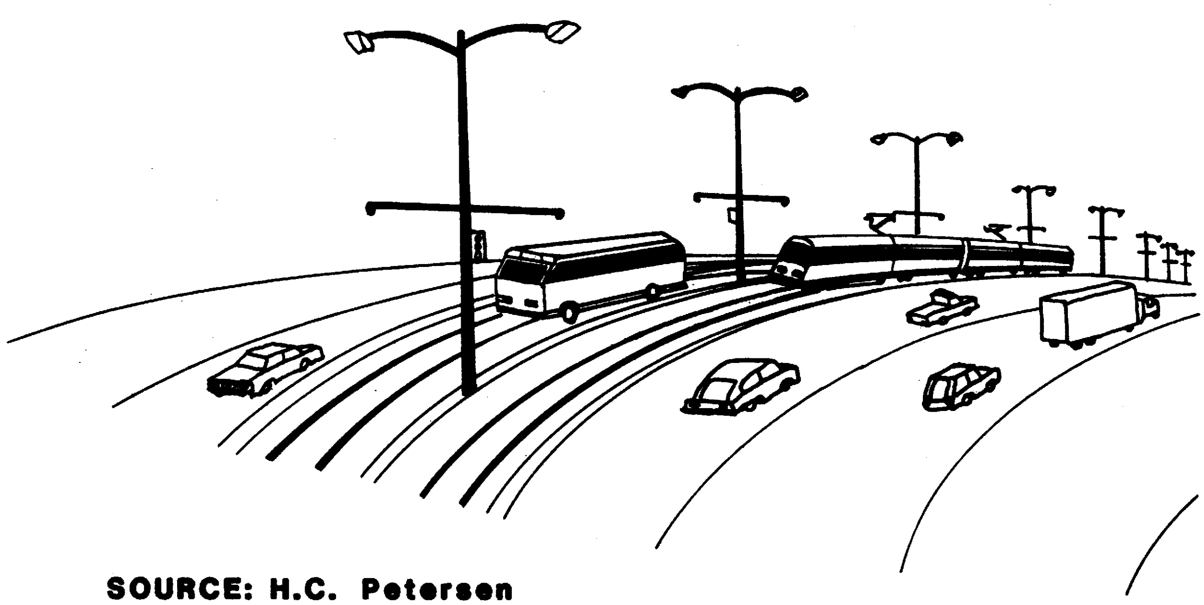
This type of guideway can be used with driver-steered vehicles (vans, buses, trolley buses), or with automatically-steered vehicles. Driver steered vehicles require a right-of-way considerably wider than the vehicles, to allow the driver to drift safely from side to side. Thus, they require the greatest width of any at-grade guideway. They have three advantages: 1) construction costs may be lower than for other types; 2) the vehicles can be steered around minor obstructions, and can be completely rerouted if alternate access roads are provided or available; and 3) the busway does not have to be constructed over the full transit route, but only over a heavily used corridor or through a bottleneck.

Land requirements and attractiveness to potential violating motorists, coupled with the complete reliance upon driver control and reflexes for safety, reduce the attractiveness of this type of guideway. In many cases, if passenger demand is high enough to warrant a busway, it is high enough to warrant a thorough investigation of a guideway which is capable of carrying trains of vehicles. One joint-use possibility is to imbed LRT rails, offset towards one side of the busway, to enable joint use by both buses (for lighter density routes) and trains of LRT or hybrid LRT vehicles (for higher density routes). Trolley buses might be able to share the overhead electrical pickup (See Figure G-3).

Automatically steered rubber tired vehicles can operate on narrower guideways and can be connected together into trains (i.e., PRT's, DFW's AIRTRAINS, Montreal Subway). These systems generally require some form of raised steering mechanism such as side rails. While the land required is generally narrower than that needed for busways, the steering guidance system usually makes grade crossings impossible, requiring Category A rights-of-way.



Joint Bus-LRT Lanes in Freeway Median



SOURCE: H.C. Petersen

Figure G-3: Joint Use of Guideway by Buses and Light Rail Transit

Rubber Tires on Straddle Rail: Monorail

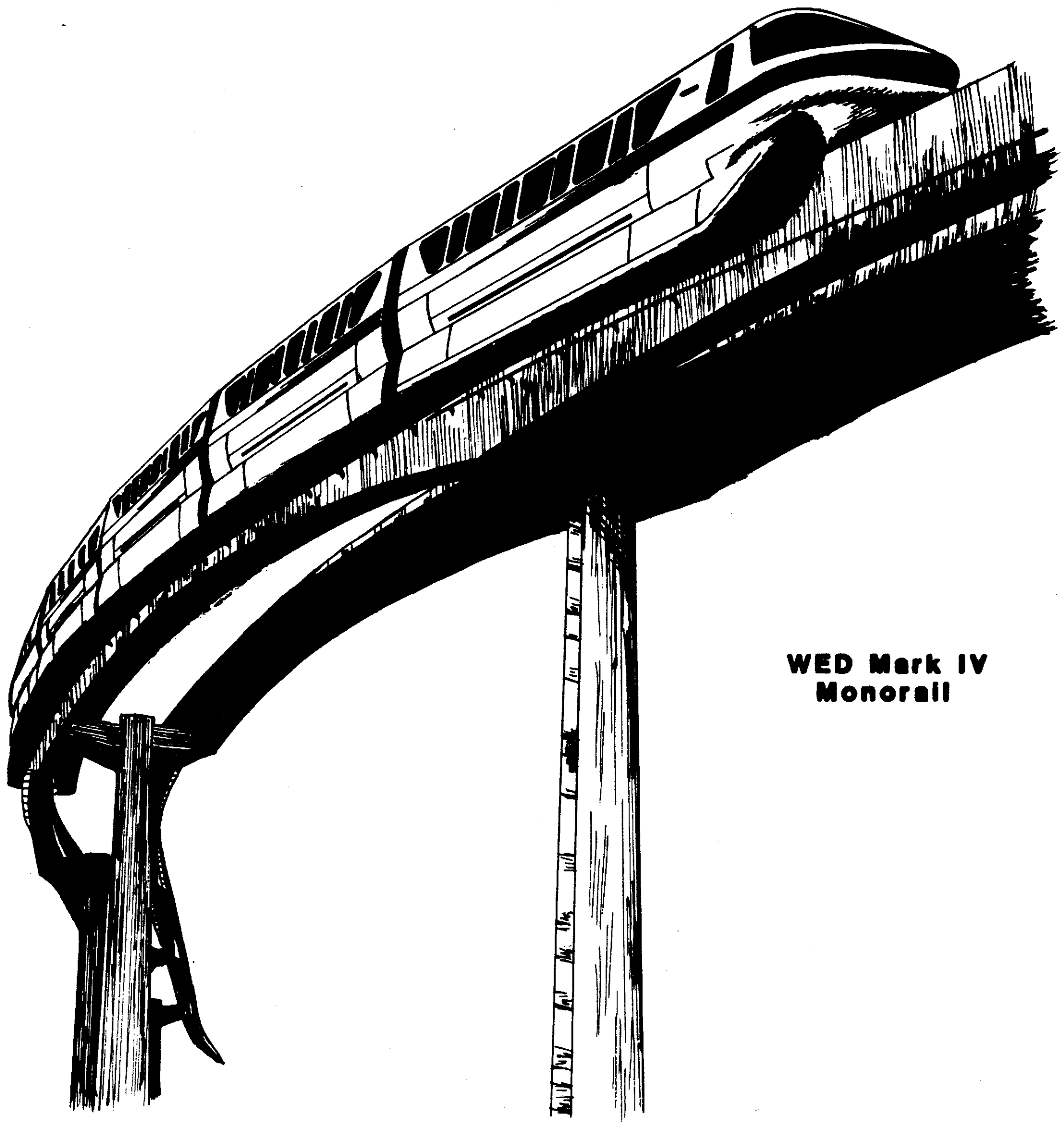
There are two basic types of hanging monorail and two basic designs of straddle rail monorails, both of which roll on rubber tires and require a large vertical guiding beam. (See Appendix H for further details). Hanging Monorails cannot be built at-grade. Either type of straddle monorail could be build at-grade with minimum-width land requirements; however, the vertical central guiding beam would preclude grade crossings with streets. Thus, all street crossings would require grade separation, which would result in constructing much of the monorail guideway in an elevated manner on some routes. In those cases where a minimum number of grade crossings exist with the present railroad alignment, at-grade monorail construction could prove to be quite economical.

Monorails are best operated on elevated structures, where they can "soar" over obstructions on wider spans than RRT elevated structures (See Figure G-4).

Flanged Steel Wheels on Steel Rails

Railroad type flanged steel wheel on steel rail allows the use of a right-of-way little wider than the passing vehicles. This type of guideway also provides for the best type of at-grade crossing allowing operation in all Right-of-Way Categories (A, B, & C). Not only can this design allow smooth crossings by motorists, but the steel rails allow for a positive, shunt-type of vehicle protection to activate grade crossing traffic control safety systems.

Not all transit types which use flanged wheels can take full advantage of this grade crossing capability. The Concept 21 vehicles, due to the steep 60^{o} angle of the track, cannot cross streets at-grade. A third rail, or a raised propulsion bar on a linear induction vehicle, may make a smooth street



Source: WED Engineering Sales Literature

Figure G-4: Monorail Soaring Over At-Grade Obstructions grade crossing impossible. Grade crossings are possible with standard railroad type vehicles such as LRT, RRT, and commuter rail if they use overhead power pick-up or diesel propulsion. Flanged steel wheels on rails can also be used for elevated and/or subway operations.

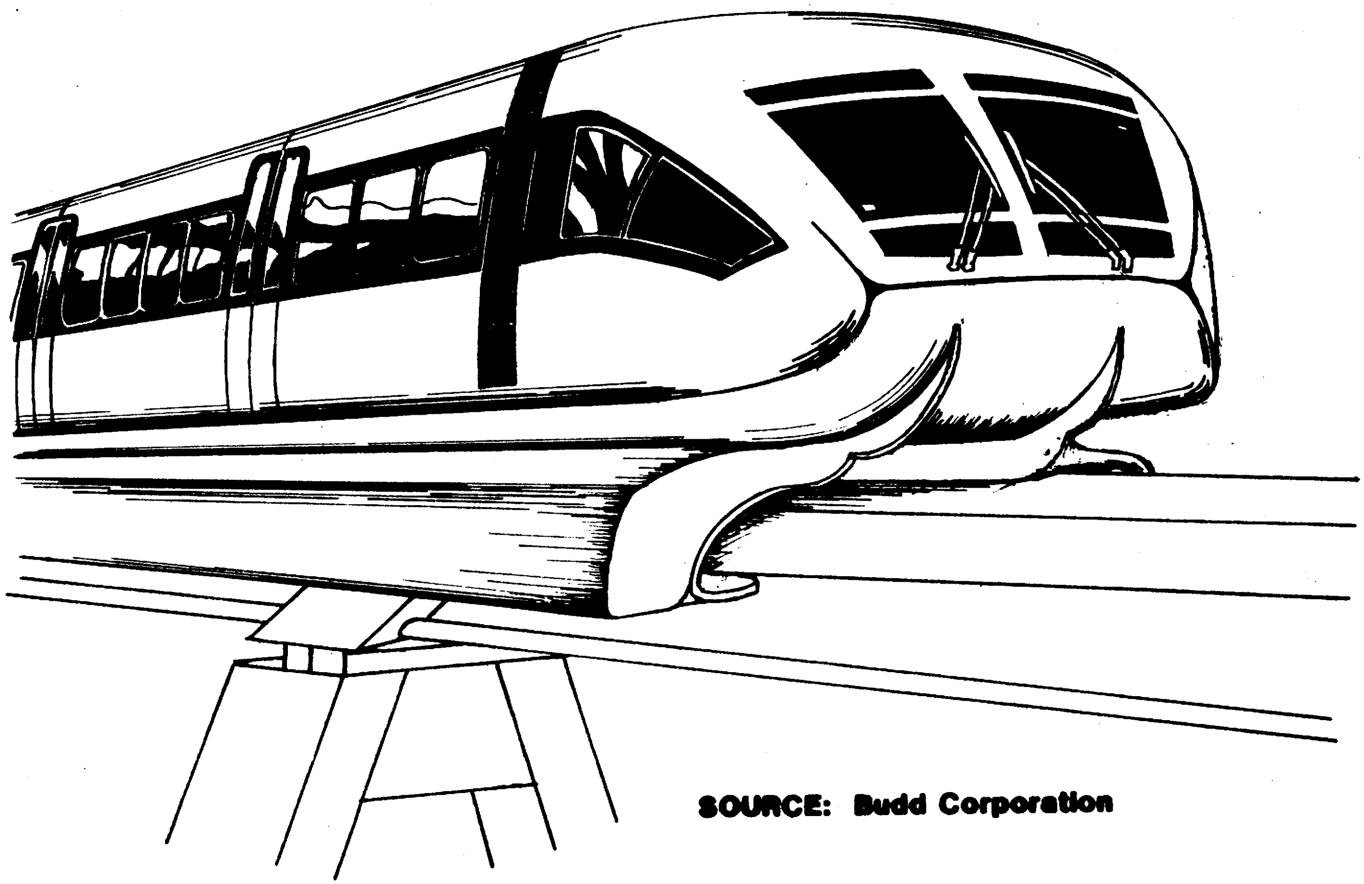
Maglev and Air-Cushion

A number of other transit systems have been proposed using different suspension systems levitation such as air cushion vehicles and magnetic levitation vehicles (See Figure G-5). In most cases, although the guideway will be of a different configuration, the comments made about PRT systems will apply. Thus, these systems are not considered separately here.

Capacities and Costs

Maximum capacities will vary with operating strategies and schedules. For a simple two-track system with no branches, line capacity is determined by the busiest station (Vuchic, 1981). Assuming a three-minute headway, twenty trains per hour can pass in a given direction. One-way line capacity in passengers per hour is determined by multiplying passengers per train times trains per hour (20 trains per hour given the above time headway assumption). Table G-1 presents capacities and costs for 4 rail technologies. RRT sometimes operates on shorter headways with capacities over 50,000 passengers per hour. Costs will vary significantly, depending upon a large number of variables. The costs given in the table were adapted from figures developed for the City of Dallas by Lea, Elliot, McGean (1983), and are given in 1982 dollars.

Budd Proposed Magnetic Levitation (Maglev) Train



SOURCE: Budd Corporation

Figure G-5: Example of Wheel-Less Suspension Transit Technology

Table G-1: Capacities and Costs

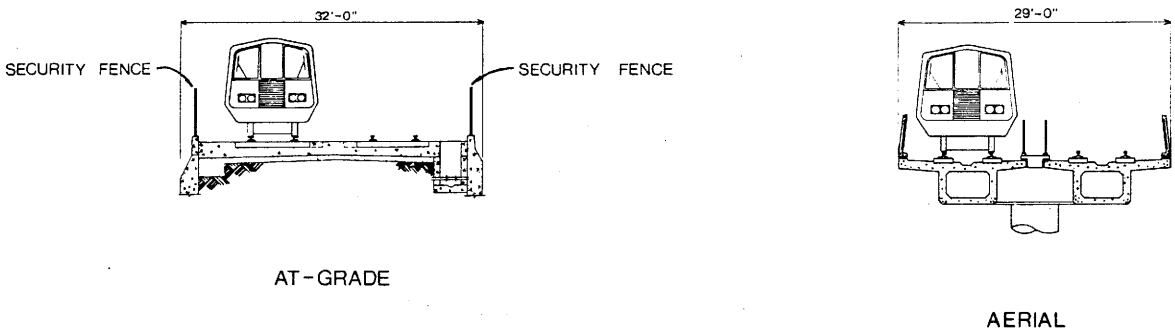
Type of Rail Technology	Rides per Train	One Way Hourly Capacity, 3 Min. Headway	Units per Train	$ Per Unit	$ Per Feet of Guideway	$ Per Feet Power Distribution	Freeway Lanes
Monorail (Hitachi) -Elevated	944	18,880	4	1,459,900	750	120	6/12
UTDC ICTS	474	9,480	3	2,184,000	850	130	3/6
Hybrid LRT	1020	20,400	6	850,500		145 (catenary)	7/14
Rapid Rail	1672	33,440	4	1,925,800		125 (3rd Rail)	11/22
At-Grade	--	--			60		
Elevated	--	--			810		
Subway	--	--			4,200		

NOTE: Stations, land acquisition, support facilities, ect. are not considered here as costs will vary according to circumstances.
Source: (Lea, Elliott, McGean, 1983)
* Single Track, Average
** One-way/both directions. Assumes: 2000 vehicles per hour per lane and 1.5 passengers per vehicle.

The final column of Table G-1, Freeway Lanes, gives the number of additional freeway lanes which would be required to handle the traffic of a single, double-track transit system. The column is based upon a theoretical freeway capacity of 2,000 vehicles per hour and 1.5 average passengers per vehicle, giving 3,000 persons per hour per lane in one direction; actual auto occupancy (and person capacity) may be less, requiring more lanes. The second figure assumes equal outbound traffic in the evening and no reversible lanes; in this case twice as many lanes would be needed to handle both inbound (a.m.) and outbound (p.m.) traffic demand. Construction of a simple transit system is equivalent to a much larger highway system to accommodate the travel demand. A double-track RRT line could theoretically replace three eight-lane freeways, while using much less land.

Impacts of Each Guideway Type

The impacts, and related construction costs, of a transit guideway depend more upon the type of guideway involved (elevated, at-grade, shared railroad trackage, or subway) than they do on the type of mode. For example, although busways, monorails, and rapid rail transit are quite different operationally, the impacts of elevated structures for each of these modes will be similar. In the same way, the impacts of parallel at-grade transitways will be similar, whether the transitways are exclusive rail rapid transit guideways, busways, or straddle beam monorail (see Figure G-6 for typical elevated and at-grade cross sections). Other guideway types inlude the joint use of existing railroad trackage and an exclusive subway. Joint track use could be in support of hy-rail buses light rail vehicles, heavy rail vehicles, or commuter trains (regional rail transit). The subway is generally not suited for joint right-of-way use.



Houston RRT: Typical Cross Sections

Source: Draft Enviromental Impact Statement, Houston Rail Rapid Transit Project, March 1983

Figure G-6. Examples of Elevated and At-Grade Guideways for Rail Transit

Elevated Transitways

The elevated transitway is the most visibly intrusive type of guideway, but not always the most harmful. Modern elevated structures are not ugly like some of the early steel structures, nor do they cause as much of a shadow. The smallest, lightest elevated structure with the widest support spacing is the straddle beam for monorails; the widest is a busway; the heaviest is the support for Rail Rapid Transit or Hybrid LRT. Elevated construction is more expensive than at-grade construction, but less costly than a subway.

Elevated structures provide minimal interference with the adjacent mobility and, thus, can be built to carry trains above busy city streets or sidewalks, parks, parking lots, and other locations where at-grade guideways would interfere with land use. Elevated guideways affect the surrounding communities in the following ways:

a) Usually, crossing streets are not closed with elevated structures; there will not be a "Chinese Wall" Effect.

b) Elevated trains will cause additional noise and some visual intrusion.

c) Convenience, accessibility, and transfers can be enhanced. Not only can the elevated guideways pass through the high-demand areas, but the guideway, stations, and route are obvious to users and/or potential users. The elevated structure may enhance service by minimizing conflicts with surface traffic.

d) Streets and grade crossings will probably not be affected, except that they may be narrowed slightly if the structure uses some street right-of-way.

e) Safety should not be a problem, if evacuation procedures are planned for, and means devised to reroute trains in case of a derailment. The general public will not have access to the guideway, so vandalism and crime should be minimal. The major safety problems are avoidance of the vehicles falling in case of derailment, open switch, or collision, and provision for emergency evacuation in case of trouble. However, these issues should be considered in the transit planning phase.

f) The following must be considered if an elevated transit guideway will be built on existing railroad rights-of-way:

   i) Minimize railroad clearance problems. Part of the transitway can be allowed to overhang the required railroad clearance area, 15 to 30 feet, provided the overhanging exceeds vertical clearance requirements, typically 23 feet.

   ii) Increased hazards & transitway support settlements. The potential for damage due to derailment of a freight train is much greater with elevated structures; a derailment which damages one or more of the support structures could result in the collapse of the transitway itself, possibly under the weight of a loaded transit vehicle. Also, the design of the transitway must take the induced vibration of the freight trains into account, which could cause differential settlement of the transitway supports, with attendant alignment problems.

   iii) Minimize access problems to adjacent industries. If the transitway provides adequate vertical clearance (23 feet or more) and the spacing of the transitway supports are carefully designed, there should be no blockage of railroad access to industries on either side of the railroad line. Future industrial access may require either track redesign or relocation of one or more of the transitway supports; this effect will be much less severe than if the transitway were at-grade. Transitways with long beam spans, over 100 feet, such as monorails, will cause fewer problems than transitways which require more closely spaced vertical supports.

   iv) Little or no effect on grade crossings should be experienced with elevated transitways, which can simply pass over the tops of the streets. Sight distance considerations should be accounted for in the design of elevated guideways and the placement of supports.

Transitways At-Grade

While at-grade is the lowest cost type of transitway construction, it can have a major "Chinese Wall" Effect. Impacts include:

   a) Maximum land requirements; clearances required. As the transitway is built at-grade, there can be no overlapping of any portion of the transitway or security fences within the clearance required from the center line of the nearest track (8 1/2 feet to

30 feet, depending upon railroad clearance needs and State clearance laws). As maximum possible spacing will be desired for safety reasons, the final figure must be negotiated depending upon the situation. Any access roads required by the railroads for maintenance purposes usually must lie between the railroad and the transitway.

b) Cuts and fills; retaining walls. Land requirements of at-grade transitways may be great enough to require the use of retaining walls to obtain adequate width and even separation from the railroad right-of-way when deep cuts or high fills are encountered.

c) Safety hazards (derailments, etc.). Blockage of the transitway, or even collision with the transit vehicle if one is passing at the time, could result from a derailment. At-grade transitways increase the hazards to pedestrians close to the railroad track, particularly in station areas. Security measures (i.e., patrols, fences, TV surveillance, etc.) may be required.

d) Freight operations (switching). At-grade transitway block expansion and industry access to the opposite side of the transitway. In most cases, grade crossings of spur lines are unacceptable from a safety standpoint. If the transitway is not grade-separated at all spurs, the guideway can deprive the railroad of customers, the customers of service, and the community of expansion opportunities.

Joint Tracking Use

Joint use of existing railroad trackage will only occur where there are existing tracks in the community. Thus, the impacts on the surrounding neighborhood will usually be minimal unless major upgrading of the existing railroad trackage is contemplated. Considerations include:

a) Unless grade crossings are closed to facilitate commuter operations, there will be no further "Chinese Wall" effect.

b) Additional trains may cause additional noise and pollution (if the commuter trains are diesel powered). If a new electric catenary is erected, there may be some visual intrusion.

c) Transit convenience, accessibility, and transfers will probably all be affected adversely, due to most freight railroad tracks not being located in the best or most convenient parts of the urban area.

Extra travel may be required to and from the commuter line, and crime may be more of a problem.

d) Streets and grade crossings will probably not be closed or grade-separated, but the additional train traffic will probably correspond with peak street traffic, causing some additional congestion to automobile/bus/truck traffic. Additional grade crossings may be signalized to protect street traffic and the transit system.

e) Safety should be quite high. The at-grade location will facilitate emergency evacuation of trains. Unfortunately, the at-grade location in older parts of town may decrease safety by inviting crime and vandalism. Added safety problems occur if third-rail power distribution is used, and intrusion surveillance may be needed.

f) Some effects of joint trackage use on the host railroad follow:

   i) Maximum interference with railroad operations will occur; in most cases transit operations should be completely time-separated from freight operations for safety reasons. Joint use of trackage can make it very difficult for railroads to schedule their freight operations.

   ii) Collision hazards and signal compatibility are very real problems. Transit signals may be lower than railroad signals and may display different signal indications. Vehicles which are significantly lighter in weight than LRT vehicles may not properly shunt the railroad signal system. For these reasons, there is increased hazard to the transit vehicles of colliding with a freight train. In many cases, railroads and regulatory agencies will not recommend joint track usage.

   iii) Safety and regulations. Joint track usage will bring the transit authority under State and Federal railroad regulations if the railroad is engaged in interstate commerce and particularly if joint operations are planned in the same time window. This is not necessarily a bad situation, however, because compliance with State and Federal railroad safety and operating regulations will, in some cases, increase the overall safety of the transit operation, but may hinder operational flexibility (e.g., by requiring a full train crew per vehicle).

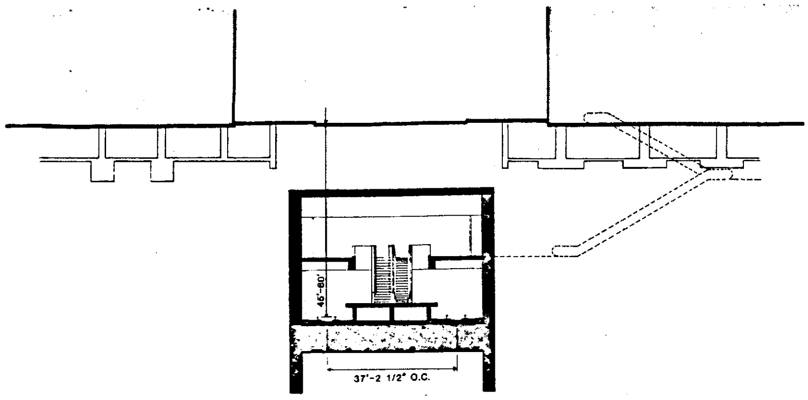
   iv) Labor agreements may become much more complex, as both railroad and transit unions will possibly claim the same jurisdictions. If joint operations are planned, it is highly recommended that union negotiations be completed as much as possible prior to major capital outlays.

v) Different levels of track maintenance may be required for freight operations than for transit operations. Particularly for branchline operation, the railroad may be satisfied with Federal Railroad Administration (FRA) Class One or Two track (loose geometry), while the transit operation may wish for Class Three, Four, or even Five (better track alignment) to provide safety and a smooth ride at higher speeds. Complicating the issue further, low speed freight trains will contribute to the deterioration of track geometry. It may be difficult to convince both the railroad and the transit authority that they are paying a fair share of track maintenance.

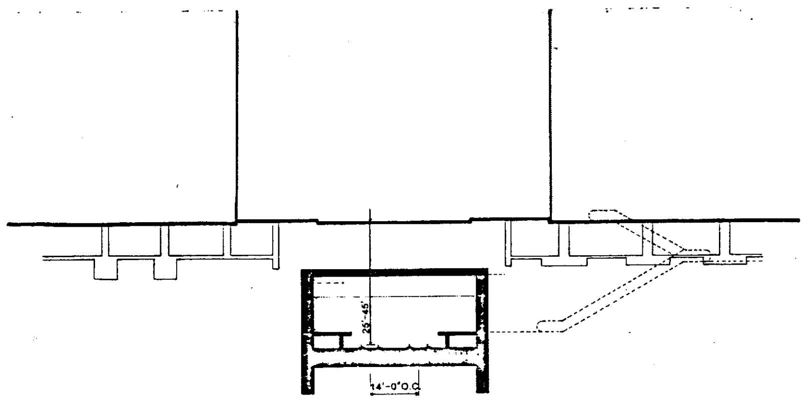
vi) For the above reasons, joint track usage should probably be minimized if possible, except for commuter trains. It is far easier on both the railroad and the transit authority from an operational standpoint, to keep the transit and railroad interests physically separate. While joint track usage may appear attractive from a capital investment standpoint, the track reconstruction costs, and added long-term operating costs especially for the railroad, combined with safety considerations will probably outweigh initial savings except for extremely lightly-used (1-5 trains per week) industrial spurs. A full economic and safety analysis is a must during the rail transit planning phase.

Subways

Subways, after construction, provide the least disruption of surface traffic and land use but are the most expensive types of transit guideways. Subways generally are used only in congested central business districts (CBD's); during construction existing buildings must be protected and street traffic rerouted for extended periods of time. A number of construction techniques may be used, including cut-and-cover where the street is excavated, the subway constructed, and the street re-covered and paved. The subway may be tunnelled beneath the city. In either case, care must be taken to avoid settlement and damage to adjacent buildings and underground utilities (See Figure G-7).



SUBWAY - TUNNEL



SUBWAY - CUT & COVER

Houston RRT: Typical Subway Cross Sections

Source: Draft Enviromental Impact Statement, Houston Rail Rapid Transit Project, March 1983

Figure G-7: Cross Sections of Completed Subway Sections Using Tunneling Or Cut and Cover Construction Techniques

Once in place, however, the subway is completely out of the way and often very accessible to riders. Some problems do exist, however. Diesel fumes preclude use of diesel power in all but the shortest subways. Drainage may be a problem, with sump pumps required to keep water out. The dark ride is much less pleasant to riders. Expansion is very difficult with the initial design normally dictating the transit vehicle type (See Figure G-8). The main problem with subways is their cost, however, which is typically much higher than at-grade or elevated guideways. Thus, subways usually are not considered unless other alternatives are proven infeasible.

Once built, the following impacts of a subway could occur:

a) There will be no "Chinese Wall" effect.

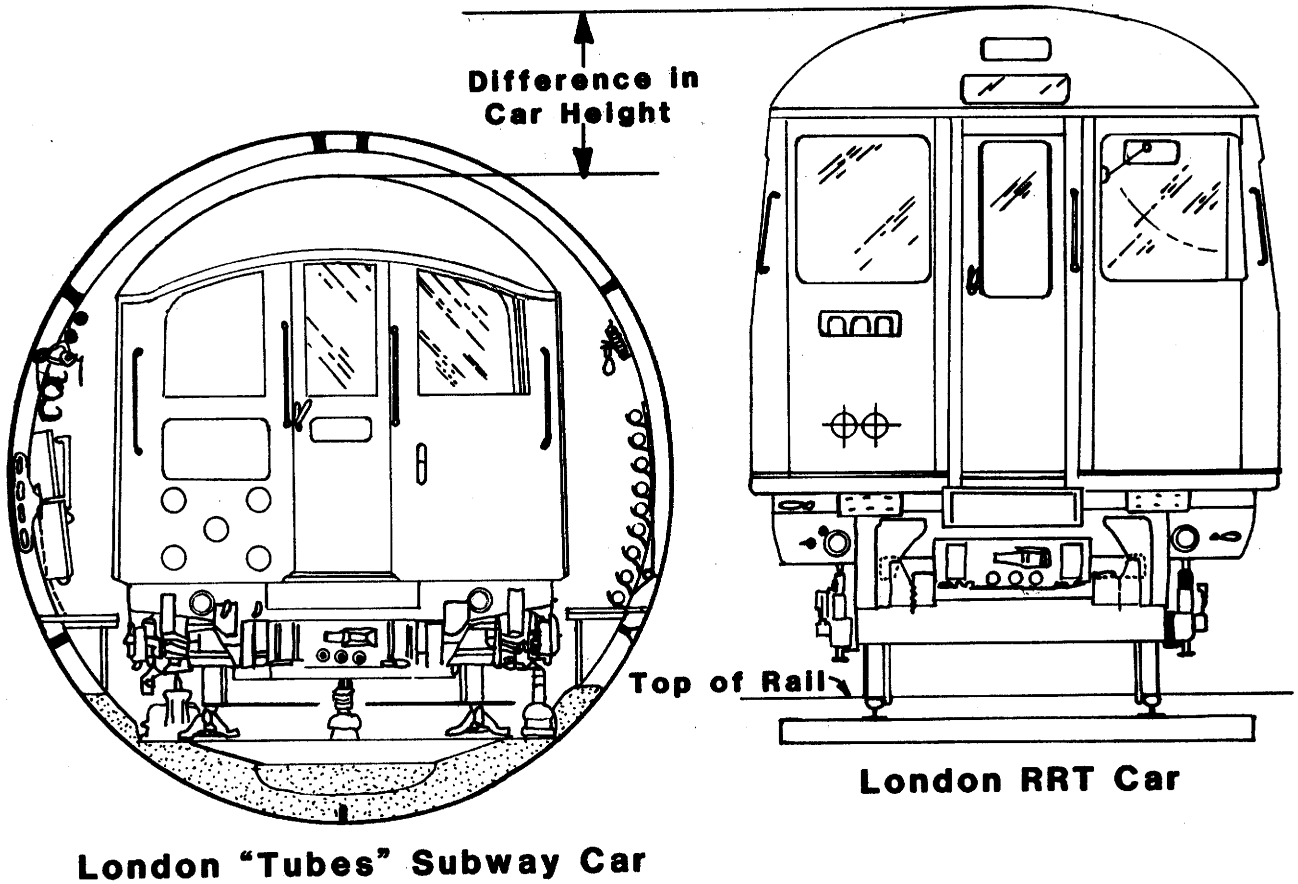
b) Additional trains may cause a low rumble, but overall noise, pollution, and visual degradation should be virtually non-existent.

c) Transit convenience, accessibility, and transfers will probably all be excellent. Due to the high costs of subway construction, they usually are built to maximize utility. They are not flexible, however, and once in place are very expensive to rebuild. Also, access to stations deep in the ground may result in inconvenience; elevators and escalators will be required.

d) Streets and grade crossings will not be closed. No congestion of surface traffic will occur due to the subway.

e) Safety could be a problem. The underground, secluded subway may invite crime, but proper surveillance and security can provide reasonable safety. In case of a problem such as fire or derailment, the constrained underground location will tend to hinder emergency evacuation of trains. Offsetting these problems somewhat is the fact that the underground location greatly restricts trespasser access and minimizes the effects of weather.

f) Subways are generally not built under existing railroad lines. The extremely heavy construction needed to withstand the loadings generated by an overhead freight train and the disruption caused by construction are two reasons. Parallel railroad-subway construction will not be considered within the context of this report.



SOURCE: Passenger Environment, 1972.

Figure G-8: Comparison of Rail Vehicle Sizes Used In London; Subway Design May Dictate Car Technology and Limit Felxibility.

Types of Vehicle Control (Operation)

Fixed guideway systems are capable of three basic types of vehicle control:

1. Full operator control, with or without signals;
2. Operator control with safety override; and,
3. Automatic control with or without on-board operator.

Steered vehicles such as buses must use full operator control. In addition, all but the simplest systems use some type of centralized dispatching to control overall operations. All except the smallest transit systems require support facilities, including a main office, support offices, maintenance facilities, and vehicle and track maintenance storage facilities. If electrically powered, the system will require a power supply and substations.

Full Operator Control

Buses and Light Rail Transit in streets require full operator control in order to allow the vehicles to move with the surrounding traffic. Operators (drivers) control the speeds, stopping, warning signals (horn or bell), door operation, and may even collect fares. Such operation requires at least one operator per train or bus who has the necessary skills to perform his tasks through primarily visual input. While the operators may control the vehicles according to signal indications and/or verbal or written communications from a central dispatcher, the possibility of an accident caused by human error is high, and safety depends upon the skills and attention of the operator. To increase safety, various operating plans and rules are usually enforced, including operation by signal indication.

The simplest types of operation exist when a single vehicle or train has exclusive use of a guideway, such as the operation of the Seattle Monorail, where each train shuttles back and forth on its own exclusive track. In this case, collisions between transit vehicles will not occur; however, operators must still be vigilant for obstructions on the guideway.

When more than one vehicle shares the same guideway, collisions must be avoided. Sometimes, all that is involved is visual alertness and/or scheduling a single vehicle on the track at a time by timetable or dispatcher's orders. More complex operation is a block signal warning system, to warn of the presences of a train ahead. The dispatcher may also use signals to control the movement of trains (Centralized Traffic Control, or CTC).

Block signals evolved from freight railroads; in fact, commuter trains operating on freight railroad tracks often operate under full operator control with signals. Railroad signals generally operate by passing a current, which energizes a relay, through the rails. A train shunts (shorts out) this current, causing the relay to drop and display a red signal which indicates stop, or stop and proceed. The current may be direct current, alternating current, or a time-coded current of a special frequency (Hay, 1977). The simplest block signals indicate either stop (red aspect) or proceed (green aspect), in which case each block length must be the stopping distance of the train at full speed. Systems such as polarized relays are used to give an intermediate yellow approach indication to warn of the presence of a train in the second block ahead; the following train must immediately slow down. Thus, overlapping blocks can be the length of the slower stopping time (for the higher speed train), allowing shorter signal blocks and smoother operation.

Hybrid LRT can operate under full operator control in downtown areas, switching to more automatically controlled operation on other portions of the route.

Operator Control with Safety Override

Due to the potential for human error with full operator control, some transit systems have developed safety overrides, usually in the form of an Automatic Train Stop (ATS). Some automatic train stops operate by direct contact between a track-side device, while other devices operate through means of an induction coil or similar system. The principle is quite simple. In one version, the train brakes are set in emergency if the train passes an ATS which has been activated in conjunction with a red signal. A second version activates a warning alarm if the train passes a restrictive signal; the operator must immediately reset the device, and in some cases also immediately reduce speed, or the train will be stopped. The first system is almost fool-proof but can cause excessive train delays, particularly when the signal system is causing problems (wet weather, etc.). The second type of system which can be overridden by the operator can also lead to accidents due to errors in judgement by the operator, but can also minimize delays. Neither system is completely fool-proof; although many accidents have been avoided there have been a few collisions even with Automatic Train Stop (Shaw, 1978).

Some commuter railroads have small signals inside the operator's cab which respond to coded frequency track circuit signals. These signals provide a continuous indication of the condition of the track (when they are working properly). A warning whistle which sounds when a cab signal changes to a more restrictive aspect is often provided; the operator must reset the system to avoid automatic brake application. Federal regulations require that either ATS or cab signals be installed on railroad trains which exceed 79 miles per hour (Shaw, 1978).

While these automatic systems will reduce accidents by stopping trains when the operator fails to act in a timely manner, control is still left completely in the hands of the operator unless an emergency situation arises.

Automatic Control With/Without On-Board Operator

Computers and microprocessors now have the capability of completely operating a transit system. Tied in with detection circuits and a centralized master dispatching computer, systems are in operation which can automatically close the doors, start the trains, control speeds, sense danger, stop the trains for service stops at stations and emergency stops, open the doors, throw switches to route trains, and completely operate the system without human intervention. Thus, an operator is no longer necessary on each train. Some systems, such as the AIRTRANS PRT, not only have eliminated the operator, but do not even have on-board manual controls (a portable control panel must be plugged in for manual operation). AIRTRANS depends upon signals from a central dispatching computer to small on-board computers for all operating functions. This system has proven to be highly reliable and extremely safe (Kangas, 1976). This type of operation allows frequent service of the small trains or single vehicles without the resultant high labor cost of individual operators.

Some systems, while designed for fully automatic control, still retain an on-board operator per train to act in emergencies, to monitor system performance, and to be present to reassure passengers and to deter crime. In such cases, the operator may perform some routine functions, but usually must override the automatic system in order to gain control of the train. Of course labor costs are higher, and such systems usually operate fewer, though longer, trains (e.g., BART).

Scheduling

Scheduling of trains is a function of demand, train size, physical routes, and operating conditions. There may be virtually no schedule for a simple shuttle system, or there may be rigidly controlled schedules which are repeatedly updated to maximize utilization.

Continuous-Unscheduled

On some systems, one or more vehicles are kept in continuous operation. At the end of the line they immediately return without waiting. This type of operation provides for maximum capacity of a simple end-to-end or loop route, although passengers may be discouraged by long uncertain waits unless enough individual trains are used to provide extremely frequent service. If more than one train is used, a delay to one train may pyramid into delays of all following trains, resulting in all trains running bunched together.

Continuous loop systems, or a two-track system with one dedicated track each way can operate at maximum theoretical capacity. The maximum number of trains which can pass through a given station in one direction can be calculated by dividing sixty minutes per hour by the headway in minutes per train, assuming stations are not extremely close together and assuming no interference from traffic or other sources. With a three-minute headway, this results in twenty trains per hour passing through a single station in a single direction. Hourly one-way capacity is then simply twenty times the capacity of a single train; in actual practice, operating delays may reduce this theoretical capacity somewhat.

Due to the irregular service which can be caused by delays, such operation is usually not advisable for any but the smallest of systems, unless service is very frequent, or centralized traffic control is used, in which case both capacity and service can be maximized through computer-assisted dispatching.

Continuous-Scheduled

While trains operate almost continuously, schedules may be provided by allowing a slightly longer time than will normally be required to cover the route, with trains which normally arrive slightly early, waiting at some stations until the scheduled departure time. The actual amount of scheduled slack time will depend upon the variability of expected delays. Systems which operate in mixed traffic will, of necessity, require longer slack time unless late schedule running is acceptable. This type of schedule operation is advantageous when fewer trains are needed per hour. If four trains per hour are operating, riders may object to waiting an indeterminate period of time, when they would not object to waiting for trains that they know will leave every fifteen minutes. Bunching of trains is also avoided. Dispatching and scheduling of trains is more complex when a number of routes converge at a junction. A disadvantage of this system is that maximum utilization is not made of either crews or vehicles. For example, San Francisco was forced to use a variable dispatching system instead of fixed schedules to maximize utilization of their Boeing Light Rail Vehicles (Rosen, 1982).

Continuous With Adjustment for Demand

Some transit systems which have peak morning and afternoon ridership demands desire to maintain the same level of service throughout the day, whether operating continuously or by the schedule system previously described. This may be done by reducing the number of cars per train during the off-peak periods, which reduces operating and maintenance costs, but not normally labor costs. Large trains are operated during the morning peak.

During mid-day, the extra, unused cars are uncoupled until the afternoon peak. This system of operation will save operating costs during mid-day, but will incur extra switching costs as the size of the train is constantly adjusted for demand. Switching time must be allowed for in the schedule.

Variable Schedule Adjusted For Demand

A number of transit systems which have peak passenger demands in the morning and afternoon simply change the service level during off-peak hours. Trains may run every two minutes during the peak hours, operate every half hour during the day, and may operate as infrequently as once per hour during the evening. Excess trains are not shortened; they are simply removed from service and the schedule lengthened when capacity is not needed. Operating costs of the trains are thus saved during off-peak hours. If labor contracts permit split shifts (when an operator works a few hours during the morning peak, goes off duty during the day, and returns to work a few hours during the evening peak usually with premium pay), labor costs can be reduced.

Fleeting/Split Shift/Storage Downtown

Lines which carry large numbers of inbound commuters in the morning with reduced trains or no trains during the day, and then carry the same commuters outbound in the evening may elect to save running costs by storing the trains at the outlying station overnight and at the downtown station during the day. This practice is common for some commuter trains. The trains pick up inbound passengers in the morning and remain parked at the downtown station during the day. Thus with no switching or other operation costs, the trains are in position to return the commuters home at night. Single track capacity can be increased in this type of operation by "fleeting" the commuter trains (running a number of trains as closely behind one another as the signaling system permits and allowing no opposing train on the track until the inbound fleet of trains has passed). This type of operation is very suitable for suburban-dwelling urban employees, and usually does not operate on weekends.

Scheduled service is subject to disruption by derailments or vehicle malfunction. The most vulnerable track to schedule disruption is a single track with passing sidings in which a single stalled vehicle can block the complete line. A double track with crossovers will allow other trains to pass a stalled vehicle, although there will be delays as the trains are fleeted around the stalled vehicle. If three or more tracks are in operation on the line, it may be possible to dispatch trains in such a way that a single stalled vehicle will cause virtually no delay (See Figure G-9). For this reason, a minimum of two tracks are recommended. Centralized Traffic Control (CTC) may be used by a central dispatcher (with or without computer assistance) to minimize effects of delays on multi-track lines. Also, proper use of CTC can allow operation of a larger number of trains on the same system, in many cases reducing capital requirements.

Safety and Human Factors

Design and operation of any transit system requires consideration of human factors, aesthetics, safety, and convenience, in order to encourage maximum public use of the system. This is especially true with joint right-of-way sharing with an existing freight railroad line, which may pass through less-desirable, run-down sections of the cities.

Most of the following points are completely mode and guideway-independent; they address considerations which any transit system must investigate but some take on added significance when the transit system is located along an existing freight railroad line. Points considered here include:

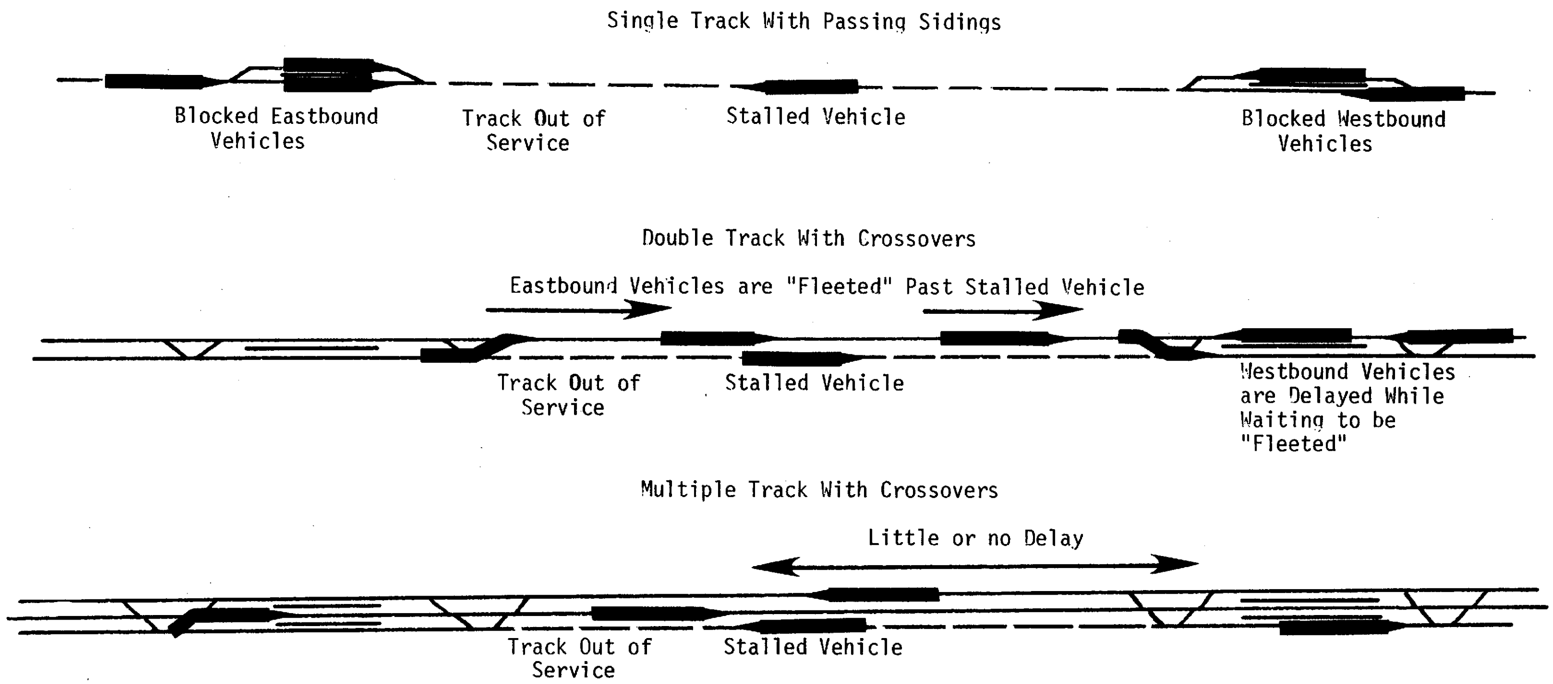


Figure G-9: Single Versus Multiple Track Influences on System Operation

1. Transit Functions - General;
2. Fare Collection;
3. Crime and Personal Safety;
4. Station Design and Function;
5. Station Dimensions and Aesthetics;
6. Handicapped Accessibility; and,
7. Rules and Safety.

Transit Functions - General

While the primary function of any transit system is to move people from place to place, once a fixed-route system with fixed stations has been selected (as opposed to taxis, private automobiles, dial-a-ride systems, etc.), certain associated sub-functions can be identified and ranked. McCormick cites a 1970 study by Golob, et al., which reads:

> "Arriving when planned, having a seat, and no transfer trip, highest; followed by minimum delay, shelters at pick-up, less waiting time, choose pick-up time, lower fares, longer service hours, shorter walk to pick-up, shorter travel time and direct route. Lower ranked functions included fare, entry-exit, dependable travel times, lack of crowding, package space, public phones, adjustable seats, etc. Of almost no concern were coffee and newspapers on board or stylish vehicle exterior." (McCormick, 1976).

Although any fixed guideway system will require some transfer trips, regular and frequent schedules by fairly large vehicles with maximum seating will meet the other highly-ranked functions; low-ranked functions should be considered only if economical. Cars should have a pleasant appearance, of course, and should be reasonably comfortable, with wide aisles, air conditioning, etc.

The study (McCormick, 1976) apparently did not address safety and clean, fresh surroundings. Considering railroad routes through older parts of cities, these could be greater problems if joint railway rights-of-way usage is planned. Safety would rate very high as a concern. Frank Mazza of New York's transit system states that the public's perception of crime is greater than actual statistics (Mazza, 1978), but fear of crime is enough to prevent many potential riders from leaving their automobiles, especially at stations located in the run-down areas.

Other functional design considerations should include convenience for Park-and-Ride passengers and commuters dropped off at the station, commonly called Kiss-and-Ride passengers.

Tracks and right-of-way structures, as well as buildings and service facilities, should be designed to maximize safety and aesthetics while minimizing negative features such as noise, visual intrusion, traffic congestion, and hazards. There are advantages to paralleling an existing railroad since the adverse aesthetics of the additional transit line may be minimal. Use of the system should be available with dignity to the maximum number of users. This means that as many barriers to the handicapped and mobility impaired should be eliminated as possible, and that information should be clear enough to allow non-English readers to freely use the system.

Fare Collection

Three basic types of fare collection are possible. The old trollies used on-board fare collection. A modified "Peter Witt" (Middleton, 1976) type of fare collection would allow on-board fare collection with rapid boarding, as passengers could choose to pass through the on-board fare gate as the car was moving, or to remain forward of the gate and pay to exit through a rear door. Many fixed guideway systems use off-board fare collection. Often, if multiple fares are used, a passenger is directed through both entrance and exit turnstiles which together determine the fare. (Schumacher, 1970).

Some European systems use self-service fare collection, with no turnstiles or monitors. Each rider purchases a ticket and validates (and cancels) it when he enters at the door. Local laws allow roving inspectors to check tickets, and to assess and collect substantial fines on the spot from cheaters. A 5% sample is typically checked, with less than 1% fraud (De Leuw, Cather & Co., 1976).

Another option, free fare, as used by the Tandy Subway System in Fort Worth, Texas, (Tandy Corp. Subway Division; Scott, 1978), is not usually practical for urban transit systems financed with public funds.

The type of fare collection will determine whether a secure area separated by turnstiles is necessary in each station. Such areas will not be necessary with on board or self-service fare collection, although slower boarding times may result in the need for larger platforms and longer station dwell times. Passenger flow and congestion will determine the number of turnstiles needed. Lang and Soberman reported that 50 people per minute can pass through a coin-operated single-fare turnstile, with 40 people per minute for multiple fares (Lang, 1964). Cards would probably give a capacity of 40 people per minute. A reasonable peak design capacity should be 25 to 30 people per turnstiles per minute, in case not all turnstiles are operative.

Use of cards or tokens would require a card, add-fare, or token vending machine. Unmanned stations would need a telephone to allow passengers to request assistance in case of vendor or gate malfunction, to enable all who pay to actually ride. Even isolated incidents of inserting money but not being allowed to ride will hurt ridership.

If bus transfers are used, entrance turnstiles could provide these, as is done in Atlanta (Metropolitan Atlanta Rapid Transit Authority, undated).

The social benefits of reducing automobile traffic argue in favor of partial transit subsidy to increase ridership through decreased fares. The proper fare and subsidy levels must be ultimately determined by the transit decision-makers using input from the urban area residents.

Crime and Personal Safety

Rail transit operations are inherently very safe. In 1981, on eleven RRT properties 1,523,087,357 passengers were carried. Only 57 injuries and 2 fatalities were attributed to train accidents. Eighty-seven percent of all train accidents resulted in no personal casualties (Dalry, 1982).

Crime can be a strong deterrent to transit use. Unless the public feels that they are well protected, they will prefer to use their slower but apparently (perceived) safer automobiles. There are three classes of transit crime: vandalism, theft of transit rides or equipment or money, and crimes against riders.

While certain types of vandalism can affect public safety, usually it involves defacing or destruction of property, or urinating and defecating. Crimes against the transit system most often involve people who jump the fare gate to steal a ride, but station or car equipment is sometimes stolen. Station attendants, operators or transit patrons may be physically assaulted or robbed.

A Park-and-Ride facility requires the user to park their automobile and leave it unattended, usually all day. This provides an ideal opportunity for car thieves to steal or strip a car, and not be detected for hours, unless adequate parking lot surveillance and protection is provided.

The most feared type of crime by the public, of course, is crime directed against the individual rider. These crimes can range from theft of items left unattended (pocket picking and purse or briefcase grabbing), to more dangerous crimes such as armed robbery, mugging, assault, rape and/or murder.

While crime is high in public consideration, safety usually is not, except when accidents result in public injury, such as collisions or fires. Personal safety and protection against accidents at stations, road crossings, and right-of-way is usually ignored. Yet, in addition to slipping, tripping, and falling, abrasions against rough walls, striking low obstructions or signs, getting clothes soiled, or parking lot accidents, transit stations pose special problems of high platforms, turnstiles, moving trains, closing doors, and electrocution. Features can be designed into stations and cars to minimize these hazards. Subways increase perception of crime by their off-peak loneliness, shadowy corners, and dark tunnels (Mazza, 1978; Hackney, 1978). Crimes are often committed by "...young kids, late teens, and early 20's...looking for trouble" during the late evening (Hubert, 1978). Thus, by designing stations to be open and airy, with good illumination and few places for criminals to hide, and by discouraging loitering by young kids or others who do not ride the trains, the perception of crime as well as crime itself can be minimized. Washington D.C. has one of the safest, cleanest systems of stations in the country. Not only is graffitti cleaned up immediately, but walls are recessed behind railings to discourage vandalism. Stations have attendants but no public restrooms, which can be havens for crime.

Most transit systems employ police to reduce crime. Some systems use decoys, dogs, and T.V. surveillance (Mazza, 1978; Hackney, 1978; Crosby, 1978). T.V. surveillance, if a video or picture recorder is included, can greatly assist prosecution as well as prevention. T.V. surveillance with recorder may also be employed to minimize crime and vandalism on trains, especially on trailer cars, where crime and vandalism is more prevalent. Atlanta has marked assistance phones and glass elevator door panels, in addition to many other more common security features (Metropolitan Atlanta Regional Transit Authority, 1979).

Thus, open, light, airy architecture, with railings, recessed cleanable walls, and glass elevator doors should be used in all station construction.

Transit police, T.V. cameras with recorders, and attendants for major stations and all trains, should be employed, as well as non-uniformed police. Attendants should not handle money unless inside a bullet-proof booth. Talk-back public address systems would enable police to aurally monitor suspicious activity and, in many cases to scare criminals off.

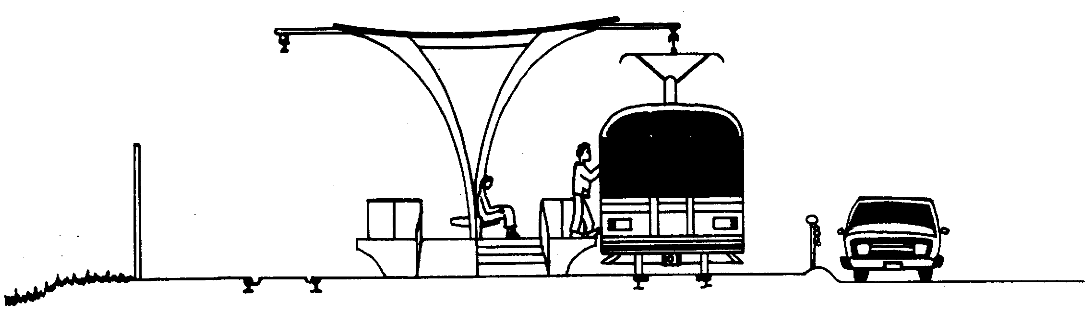
Public safety can be enhanced through stairway guardrails, good lighting, and elimination of rough walls and low clearances or sculpture with overhanging parts or extensions which could strike heads. Where possible, clearance should consider the tallest riders, rather than the "average man" (Damon, 1966). Hedges and draped decorative chain barriers can discourage crossing tracks at poor locations or along the right-of-way, minimizing chances of being struck by trains. A single center fence or shrub hedge should be adequate (Fox, 1968). Fences to force pedestrians to zig-zag in crossing tracks would cause them to face both ways before crossing.

Overhead wires at all stations greatly minimize electrocution dangers. High station platforms should be edged with a rough paving 18" wide to catch slipping riders and to warn the blind to step back through tactile input. An overhanging platform lip provides space for a fallen person to roll out of the way of a train.

While the safest approach to street grade crossings is complete grade separation, this can be very expensive. Lightly used private crossings, and street crossings near stations where trains are moving slowly, can be safely crossed by transit trains at-grade if overhead power distribution (or dual pickup) is used. One suggested criteria is to provide grade-separated crossings for streets where traffic flow exceeds 5,000 automobiles per lane per day (DeLeuw, Cather & Co., 1976). All at-grade street crossings will require automatic gates and warning lights. Of course, such crossings can be tied in with traffic signals to minimize chances of automobile traffic turning or crossing in front of an approaching train (Olson, 1978). A loud horn on the trains will warn both passengers and automobiles of a train's approach.

Station Design and Function

The primary function of any station or stop, of course, is to provide a location for boarding and leaving the transit cars. This can range from unprotected mid-street boarding such as used for LRT (Olson, 1976), to multi-million-dollar structures which incorporate streets, freeway bridges, and expensive architecture, such as the MARTA Civic Center Station (Metropolitan Atlanta Rapid Transit Authority, 1976). To save initial start-up costs, simplified stations may be considered, ranging in complexity from the simple covered platforms with benches and on-board fare collection as shown in Figure G-10 to fairly complex stations at major stops, with off-board collection, sanitary facilities, attendant, and air-conditioned waiting areas. Stations should be designed to blend with the surrounding areas, and be landscaped with low shrubs or other decorative barriers to keep the public separated from the railroad operations.



Light Density LRT Station

Source: H.C. Petersen

Figure G-10. Simplified Rail Station With On-Board Fare Collection

To assist riders, standard consistent conventions should be followed in design, wherever possible. For example, the AIRTRANS transit system at the Dallas-Fort Worth Airport installed some exit turnstiles to the left of the entrance turnstiles. This violates the "keep right" rule usually followed in the United States, resulting in unnecessary congestion and confusion. Some entrance turnstiles were placed next to walls; these are much less used than adjacent turnstiles, as they violate personal space by forcing users next to a wall (Kangas, 1976).

Information should be made available throughout the station by use of clearly-visible, bold signs, maps, directions, and other displays. Where possible, visual displays should be bold with good contrast against the background (realizing some viewers may be color-blind), with strong, closed, contrasting boundaries. Symbols should be simple, self-contained, unified, and easily recognizable; they should be universal (international) symbols wherever possible. Signs and maps should be at or slightly below eye level. One example of display would be bold silhouettes of an airplane and city skyline to indicate the directions of airport or downtown, respectively. Major destination points, such as fare devices, attendant's booth, exits, bus stops, etc. should be clearly visible, with clear flow paths (Demetsky, 1978). An attendant announcing trains and giving information (trained in sign language for the deaf) along with raised maps with Braille, and Braille signs would assist the handicapped.

Station Dimensions and Aesthetics

In addition to providing comfortable shelter, the station should be designed to maximize passenger flow. Thus corridors, doors, and platforms must be sized for the expected passenger loads or usage. Lang and Soberman cite design passenger flows per foot of width per minute as follows:

Level Corridor - 27 passengers/foot (width)/minutes;
Upward Stairs - 19 passengers/foot (width)/minutes; and,
Downward Stairs - 21 passengers/foot (width)/minutes.

While maximum capacity occurs at 0.4 persons per square foot, they write, walking becomes a shuffle. Stairways should be widened approximately 50% to avoid bottlenecks (Lang, 1964). Dimensions should consider not only the people, but bulky packages or clothing (Damon, 1966). These guidelines should thus be treated as minimums, and be generously enlarged in actual station design. Pedestrian facilities should be designed for the highest level-of-service possible as shown in Table G-2.

Table G-2: Pedestrian Levels-of-Service Design Guidelines

Level-of-Service	Flow Occupancy	*Flow Rate	Queue Occupancy
A	35+	0-7	13+
B	25-35	7-10	10-13
C	15-25	10-15	7-10
D	10-15	15-20	3-7
E	5-10	20-25	2-3
F	0-5	25+	0-2

*NOTE: Flow Rate in Persons per foot width per minute.
Source: "Guide for the Design of High Occupancy Vehicle and Public Transfer Facilities," AASHTO, 1983, p. 21.

Due to the short headways between trains, probably not exceeding 20 minutes even at low-ridership periods, large numbers of seats will not be necessary; but some seats, at least, should be provided at each station to accommodate tired and/or handicapped riders. Stations which serve as transfer points will require more seats. These should be molded and dimensioned for comfort, approximately 17.5" high, 11.8" deep, with tilted, formed back rests (McCormick, 1976). At stations with off-board fare collection, seats should be provided on both sides of the turnstiles.

To distribute the load throughout the trains, multiple entrances throughout the length of the station's platform should be provided. The platform should be large enough to hold waiting passengers between trains; at least large enough to provide for densities of 0.2 to 0.5 passenger per square foot to allow entering and leaving passengers to pass each other freely (Lang, 1964).

Park-and-Ride lots, distances to offices, homes, etc., should provide for maximum walking distance of 3,000 feet (Westley, 1978); much less if possible. Otherwise, connecting bus or people mover service should be provided. Atlanta provides bicycle lockers for students and others who ride their bicycles to the stations (Metropolitan Atlanta Rapid Transit Authority, undated).

Parking lots should be designed with 90^{o} stalls, if possible, to enable head-in parking from either direction for Park-and-Ride users looking for spaces. The standard stall is 102 inches wide and 18 feet long for this arrangement (Carter, 1978). Small car spaces 90 inches wide and 15 feet long, with a 20 ft aisle, for compacts could be placed nearest the station, both saving space and encouraging drivers to use small fuel efficient automobiles.

While not a strict function of station design, employees should be required to always be courteous and helpful, to make transit riding a pleasant experience. Suggestion boxes should be used to elicit passengers' ideas, and to give them a perception of input to what decisions are made.

Stations can be designed to individually blend in with the surrounding area, as was done at Atlanta (Metropolitan Atlanta Rapid Transit Authority, 1979). For example, use of Houston's Union Station as a downtown transit center has been proposed (Metropolitan Transit Authority of Harris County, 1978), with the building's architecture being preserved. Union Station in Dallas and the Texan and Pacific Station in Fort Worth are two other examples of planned, adaptive reuse for modern transit terminals.

Each design should be acceptable to the majority of the public with art work or unique architecture appropriate to the particular location. One aesthetic feature deemed worthy of all stations is the softening of the silhouette of the overhead wire (if used) through the use of trees, and use of multi-use poles, existing buildings, and cantilever arms to prevent a proliferation of poles and overhead wires (De Leuw, Cather & Co., 1976; Fox, 1978). Another feature is the use of low shrubbery to minimize noise transmission throughout the length of the route (De Leuw, Cather & Co., 1976).

Handicapped Accessibility

Many features can be included in station design to minimize or eliminate barriers to the handicapped, elderly, and the mobility impaired. Level platform boarding is the best solution to handicapped accessibility. Ramps and/or elevators to the platform must be provided. Any tunnel or elevated ramp across roads or railroads should be built with elevators or ramps for wheelchairs and the mobility impaired. Operators and station attendants should be formally trained to be sensitive to the needs of the handicapped (Elderly & Handicapped, 1976).

Reznikoff cites many specific design criteria and dimensions for providing for the handicapped (Reznikoff, 1979). Among the barrier-free designs are doors at least 32" wide and easily operable, 36" minimum aisle width, rest stops (widened areas) along corridors, handrails in elevators, wheelchair turning areas, side transfer toilet facilities, drinking fountains, telephones and many other features to assist those with visual, hearing, and strength impairments as well as wheelchair users.

Rules and Safety

Maintenance men must be trained and equipped to work safely around electric power distribution systems, and to recognize the hazards of the adjacent railroad operations. Railroad-type fail-safe signals should be employed, with cab signals used to avoid confusion with adjacently located railroad signals and traffic lights.

Regular preventive maintenance and system tests must be scheduled to ensure system safety and reliability. Any public complaints or warnings must be immediately investigated, with feedback to the complaining party.

Railroad safety and operating rules and training should be adopted and enforced. These rules have evolved into extremely safe guidelines, and should be scrupulously followed by all employees.

APPENDIX H

TRANSIT MODES: DESIGN, SAFETY & CONSTRUCTION CONSIDERATIONS

Contents:

APPENDIX H - TRANSIT MODES: DESIGN, SAFETY, AND CONSTRUCTION CONSIDERATIONS

Descriptions, Definitions, and Comparisons of Transit Modes

Types of public transit modes which could be considered for joint use of existing railroad rights-of-way vary from operation of small "Personal" transportation vehicles such as the AIRTRANS and proposed Project 21 vehicles on separate guideways, to the use of rail rapid transit and commuter trains operated on existing tracks. As each mode has its own special characteristics and effects on adjoining railroad operations, the first part of this appendix will summarize the major characteristics typical of each transit mode and the effects of shared right-of-way usage with existing railroads.

It must be noted that some general mode categories (such as Light Rail Transit) have widely varying characteristics and designs. Not only may "typical" designs presented here vary greatly from some specific examples of available systems, but overlap between modes may render it difficult to precisely classify some types of public transit systems. Some systems may operate the same vehicles in a manner typical of one mode over one portion of the route, and in a different modal manner over another portion of the route. Light Rail Vehicles can be routed in the streets "streetcar-style" on one part of the route, but the same vehicles can operate on exclusive, protected rights-of-way and in subway tunnels in a "Light-Rail-Rapid-Transit" mode on another part of the route. While these widely varying characteristics are usually addressed in the descriptive text below, not all variants are illustrated nor detailed in the descriptions of "typical" modal characteristics. Thus, it is unwise to over-generalize from these condensed descriptions.

Inclusion (or exclusion) of any given mode or corporation's name is not intended to be either an endorsement or a non-endorsement. Some designs have been proven over millions of passenger miles; others have yet to be fully tested. While certain mode characteristics may make a given transit technology more or less attractive for a given situation than other technologies, the final choice must remain the province of the local agencies and communities, after weighing all pertinent information (e.g., proven reliability vs "futuristic" design, costs and economies, required schedules and headways, land requirements and availability, noise and pollution, repairs and maintenance, operating costs and problems). The following modes will be discussed in this appendix:

1. Personal Rapid Transit (PRT) (e.g., AIRTRANS at DFW Airport)
2. Buses and Busways
3. Project 21 (a proprietary, elevated monorail-type of system)
4. Monorail
5. Rail Transit Modes
   a. Light Rail Transit (LRT)
   b. Hybrid Light Rail Transit (LRRT, pre-METRO)
   c. Rail Rapid Transit (RRT), often called Heavy Rail
   d. Commuter Rail Transit (CRT)

Futuristic high-speed modes, such as Maglev, Shinkansen and TGV high-speed trains, will not be discussed in this paper, as they are more suited for inter-city travel rather than travel within an urban area. Table H-1 gives a summary of characteristics of the following prototype vehicles:

- AIRTRANS (PRT)
- GMC RTS-2 (Bus)
- MONORAIL (WED and Hitachi)
- ICTS
- LRT (Standard and Hybrid)
- RRT

TABLE H-1
PHYSICAL PROPERTIES OF PROTOTYPE VEHICLES

Criteria	AIRTRANS PRT	GMC RTS-2 BUS	MONORAIL WED (MARK V CONCEPT)	MONORAIL Hitachi (Kitakyushu)	ICTS	LIGHT RAIL San Diego (Duwag U-2)	HYBRID LRT	RAPID RAIL Baltimore/Miami (Budd)
Cars per Unit*	1	1	3	2	2	1 (articulated)	1 (articulated)	2
Passengers per Unit (" 3.21 sf/pass)	40	71	282	236	158	170	170	418
Unit Dimensions								
Height	10'	9'7"	12'0"	16'9"	10'4"	10'9"	10'9"	12'0"
Width	7'	8'1"	10'7"	9'6"	8'2"	8'7"	8'7"	10'3"
Length (rounded, over couplers)	21'	40'0"	125'	99'	84'	80'	80'	150'
Unit Weight (empty) lbs	14,000	24,000	86,000	119,000	57,000	71,720	71,720	152,000
Assumed Maximum Number of Units per Train	2	1	4	4	3	4	6	4
Maximum Train Length (ft)	42	40	500'	396'	252'	320'	480'	600'
Maximum Practical Train Capacity (Persons)	80	71	1,128	944	474	680	1,020	1,672

* A Unit is the minimum operational set of vehicles or cars
NOTE: Project 21 has no working prototype and is not included here.
Source: (Lea, Elliot, McGean, 1983; Kangas, 1976; Vuchic, 1981)

Personal Rapid Transit - PRT

General

For this report, Personal Rapid Transit or PRT is defined as a system of small guided vehicles (typically carrying eight to forty passengers) which can be flexibly routed to carry small numbers of patrons directly from origin to destination, sometimes with intermediate stops. Some writers make a distinction between very small vehicles (traditionally called PRT vehicles) and the larger vehicles such as those used with the AIRTRANS system at the Dallas-Fort Worth International Airport (sometimes called Group Rapid Transit or GRT); both systems are combined here under the generic term "Personal Rapid Transit."

Due to the large numbers of vehicles and runs required by these systems, control must be automated in order for the PRT system to be economical. PRT's may be thought of as providing a service similar to that of a self-service elevator, but on a horizontal plane.

Operating Systems

Personal Rapid Transit systems have been installed at Dallas/Fort Worth Intercontinental Airport (AIRTRANS by Vought Corporation) and by Disney/Turner at Houston Intercontinental Airport (the WEDway Automated Transit System). A PRT system has been built in Morgantown, West Virginia by Aldon and the Boeing Company under sponsorship of the Urban Mass Transportation Administration (UMTA). Other systems have been developed by the Westinghouse and Bendix Corporations in the United States, Krauss - Maffei in West Germany, MATRA in France, and Kawasaki in Japan (Vuchic, 1981).

Technical Factors for PRT

Vehicles are typically small, 15.5 feet long by 6.0 feet wide (4.73 meters by 1.83 meters) up to 41 feet long and up to eight feet wide (12.5 meters by 2.4 meters), often futuristic in styling and generally riding on steered rubber tires (magnetic levitation is also being proposed, although no commercial MAGLEV operation has been implemented to date). Some systems use single vehicles, while others allow training (coupling) of up to ten vehicles. Vehicle weights range from 8,600 pounds (3,900 kilograms) to 30,500 pounds (13,850 kilograms).

Capacities range from eight up to 40 passengers, with various mixes of seats and standee spaces possible. Performance ranges from a speed of 17 MPH (27 km/h) to 62 MPH (100 km/h), with most vehicles operating at maximum comfort acceleration and deceleration of 3 to 4 MPH per second (Vuchic, 1981).

Overall, line location is much more flexible than for other types of transit, except that at-grade crossings are generally not possible. The narrow widths and small cross-sections allow "fitting in" of the system in places where most others would not fit, making subway and at-grade (without grade crossings) locations simple. In addition, the light vehicle weights allow elevated structures to be lighter and less costly.

Vehicle guidance usually consists of horizontal wheels running along vertical guides, with switching accomplished in various ways (some using the same guide wheels, others using separate switching guides on the vehicles). This often results in fairly massive, "boxy" channel or T-shaped track. The presence of live electrical conductors combined with automated operation without on-board drivers results in the requirement that all conflicting traffic and debris be kept from the guideway, resulting in extensive use of fences, grade separations, and other security treatments.

Land required and clearances are relatively less than other transit systems. A one-way guidance track may be less than ten feet wide, and low-speed curves can be of fairly sharp radius (i.e., 150 ft. radius). The major problem encountered in joint railroad right-of-way use will be complete elimination of at-grade crossings, and the possibility of blocking the railroad from serving present or future shippers located on the other side of the PRI guideway, as well as blocking maintenance gangs or accident clean-up. As an alternative, the guideways can be elevated at least 23 feet above the top of the railroad, resulting in somewhat higher construction costs. Normally it is not feasible to construct a subway under the railroad track for extended distances due to the very high construction costs and disruption, and the extremely heavy-duty construction necessary to withstand the overhead operation of heavy freight trains.

Interface with the environment, aesthetics, and community impact will generally be similar to that of a modern rail transit system, except for lower noise levels of PRT systems. At-grade protective requirements will result in a "Chinese Wall" severing communities, unless the guideway is elevated; in which case the lighter construction requirements could result in more widely-spaced columns than other transit modes except, perhaps, monorail. Construction/implementation time will be similar to other rail systems, due to the required guideways.

As this is a relatively new technology, there is no uniform body of standards and legal requirements associated with PRT systems. Signalling is not necessary, as control is automated; on the other hand, due to the lack of an on-board operator, computerized safety systems must be more complex and fool-proof than for operator-controlled systems. Generally this results in designing heavily toward safety. Most basic designs virtually preclude the vehicles leaving the guideway (similar to a derailment);

the major operational hazards are collisions with other vehicles and people on the guideway. To date, there have been no serious collisions, due to the high degree of safety designed into the control systems; but this has led to vehicles stopping with passengers stranded with no ready explanation. Some PRT Systems (i.e., DFW's AIRTRANS) have voice communication capabilities between the traffic controller and the vehicle occupants in case of an emergency, break down or system failure.

The guidance way usually cannot be used for any other transit mode than the PRT vehicles for which it was designed. Operation requires automation in order to control labor costs. It would not be economical to provide or feasible to consider a driver for each vehicle, since this is in conflict with the basic PRT concept. On the other hand, when the "bugs" have been worked out of the computerized control system, reliability can equal that of less-automated (vehicle operated) systems, and schedule flexibility can be much greater. Smaller vehicles can be programmed to carry a group of passengers directly from origin to destination, by passing all unused or low volume stations. A more common alternative (if more than one route is used) is to have specific vehicles follow specific routes on an on-demand schedule, with short waiting times for the patrons. Fares are usually collected by automated turnstiles or similar operations. Routine or preventative maintenance is normally done at night.

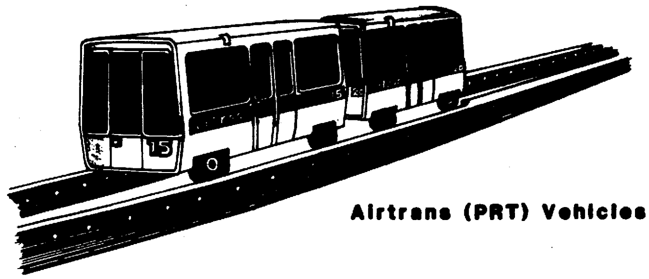
Electric power is universally used, due to needs for operating system communication and control, with electric traction motors onboard rubber-tired vehicles. MAGLEV systems use inductive magnetic attraction/repulsion systems supporting and moving the MAGLEV vehicles.

Economic considerations vary from system to system. While some predict theoretical line capacities as high as 24,000 passengers per hour, most have theoretical line capacities of under 10,000 passengers per hour (Vuchic, 1981). Thus PRT can be expected to be relatively more expensive on a per passenger mile basis than most other transit systems. In addition, as some PRT systems (i.e., MAGLEV) have never been operated on a fare-producing basis, it is reasonable to assume that unforeseen operating problems could arise during revenue service, requiring more-or-less costly solutions which were not anticipated.

Capital and construction costs will be similar to those for a Hybrid Light Rail Transit line. While each vehicle should be less costly than a LRT vehicle, more are needed. The control system must be computerized, and public access denied or restricted. Offsetting these will be the lighter guideway requirements engendered by lighter vehicles. For example, the highly-automated AIRTRANS system (shown in Figure H-1), 13 miles long with 14 stations, cost $64.5 million in 1971 dollars (Kanges, 1976).

Land requirements will be less than for most other exclusive right-of-way systems, but may be more than for shared rights-of-way. Stations may be more complex and land-intensive due to automated security requirements. Elevated guideways will require little more land or air rights than Monorail, but the guideway will be more visually intrusive. PRT's narrow guideways could make it a good candidate for joint right-of-way use with a freight railroad (where the Chinese Wall effect already exists) provided the situation where the Railroad access is blocked from shippers across the PRT guideway is addressed (or does not exist).

Operating costs will be low from a labor standpoint, ($0.11/passenger labor cost in 1976) due to the automated nature of operation eliminating the need for vehicle operators (Kangas, 1976). Maintenance crews and dispatchers will still be necessary, however. Energy costs will be higher



Source: Vought Corporation Sales Literature

Source: Vought Corporation Sales Literature

Figure H-1: AIRTRANS System Vehicles in PRT Service at D/FW Airport

for two reasons. First, smaller vehicles generally result in higher energy needs per passenger due to higher per-passenger weights and less-efficient heating and cooling. Second, the use of rubber tires (with considerably greater rolling friction than steel wheels on steel rails) or a separate levitating power source on slow-speed vehicles will require more energy to be used to move the vehicles.

Maintenance and reliability of the untested systems (i.e., MagLev) remains an unknown. The Morgantown system has been dissappointing (due to small vehicle size and the need to heat the guideway in winter to gain traction). The AIRTRANS system has, after starting pains, proved reliable as compared with other systems (Kanges, 1976). From the standpoint of joint railroad right-of-way usage, it is reasonable to assume that, once signal interference problems have been corrected, there should not be any occurrance (derailment, etc.) that would adversely affect the operation of the railroad.

Buses and Busways

General

Buses are the most common form of public transit within urban areas. Based on truck technology, the buses themselves range in size from very small (slightly larger than vans and seating possibly 12 people) through the standard size buses seating approximately 50 passengers which are common in many cities in the United States and up to the larger articulated buses such as those made by American General which seat 72 passengers and can carry 100, including standees (Vuchic, 1981).

Buses have the advantage of flexibility in that they can travel over city streets and highways, in most cases without any special facilities other than provided for the private automobile. Bus stops are often nothing more than street corners marked by signs. On the other hand, buses can also utilize exclusive transitways called busways; exclusive rights-of-way upon which only buses (and sometimes vans and carpools) are allowed. These rights-of-way may be specially built busways of one or more lanes in width or they may be contraflow lanes, such as utilized in Houston (the contraflow lanes in Houston are shared with vanpools).

The flexibility aspect is one of the greatest assets of buses for mass transit. Unlike fixed guideway guidance systems, buses are free to take to the city streets if there is a blockage in a contraflow lane or a fixed busway. This flexibility is also one of the weaknesses of buses in that buses on city streets are subject to interference by city traffic; also, this great flexibility is at the expense of the requirement that each bus have a driver who must guide and brake the vehicle. Unlike fixed guideway systems which automatically steer the vehicles and can have automatic overrides such as automatic train stop or other devices to stop the vehicle short of an accident, buses must rely upon the skill, attention, training and reflex of the drivers.

Buses cannot be connected into trains (an articulated bus is still a single vehicle); the requirement of a single driver per vehicle generally results in considerably higher labor costs for higher density lines than is required for fixed guideways which allow coupling of vehicles into trains, or for automated systems which do not require the one operator per vehicle.

Technical Factors for Buses and Busways

Vehicles are, of necessity, relatively small ranging in size from approximately 12 seats for mini-buses to as many as 72 seats (Vuchic, 1981). In order to operate on city streets the vehicles are generally eight to eight and one half feet wide. Most buses have diesel motors powering the rear wheels for propulsion. Because of this, the acceleration of a fully loaded bus may be less than that of an electrically powered vehicle. Also, fuel utilization may be greater. To overcome these problems, a few United States cities (Cambridge, MA; Dayton, OH; Philadelphia, PA.; San Francisco, CA; and, Seattle, WA) use the trolley-bus system (Transportation Research Board, 1982), which uses an electrically powered bus with two trolley poles which pick up current from overhead wires. Trolley buses have two of the problems associated with light rail transit; first, the unsightly overhead wires, and second, the lack of route flexibility (although the trolley bus--the so called "trackless trolley"--does have the ability to bypass "minor" street obstructions as long as the bus does not get too far from its overhead wires). The ride of a bus (or trolley bus) is generally smooth due to rubber tires and soft suspensions, often with air springs. However, ultimately the ride quality of the bus depends upon the condition of the public streets over which they travel. Particularly in heavy traffic, buses must often do a fair amount of accelerating, braking, and swerving to avoid accidents which results in a relatively rough ride (compared to other transit systems), particularly for standees.

Except for a few small mini-buses which are sometimes used to shuttle people around a loop in downtown urban areas, most buses are capable of maintaining speeds close to 55 miles per hour. Thus the schedule performance of a bus, in general, is limited by the street network and traffic situation as much as by the performance characteristics of the vehicles themselves. While there have been European and some U.S. applications of inductive transmitters to preempt traffic signals, most buses simply go with the flow of traffic. Buses normally pick up passengers from the sidewalk on the right side of the street and, consequently, are forced to operate in the lower-speed right-hand lanes. Some cities have used exclusive bus malls or bus lanes to help expedite the movement of buses. These help scheduled speeds considerably, but one problem with the exclusive right-hand bus lane is that some automobiles will violate the lane and/or double park. The bus does have an advantage over the light rail transit vehicle operating in street car mode in this situation due to the fact that the bus can change lanes and go around the parked vehicle, where the light rail transit vehicle would be required to remain until the double parked vehicle was moved.

As buses have been around for quite some time and share the highways and streets with other motor vehicles, buses generally are regulated by motor vehicle laws and are constructed very much like trucks using truck-type tires and technology. This has a tendency to reduce costs and to simplify maintenance, as well as to increase availability of repair parts. Furthermore, because each bus is an individual unit, a transit system which chooses buses as the primary mode of transport is not forced to remain with one given manufacturer but may use buses from multiple manufacturers. One problem with this approach, however, is the non-standardization of service and the spare parts inventory. Consequently, for reasons of economy, most transit agencies attempt to limit the types of vehicles to one or only a few manufacturers.

As buses are ideal collector vehicles, there has been considerable interest in recent years in the concept of providing intermediate exclusive busways or bus lanes on express highways, with buses serving as collector vehicles at one end, then moving rapidly over these exclusive busways to the central business district where the same vehicle can exit and provide a distribution service downtown. This has the major advantage of a single vehicle from origin to destination, in many cases. As many people object to being required to transfer from one vehicle to another, this concept can be quite valuable in attracting and retaining riders. However, due to the multiplicity of routes possible, it is often the situation that a rider must change bus at one trip end or another.

While bus interchange or transfer can occur in large terminals (and frequently does in downtown areas), all too often bus interchange involves nothing more than the passenger being left standing on a street corner waiting for another bus to arrive. This situation tends to reduce the attractiveness of bus travel. Also the street operation portion of a bus route is difficult to control and schedule with a high degree of accuracy. To overcome this problem, buses usually have schedules which give longer times than would be normally expected between origin and destination, with built-in layover stops where the buses which arrive early must wait until their scheduled departure time.

As all buses require individual operators and the bus stops are often nothing more than signs on street corners, most buses employ on-board fare collection. This produces the problem of delays, particularly at stops where large numbers of people are boarding, while the boarders queue up one by one to pay their fares. To expedite this boarding procedure and to reduce the possibility of thefts most bus operations have adopted an exact fare, token, or transfer policy in which the drivers do not make change for boarding customers. This is an inconvenience to those customers without exact change who on occasion pay higher amounts than the required fare.

Buses are unique among transit systems in that, if buses are to operate solely on existing streets, no additional land is required for the guideway, thus bus service can be very rapidly instituted. On the other hand, if a contraflow lane is going to be used, there will be the expense of putting up warning lights and setting pylons, or whatever protection system is necessary to operate the lane. Because the buses are guided by the operator and not by some type of automatic steering mechanism, busways must be considerably wider than the vehicles themselves. Eighteen feet minimum is recommended for relatively high speed busways (Vuchic, 1981). Therefore, the land required for a busway may be greater than that for a rapid rail transit system, a light rail type of system or a monorail. Where exclusive busways are desired, they are often constructed in the centers (medians) of expressways with exit and entrance ramps (fly-overs) on either side. In some cases, the busways remove lanes from expressways (i.e., contraflow, with-flow).

If the main advantages of a busway are to be utilized, major streets must be grade-separated from the busway, and low occupancy vehicles must be prevented from entering busways by means of fences and other barriers. Because of the wider lanes required for the busways, the impact upon the surrounding environment will often be as great or greater than the impact of a rapid rail transit system.

Buses are not considered ideal for subway operation due to the wide clearances required and the diesel fumes produced by buses. A busway in a residential area can be expected to produce less low frequency vibration than a rail system but will produce more diesel noise and fumes. The overall air pollution, of course, will be much greater for busways than for an electrically powered vehicle. Some of these environmental problems can be overcome by the use of a trolley bus or dual power bus systems so that the buses will be operating on the busway or in the downtown area under electric power. Another possibility is to put rails, offset toward one side in a busway so that light rail vehicles can share the busways with the buses; but this dual mode operation opens up the possibility of inter-vehicular collision, in which case the lighter weight buses will generally fare the worse. Some ideas for overcoming these joint-operation problems include utilization of radar-type position detectors with the bus operators being required to use the LRT signal indications, or using trolley buses exclusively on these joint bus-rail busways with the current draw of the bus being used to identify the present location of the bus itself (also, the current could be shut off to provide a failsafe stopping system).

Construction and implementation time for a bus which will be using existing streets in an unchanged manner is, of course, virtually nothing. The route simply needs to be planned. Once the route has been agreed upon, a bus can be instituted upon the route the next day without any further construction. If a bus stop is found to be located in an inopportune location, the location can be moved very quickly and simply. In the case of contraflow lanes, implementation time is increased to that time necessary to provide for the safety pylons, warning lights and other systems to keep opposing traffic out of the bus lane. In the case of a busway, the implementation and construction times could equal that of the implementation and construction times of a light rail system; if a trolley bus power system is used, the cost of power distribution and other such costs will be involved, resulting in few if any time or cost advantages. The busway system has a great time advantage over fixed guidance systems, however, in that there need be no construction in the downtown area and in the feeder areas out in the residential communities. The capacity of an exclusive busway is not as great as that of a rapid rail transit system. In some urban corridors this will be of little consequence because a rapid rail transit system would be under-utilized and the capacity of a busway which can exceed 20,000 passengers per hour may be adequate for many travel corridors in urbanized areas. On the other hand, unless rails are imbedded in the busways during the initial construction, once this 20,000 passenger per hour capacity has been reached, the only way to increase busway capacity is to construct more busways or more lanes on the busway: an expensive, time consuming, and disruptive undertaking.

In summary, buses are ideal for feeder service, lightly used routes and in situations where under-utilized freeways exist. When ridership density is high and/or land is at a premium, or where exclusive guideways are needed (such as subways), manually-driven and labor-intensive buses or trolley buses may not be as efficient as some form of fixed-guideway transit system with vehicles which can be joined into trains. Even then, buses are ideal collection/distribution vehicles to complement the high capacity rail system.

Project 21

General

Presentation and discussion of this system is neither a recommendation nor a disrecommendation for similar systems. Project 21 has been presented merely as an example of one of the many interesting transportation concepts that are as yet untried, but could show promise.

Project 21 is a proprietary system based somewhat upon the monorail design. Unfortunately, Project 21 has not yet been tried out on a full scale basis and so much of the information and estimates must be taken from the projections by the designer, L. K. Edwards. Vehicles themselves will ride on dual rails mounted on a triangular beam which is suspended above grade on pylons very much like a monorail. Project 21 differs from the standard monorail in that the vehicles can pass each other - one on one side of the guide rail and one on the other. This also means that the structural strength of the beamway must be designed strong enough to support two fully loaded trains that are passing at the same time at the mid-point of the span.

The basic concept of Project 21 is very similar to taking a standard railroad track and tilting the track at approximately a 60 degree angle.

In so doing, the weight, traction, guidance and support are all borne by the lower rail while the wheel that contacts the upper rail rides under the rail head, to support the vehicle out to the side. The designer claims that there are no major problems in terms of switches, which in his design would be similar to rapid rail switches in operation and in terms of speed.

Technical Factors for Project 21

Each car is approximately the size of a small shuttle bus with seats for 22 passengers and standing room for approximately 20 more passengers, representing a total capacity of 42 per car. The vehicles can be coupled together to form longer trains; to minimize station size the recommended maximum train length is four vehicles.

Each vehicle is powered by electric current collected from a bus bar running along the support (lower) rail. The support rail is designed to be a moderately unobtrusive structure mounted on pylons, quite possibly within a median down the center of a city street. The stations are conceived to fit within a 10 foot wide median at the base, being expanded somewhat to meet the cars overhead, with protective doors which open only when a car is in position. The design capacity for the system would be approximately 12,000 passengers per hour per direction with 50 second headways. The designer envisions operator control as being the major control and safety factor much like light rail transit; however, like light rail transit, certain safety features could also be incorporated. Unlike light rail transit, the system would be overhead causing an increase in visual intrusion compared with light rail and bus, but with the advantage of separating the vehicles from the traffic flow beneath. Handicapped patrons would be accommodated by elevators at each station. The system could, according to the designer, handle as many as 19,000 passengers per hour per direction making it essentially equivalent to a busway. One estimate of cost of the structure is approximately $3,000,000 per mile for a guideway providing two-way operation. There is not a cost estimate available for the vehicles, although the vehicles would probably cost an amount similar to that of a single-unit light-rail vehicle such as the Toronto LRT's.

Being electrically powered, performance could be expected to be very similar to other electrically powered systems with the comfort, maximum acceleration and deceleration of 3 miles per hour per minute being the limiting factor. The type of system and overall comparatively small cross-sectional area would lend itself fairly well to a subway tunnel, although the small and relatively unobtrusive elevated guideway would probably preclude the necessity of constructing a subway system.

The effects on the environment would probably be quite minimal. There would, of course, be flange noise similar to that of light rail systems, and there would be a small amount of visual intrusion due to the elevated structure. If the elevated structure were to be elevated above 23 feet, which would provide adequate clearance over a railroad train, the system could be expected to provide minimal interference with adjacent railroad operations in cases of joint usage of railroad rights-of-way. However the system, like a monorail, could also be suspended over an existing arterial street which would provide more collection convenience for patrons than if located along a freight railroad. The system would probably be treated legally very much like a light rail system, with few laws directly affecting operations. From a safety standpoint numerous safety devices appear to be provided (Edwards, 1981).

The major problem with this system and others of similar nature is that there has been, to date, no full scale system built in an urban area in the U.S. In addition to the development costs, problems of obtaining Federal funding for an untried system could be difficult or insurmountable. And, while the designers claim that 20,000 passengers per hour per direction would prove adequate for most cities, there is the possibility that in the future a larger capacity might be needed; in such case, the system capacity would become a limiting factor. Nevertheless, this and other types of systems are of potential interest to public transit officials. The Project 21 system has been presented as a hybrid between the smaller PRT people-movers and the monorail systems presented in this appendix.

Monorails

General

There are three types of monorail which will be considered here: the suspended monorail (Types I and II, which will be considered together), and the straddle type of monorail (Type III). The Wuppertal monorail in Germany is the suspended type, while the Disney monorails (WED), the Japanese Monorail (Hitachi), the Seattle Monorail (Alweg) and the Advanced Monorail Systems, are of the straddle type. These are different enough to be considered separately.

Suspended Type

The suspended type of monorail (Types I and II) can follow curves and grades similar to a Light Rail vehicle or a busway. The track, of course, is narrow and must be supported high above the right-of-way. The support columns can overhang features and obstructions below, such as the Wuppertal, which overhangs the Wupper river. The ability to "soar" over obstructions simplifies land acquisition and minimizes delays, as well as capturing the imagination of the public. This type of construction of the rail and supports tends to be expensive, and can intrude visually. Also, should a car leave the track, it would fall unencumbered without extensive safety appliances. The cars are inherently stable, with the center of gravity well below the track, but sway can still pose problems.

Straddle Type

The Type III monorail straddles the rail which can be a structural beam supported from below (see Figure H-2). This type of structure provides one of the least costly elevated fixed-guideway systems available, as well as one of the safest (in case of derailment, the train simply stops). But at-grade crossings are impossible due to the large size of the required rail; a Type III monorail must operate in an elevated or subway mode. Due to the straddle construction, however, a subway tunnel for a Type III monorail must be considerably larger than a tunnel for a conventional rail transit vehicle of the same internal size.

The Alweg/WED/Hitachi Type III monorails are essentially unstable unless the passenger compartment is positioned on either side (staddling) of the support rail. (See Figures H-3, H-4, and H-5.) These Type III monorails rely on balancing wheels to allow a full-width floor. The Advanced Monorail Systems vehicle is somewhat more stable, with support wheels running on a horizontal surface, and the vertical beam serving to steer the vehicle. (See Figure H-6).

Characteristics

All types of monorails have problems with switches that some authors claim relegate them to single-loop operation in most cases, but this is not quite accurate. Existing monorail switches are slower than those of

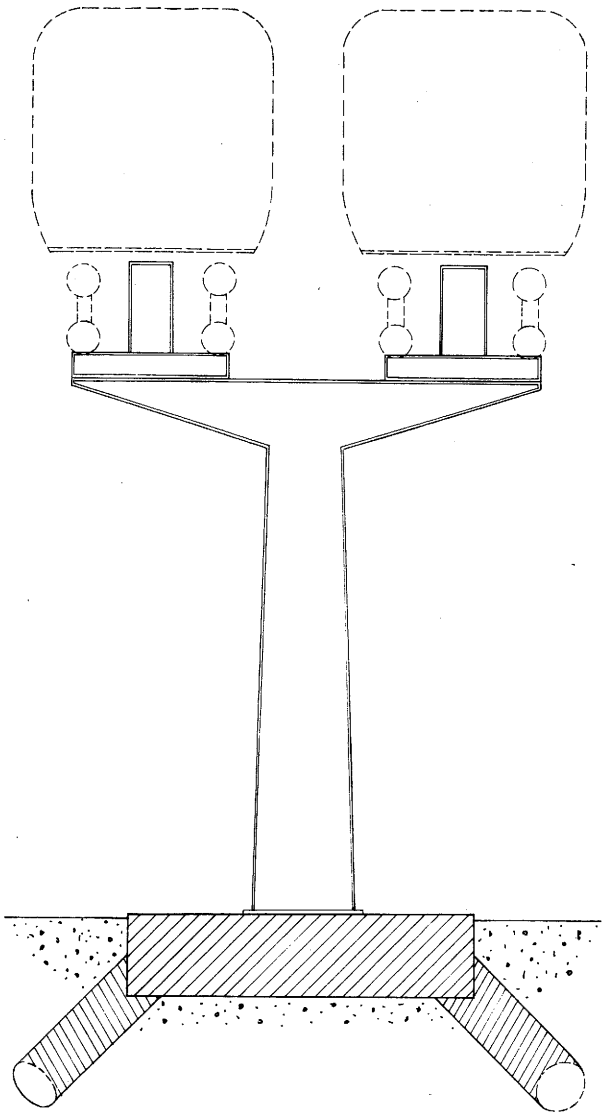


Figure H-2: Proposed TYPE III Straddle Monorail Guideway

WED MARK IV MONORAIL

Source: Lea, Elliott, McGreen/DeLeuw Cather, Dallas Fixed Guideway Rapid Transit Mode Analysis, March 1983.

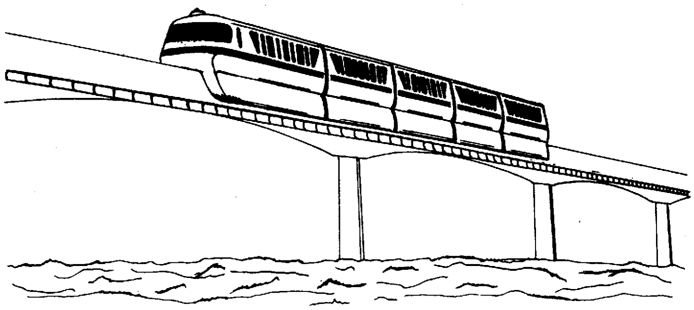


Figure H-3: WED Type III Straddle Monorail

MARK V CONCEPT DRAWING

Source: Lea, Elliott, McGreen/DeLeuw Cather, Dallas Fixed Guideway Rapid Transit Mode Analysis, March 1983.

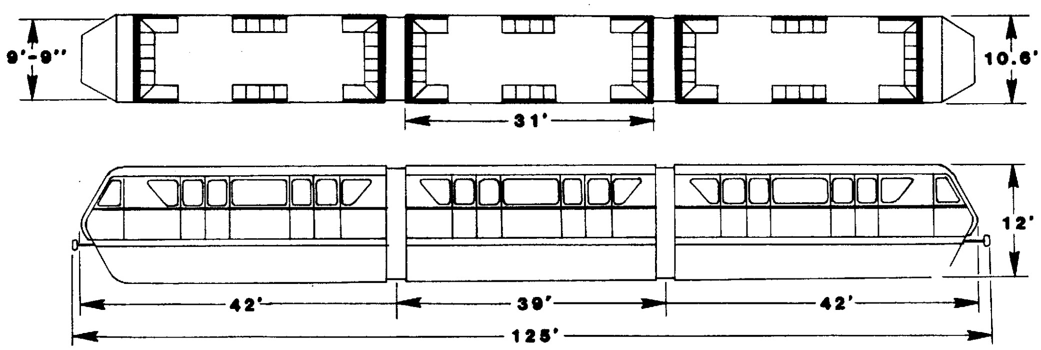


Figure H-4: WED Type III Straddle Monorail Showing Typical Plan and Profile

HITACHI MONORAIL VEHICLE

Source: Lea, Elliott, McGreen/DeLeuw Cather, Dallas Fixed Guideway Rapid Transit Mode Analysis, March 1983.

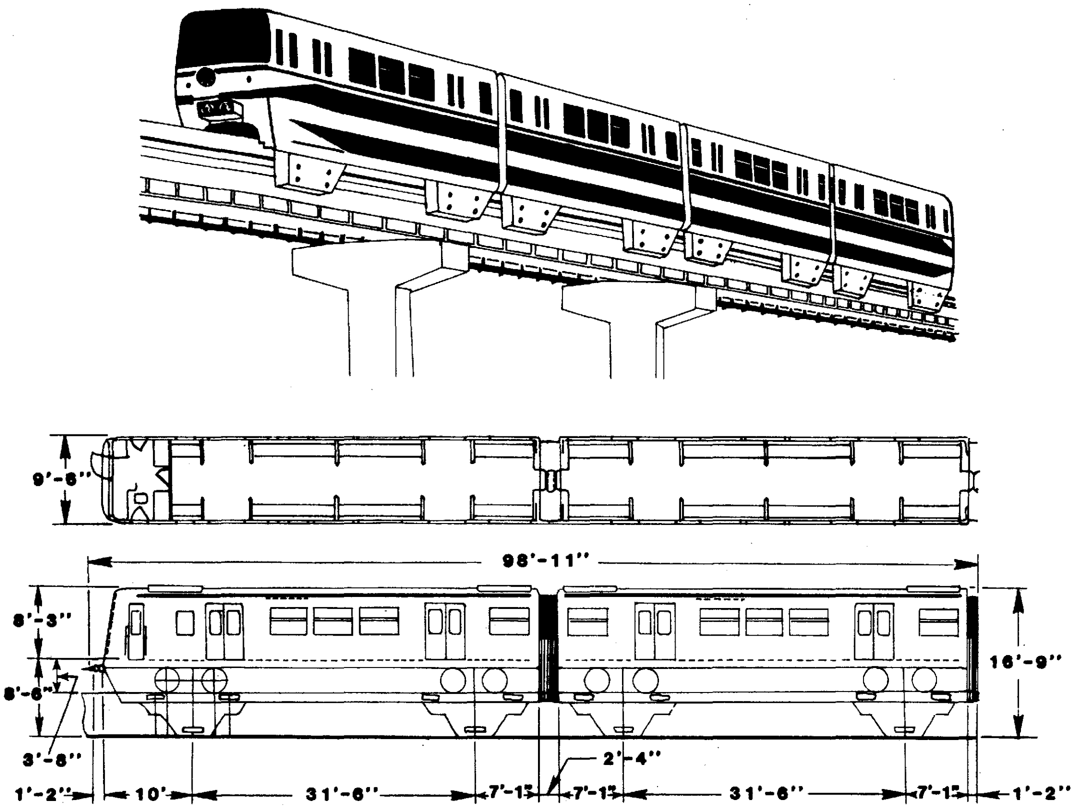
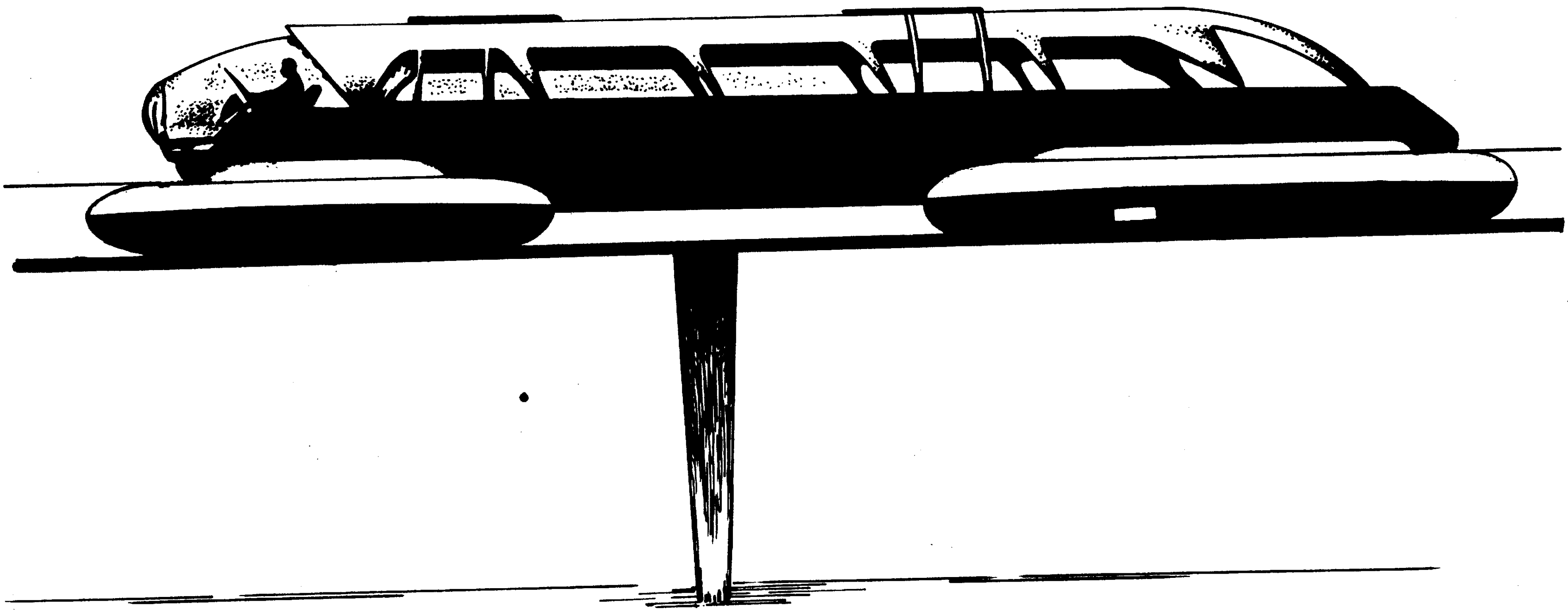


Figure H-5: Hitachi Type III Straddle Monorail

Early Prototype of Advanced Monorail Systems, Inc.
Vehicle Operated in Houston 1957-1965.



SOURCE: Advanced Monorail Systems, Inc. Sales Literature

Figure H-6: Type III Straddle Monorail Tested in Houston, Texas conventional rail systems, and can allow the cars to drop without special safety precautions. Both WED and the Hitachi monorails successfully use shifting-beam switches but not under heavy commuter, multi-route traffic typical of urban transit (see Figure H-7). The Advanced Monorail has developed an even safer-appearing flat-switching arrangement, but a prototype switch has yet to be tested.

Two recent studies (Lea, Elliot, McGean, 1983; Brackett, 1982) have concluded that monorails are now viable transit systems which should be given consideration. Certainly monorails will have minimal effect on adjacent railroad right-of-way and operations. The Monorail concept has captured the imagination of the public. In theory, monorail capacities could equal those of RRT, but at lower cost. Monorails are worth consideration and may be an important urban transit mode of the future.

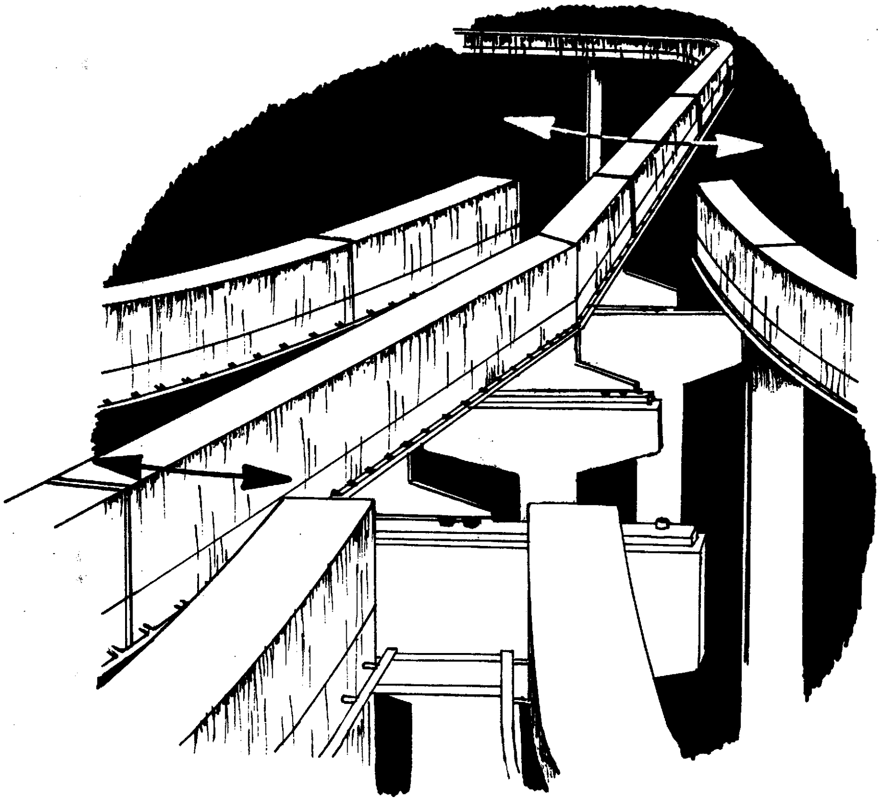
Rail Transit Modes

General

For this appendix, Rail Transit Modes will be defined as those modes which operate railroad-style using flanged steel wheels running on conventional railroad-type track. These modes form a continuum from the small 4-wheel street trolley to heavy intercity railroad passenger equipment used in commuter service. As a result, there are sometimes differences of opinion as to proper terminology for each mode, especially concerning Light Rail Transit on exclusive right-of-way. To minimize arguments, the term "Hybrid LRT" will be used in the case of LRT vehicles operating on any type of exclusive or semi-exclusive right-of-way, regardless of type of power collection or platform height.

Also, as modern "Heavy Rail" vehicles may weigh little more than "Light Rail" vehicles (in fact, the Chicago CTA rebuilt a number of PCC streetcars

WED Monorail Guideway Switches



Note: Switching by hinged segments controlled from central monitoring point. Train speed is reduced in the switch. Lock-to-lock time is about 50 seconds.

SOURCE: WED Engineering Sales Literature

Figure H-7: Example of Shifting-Beam Switches Used for Type III Straddle Monorails

into elevated "Heavy Rail" cars) (Lind, 1978), the term "Rapid Rail Transit" (RRT) will be used instead. Finally, as commuters are the most likely passengers to use the longer suburban passenger runs over freight railroad trackage, such service will be called "Commuter Rail Transit (CRT)" instead of regional rail transit. Although there are other rail vehicles (i.e., cable cars found in San Francisco), they will not be considered in this report due to their specialized nature and use.

Thus, individual vehicle categories discussed below include Light Rail Transit (LRT), Hybrid LRT, Rapid Rail Transit (RRT), and Commuter Rail Transit (CRT). Types of operation and categories of guideway (elevated, at-grade, subway) are discussed in Appendix G of this report.

Fixed-route rail systems can establish a basis for land use planning and for preserving or improving the quality of urban life. Guided systems can operate on narrower rights-of-way than driver steered systems and are less obtrusive in many areas. The proven technology of steel wheels on steel rails has low rolling resistance and is attractive environmentally in terms of reducing energy consumption and air pollution. Tracked systems are adaptable to automated controls that enhance safety and reliability, and rail vehicles can be coupled to increase system productivity and reduce unit operating costs.

A fixed transit guideway must significantly improve the ease of existing travel. Travel-related benefits cause the more accessible sites to be more desirable and ultimately translated into higher land values. After the automobile made a great many sites equally accessible in the urban area, clustering and high density development were diminished. New rail lines, such as Boston's South Shore, Philadelphia's Lindenwold, Washington's Metro, and Atlanta's MARTA have been shown to significantly influence land values and result in some reallocation or attraction of development. Some of the disadvantages and advantages of Rail Transit are summarized in general terms below.

Disadvantages of Rail Transit Systems:

1. Noise levels of wheels on rails can be higher (especially "Flange squeal" on sharp curves) than tires on roadway pavement. (The quiet electrical propulsion offsets this somewhat, and rubber inserts in wheels can greatly reduce noise).
2. As with any fixed guideway system, route changes can be difficult and costly.

3. Trains (multiple cars) block at-grade crossings longer than single vehicles.
4. Although they last longer, rail systems are more costly to build and to upgrade or change.
5. Many citizens consider conventional rail "old fashioned."

Advantages of Rail Transit Systems:

1. Rail transit systems have been proven and refined over millions of operating miles throughout the world.
2. Rail transit systems are among the most energy-efficient, and can use any form of energy which can produce electricity.
3. In addition to generally low maintenance requirements, proper design using available components reduces problems of procuring replacement parts.
4. New-concept overhead structures now compare in cost and appearance with monorails (Lang, 1964), with the added benefits of easier maintenance.
5. Electrical control and signalling by computer is relatively easy.
6. Grade crossings, subways, switching, and mode sharing (rails in streets and/or busways) are fairly easy to accomplish (Light Rail Transit is especially flexible).

Many other considerations than those listed above are mentioned in other parts of this report.

Like freight railroads, Rail Transit vehicles are guided by flanged steel wheels running on steel rails, and switched to various routes by means of moveable switch points at turnouts, which also include a "frog" to allow the wheel flanges to pass over the rail of the route not taken. These turnouts are reliable, and can be operated automatically or manually, and are usually tied into the signal system. Signalling can easily be done by use of track circuit, with the wheels of the vehicles indicating their presence by shunting (shorting out) the current in the circuit. This shunting causes a relay to drop which energizes a signal to warn following trains, provided that the vehicles are heavy enough to make reliable contact. When computer control is used, it usually is added on to the basic signal and switch control system. For further information, the reader is referred to the excellent books by Hay (1982) and Vuchic (1981).

Standard railroad track construction is used, for the most part, except that wooden ties may be replaced by concrete ties or slab structure. The rails of a LRT system may be laid directly on ballast (DeLeuw, Cather & Co., 1976). Rails may be standard freight railroad type (American Railway Engineering Association) in cross-section although sometimes lighter in weight (Hay, 1982), or they may be a special self-flanged girder rail for street operation (DeLeuw, Cather & Co., 1976).

Rail transit rights-of-way have been classified into three basic categories (Vuchic, 1981):

> "Category A" is an exclusive, fully controlled right-of-way with complete grade separation of vehicular and pedestrian crossings. RRT systems operate only in this manner, but portions of LRT systems may also use this right-of-way category.
>
> "Category B" is a semi-exclusive, partially controlled right-of-way. This category includes operations primarily on reserved rights-of-way separated from other traffic except at grade crossings. It may share reserved lanes with buses or be located in roadside areas of medians of separated roadways.
>
> "Category C" is a non-exclusive, shared right-of-way typified by street car or trolley operation in mixed traffic flow with automobiles and buses.

The most commonly specified minimum separation between adjacent track centerlines for railroad and RRT transit facilities in this country is 14' to 15'. When curve radii fall to the 300' minimum range for RRT secondary and yard tracks, or when they approach the LRT operational limit of a 50' radius, clearance envelopes are affected by vehicle displacement and track spacing may also be affected. The American Association of Railroads (AAR) has adopted universally accepted rail car dimensions which will affect the minimum clearances required on railroad right-of-way (see Figure H-8). For more detail, see Vuchic (1981).

Most rail transit systems in this country employ a standard gauge of 4'-8 1/2" (or close to it). The gauge is the distance between the inner sides of the heads of rails measured 5/8" below the tops of rails. Most systems specify that the track gauge for other than tangent alignment be

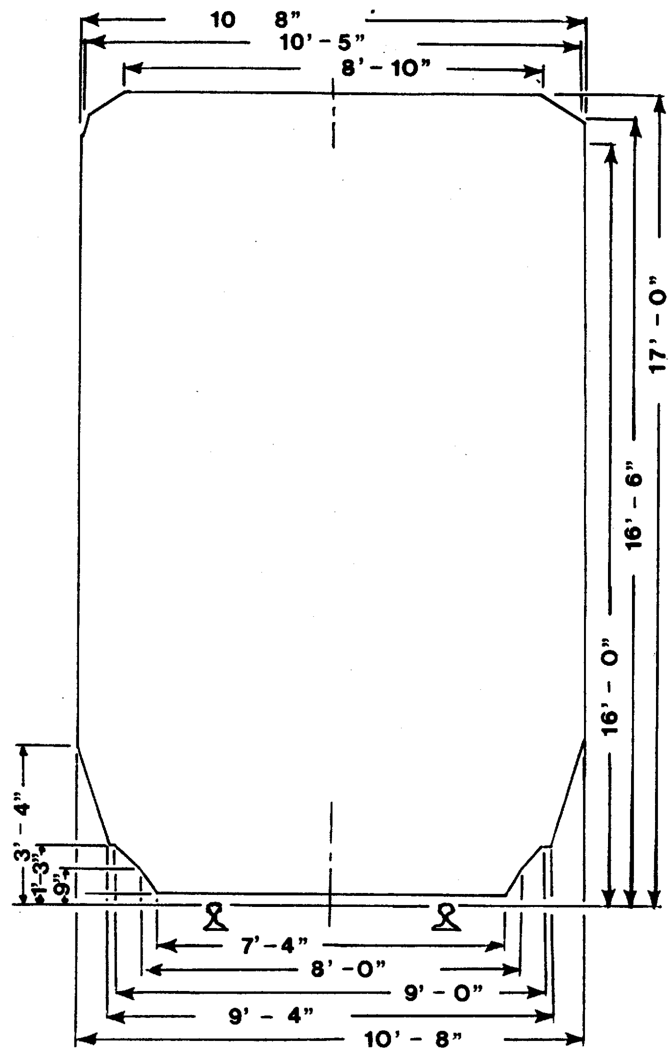


Figure H-8: AAR Standard Plate "F" Interchange Regulation; Maximum Standard Rail Car Dimensions

increased in increments of 1/4" as curvature becomes more severe. The point at which adjustments begin, and the number of increments to be applied, differ markedly from system to system depending on permitted degrees of curvature, vehicle characteristics, and operational considerations. Some RRT and LRT systems make only one adjustment to accommodate the range of their horizontal alignment. Spirals (gently increasing, with incremental curvature going from tangent alignment to sharper curves) may be desirable to increase comfort and to decrease lateral forces. If it is desired for riders to pass between train cars during on-line operation to effect load adjustments or for other reasons, spirals at the ends of curves may be necessary to avoid the dangers of car-end misalignment (see Figure H-9).

Standards relating to trackbed width (the finished surface of the subballast or subgrade between outside edges of the shoulders) are affected by a number of factors including:

- Track gauge
- Presence of superelevation
- Depth of tie, slab or beam supporting the rails
- Minimum ballast depth under the tie
- Width of ballast shoulder
- Walkway requirements
- Tie length and replacement clearance

The Federal Railroad Administration (FRA) prescribes track safety standards and operating limits for the general freight railroad system of transportation in the United States. If joint freight operations are contemplated (such as the San Diego LRT System), or in most cases if commuter operations are planned, these standards will apply to the transit system. Since the FRA standards were developed from data of many years of operational experience, any new transit system would do well to consider their adoption. Table H-2 presents the maximum allowable operating speeds for each of the six current FRA track categories.

Figure H-10 shows the "branding" notation used by one steel rail manufacturer while Figure H-11 shows the rail "stamping"; both the brand and the stamp identify various characteristics of the rail. Tables H-3, H-4, H-5 and H-6 present design considerations for tie plates, spikes, anchors and rails, respectively.

Note: Drawing shows danger to passenger crossing between cars on non-spiraled curve.

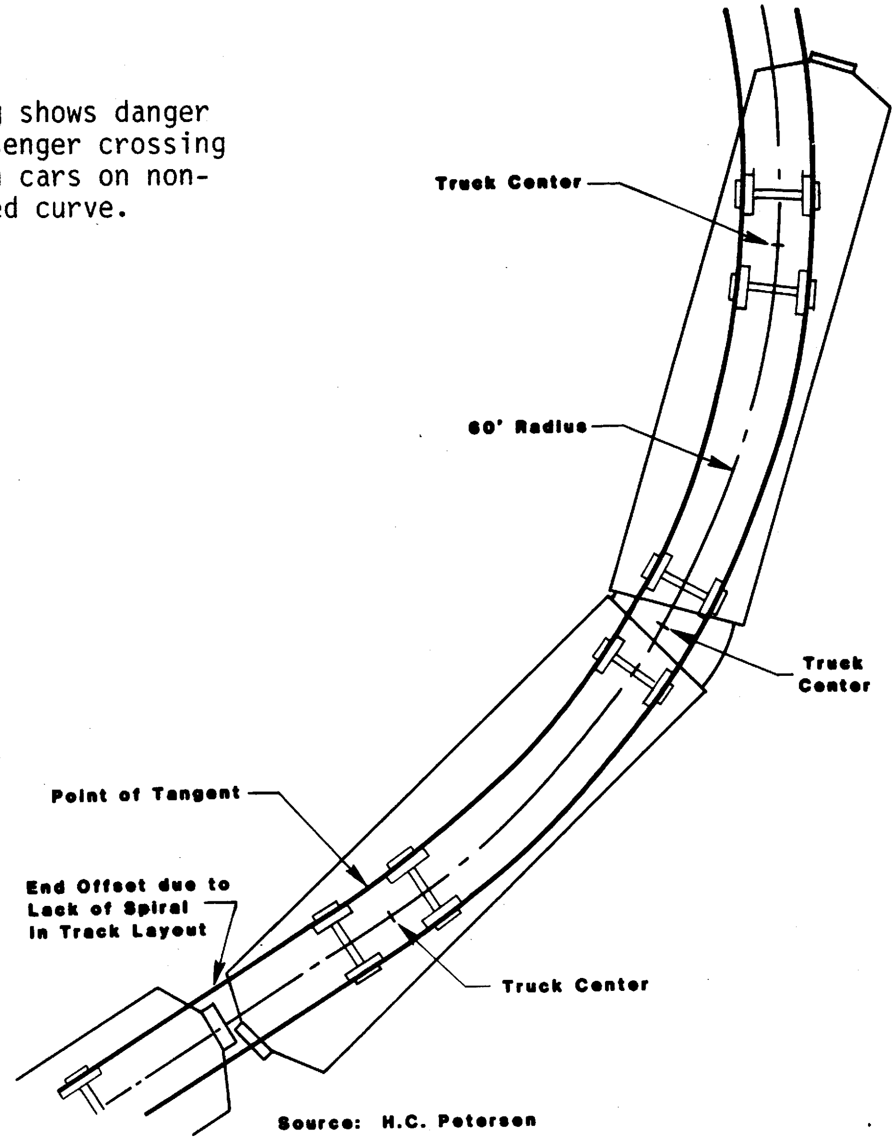


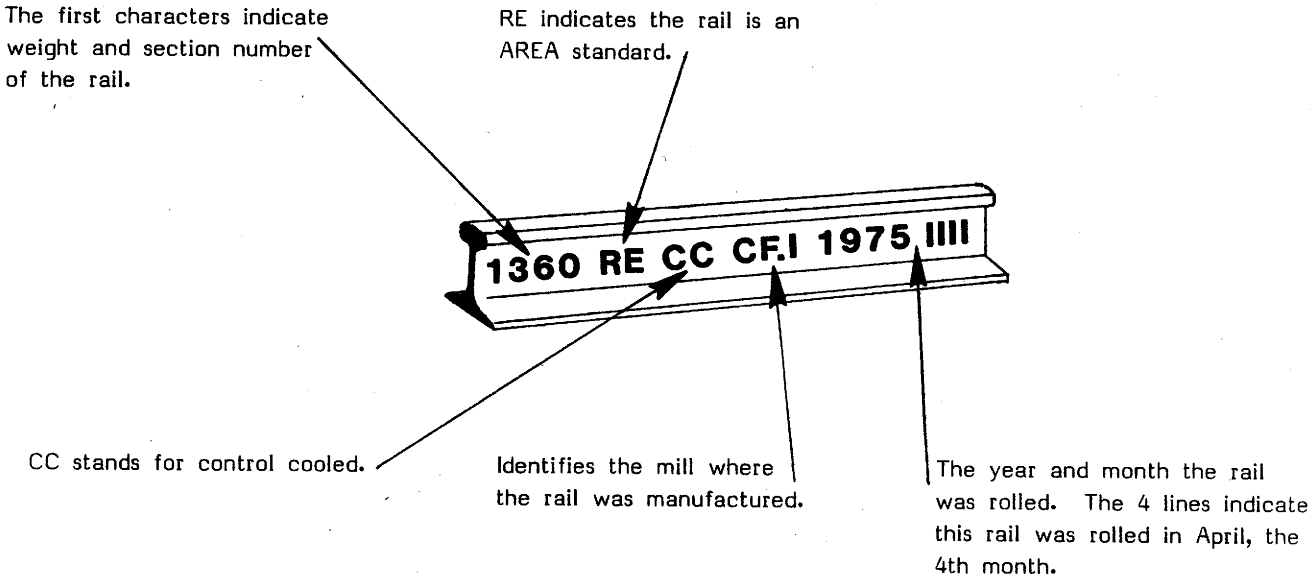
Figure H-9: Rail Vehicles On Curve Without Track Spiral

Table H-2: Maximum Allowable Speed By FRA Track Category

Track Category	Freight Trains	Passenger Trains
Class 6	110 mph	110 mph
Class 5	80 mph	90 mph
Class 4	60 mph	80 mph
Class 3	40 mph	60 mph
Class 2	25 mph	30 mph
Class 1	10 mph	15 mph

Branding

The brand is rolled on the web of the rail in raised characters.



Source: CF&I Steel Corporation Sales Literature

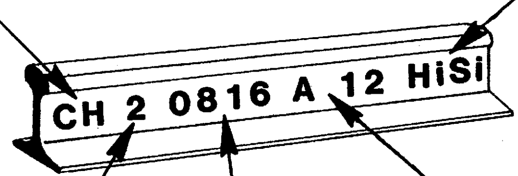
Figure H-10: Identification of Rail Characteristics By Branding

Stamping

Additional identification coding is hot-stamped in the web of the rail opposite the brand.

When rails are to be end hardened. CH is stamped on all rails of that rolling.

CROMORAIL - When CROMORAIL appears here or HiSi, this is a special type of alloy rail developed by CF&I.



2-This number indicates which furnace produced the steel for this rail. 1 and 2 indicate basic oxygen furnaces, 3 and 4 incicate electric furnaces.

This number tells which heat of steel this rail is from. The first heat from the basic oxygen furnace is given the number, 0001, the second 0002, and so on until 9999 is reached and the cycle then repeated. The numbering is the same for electric furnaces.

A-Approximately 20 ingots are teemed from each heat and are numbered in the order they are poured. An ingot will produce from 3 to 6 rails, depending on the section and length being rolled. Each rail is identified by a letter. The top rail of the ingot is lettered A, the next B, and so on through F. This is rail A from ingot 12.

Rails are available in lengths up to 82 feet (25 meters).

Source: CF&I Steel Corporation Sales Literature

Figure H-11: Identification of Rail Characteristics by Stamping

The remainder of this appendix describes the various Rail Transit Modes individually. As there is a great degree of overlap between the definition of modes, the categories will not be in full agreement with all publications.

Light Rail Transit (LRT)

As defined here, LRT systems are modern streetcars which operate predominantly in streets or street medians on Category C type of rights-of-way (see Figure H-12). LRT vehicles which operate in Categories A (exclusive) or B (semi-exclusive) rights-of-way will be considered as Hybrid LRT. In the LRT mode, the vehicles' speeds are limited by traffic conditions and signals. Stops are frequent, fare collection is generally on-board, and no operational control signals are used; operation depends upon the driver's skills. Some streetcars use "people catcher" devices which drop to scoop up fallen pedestrians before they pass under the wheels of the vehicles.

As vehicles can be coupled together into trains, and each vehicle is usually larger than a bus, LRT streetcars can give greater load capacities than buses, although schedule times and routes may be similar. Most "pure" streetcar systems are remnants of old systems, such as the New Orleans system which runs in streets and grassy medians. Modern LRT systems may utilize some street running over a portion of the route, but generally will include considerable Category B and/or A right-of-way operation, which makes the system a Hybrid LRT system, described below.

Hybrid LRT Systems

Modern Light Rail Vehicles usually have the capability to operate in trains at fairly high speeds, often with selectable high or low-level platform boarding. Unlike many old streetcars such as the PCC streetcars

LIGHT RAIL/PRE METRO VEHICLE

Source: Lea, Elliott, McGreen/DeLeuw Cather, Dallas Fixed Guideway Rapid Transit Mode Analysis, March 1983.

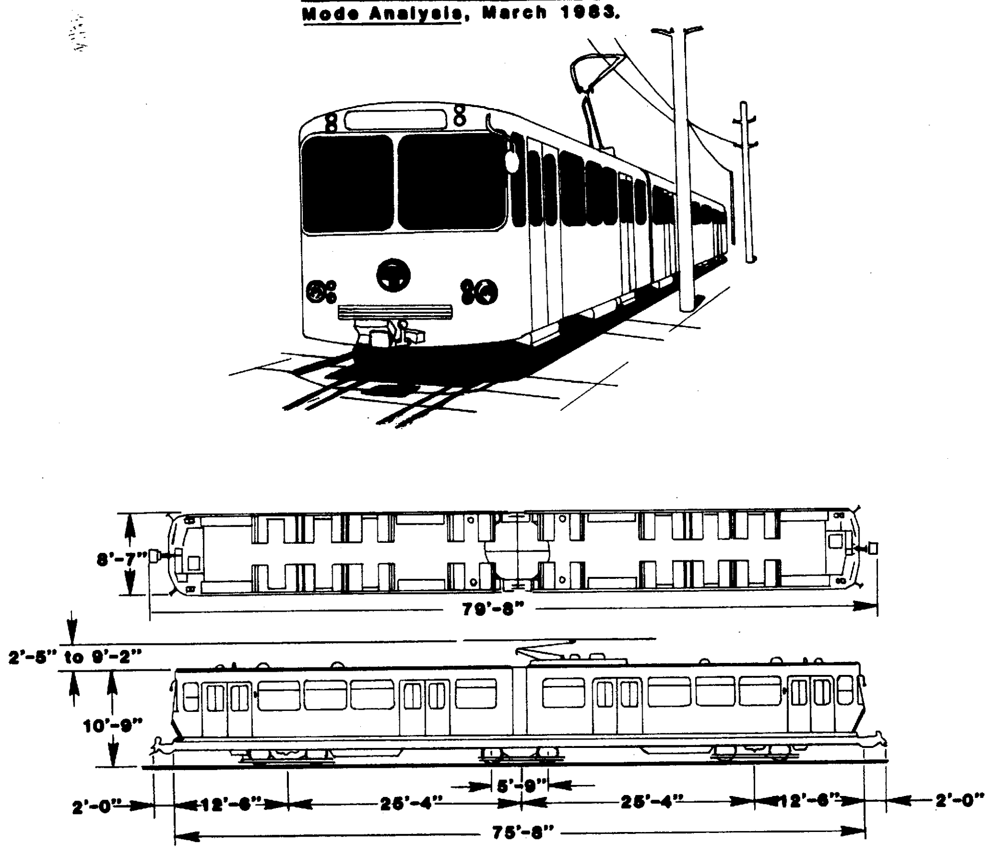


Figure H-12: Typical LRT Vehicle

of the 1930's (see Figure H-13), modern Hybrid LRT Vehicles are comfortable and attractive. Although generally one or two feet narrower than a typical Rapid Rail Vehicle (to facilitate operation in streets and on narrow rights-of-way), and often shorter or articulated to facilitate sharper curves, modern LRT vehicles can be operated in RRT modes on exclusive rights-of-way and in subways to give schedule performance approaching that of RRT at lower cost, in many cases. In fact, if longer runs dictate, the maximization of seating for passenger comfort (with few if any standees even at peak operation) along with frequent service, a system which uses modern LRT vehicles in semi-automatically controlled trains may prove as adequate in performance and capacity as a more-expensive RRT system.

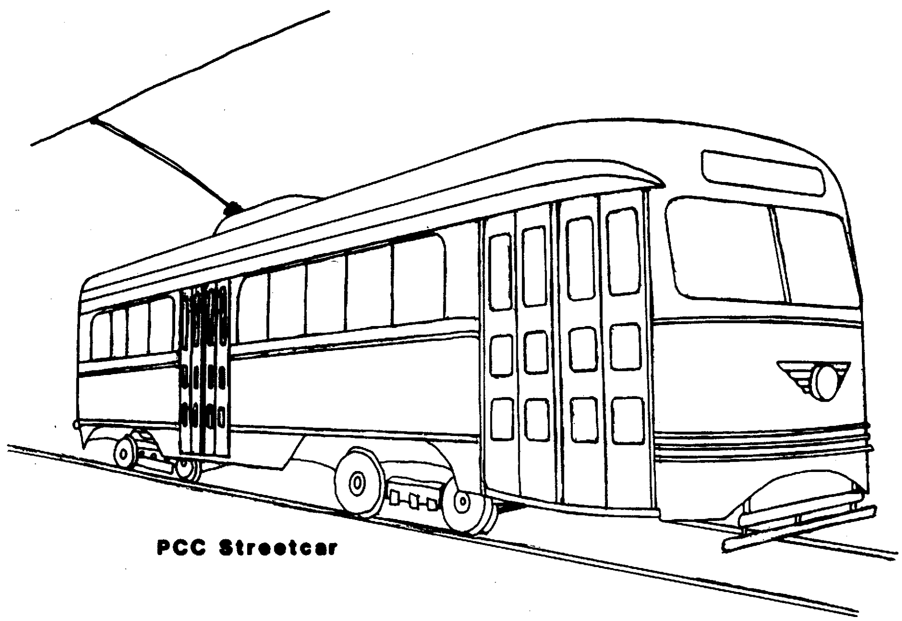


Figure H-13: Old Presidential Conference Car (PCC) Typical of 1930's

A major construction cost saving of this type of system is that, instead of building expensive subways or collection terminals, designers can take advantage of the LRT vehicle's capabilities to operate in Category B and C operations at one or both ends, with the LRT system providing some of its own feeder and/or distribution service. In this way it can reduce passenger delays enroute, compensate for slower operating speeds, and compare favorably with overall trip times and capacities of more expensive RRT systems.

Flexibility is considered to be an advantage of Hybrid LRT systems. Train lengths and turning radii are short and street-level loading is possible. Extensive station facilities are not always required. Virtually any place where a safe refuge for pedestrians can be developed next to the tracks may serve as a station. Provisions for intermodal transfers are relatively easy to provide, although separating pedestrians from vehicular traffic is a major concern in the design of any transfer facility. It is even possible to design a dual-pickup system to allow current pickup from a third-rail system with pantographs retracted when operating in Category A right-of-way, with the pantographs automatically extending to an overhead catenary system (and the third-railshoe going electrically dead) when operating in Categories B and C. See Figure H-14.

The initial choice of Hybrid LRT transit on existing railroad right-of-way should speed up implementation of a new transit system in the following ways:

1. Environmental Protection Agency (EPA) approval should be streamlined due to construction, for the major part, along existing railroad right-of-way. This, coupled with the non-polluting vehicles drawing power from a centrally-located and environmentally-controllable electrical power supply system will minimize adverse environmental effects while reducing automobile pollution on parallel highways. The Environmental Protection Agency will, however, still require an environmental impact statement to address these and other design features of the System.

2. Preliminary engineering studies and design will be required, followed by public hearings, meetings, etc. to finalize details of the system. A proven design such as Hybrid LRT should be more easily implemented than a system requiring extensive concept design engineering and new, special construction techniques.

3. Agreements must be reached with the railroads whose right-of-way is desired. The various railroad companies are more likely to quickly approve construction of a transit system which uses conventional railroad track. In fact, the railroad may allow operation over portions of existing track in a few special cases if they are familar with a proven rail technology.

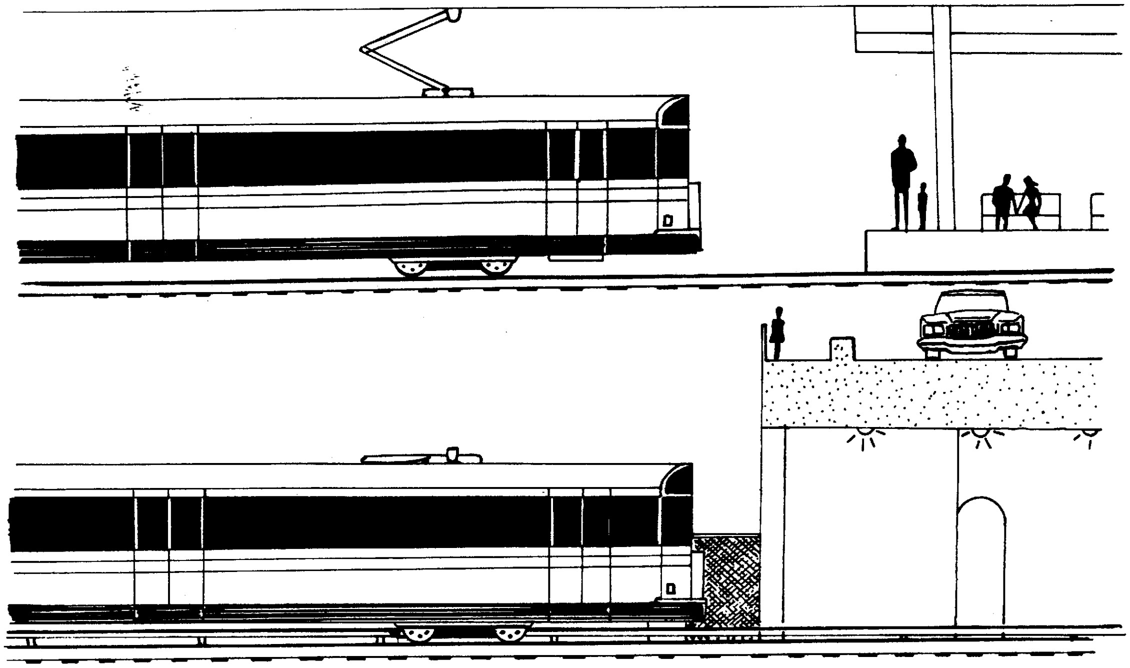


Figure H-14: Dual Power Pickup System for LRT Operating At-Grade in Mixed Flow With Pantograph and on Exclusive (or Semi-Exclusive) Right-of-Way With Third Rail

4. Unionization is a possible consideration. Negotiations should be facilitated with a predictable system, where work rules and requirements can be anticipated.

5. Future expansion should be designed into the plans. With greater than minimum clearances and structural loading requirements followed where practical, especially for bridge and subway construction, upgrading an existing line to higher-capacity trains in the future would be less of a problem. Also, the Hybrid LRT rail system can expand along streets, railways, and other rights-of-way such as busways.

6. Construction at one or both ends of the routes may be minimized, resulting in less implementation time and lower initial capital requirements.

Nevertheless, design and construction should recognize the possibility that future line capacity needs may exceed Hybrid LRT capabilities. Thus, to avoid excessive reconstruction costs at a later time, all Category A construction for LRT should be done to full RRT standards. Any subways and elevated structures can be built slightly oversized for LRT at much less cost and disruption than a later reconstruction. High-level station platforms can be built with a removable strip to accommodate the future wider RRT vehicles. If joint freight operations are planned, construction must conform to state railroad clearance requirements, including an extra high overhead catenary wire - 22 feet above top of rail or more - which may require special modifications to the LRT vehicles such as special pantographs, low-level boarding, etc. (Quintin, 1982).

A number of disadvantages to Hybrid LRT systems exist. First, capacity is not as great (650-1,020 persons per train) as the capacity of a 6-car RRT system which allows for standees (1700 persons per train). Another disadvantage stems from Hybrid LRT's flexibility and the related potential conflict with other vehicles when operating at street level. Closing some streets, preempting traffic signals, and grade separating selected intersections are steps that can be taken to minimize cross traffic conflicts. When operations are mixed with street traffic, light rail vehicle lengths must be considered. A modern three-car train can be over 200 feet long or equivalent to 10 standard size automobiles. This is a significant factor in station design and in signal timing and pre-emption.

Every rail transit proposal (or any transportation proposal) must consider economic feasibility, social equity and desirability, and environmental compatibility. In broad terms, the planning and design process establishes desired system performance criteria and objectives, develops alternatives, and then selects the best balance or combination of transportation modes and elements to fit the situation. This is done by testing site-specific assumptions and costs against financial constraints. Policy determinations and design criteria are interdependent. Policy elements influence physical and operational criteria for vehicles while vehicle selection establishes definite limits for system operations.

The current "rebirth" of the light rail mode, directed at filling the gap between bus and Rapid Rail Transit systems, makes possible a variety of cost/concept alternatives for rail transit. Vehicles, passenger facilities, and service range from spartan to very plush. Light and Rapid rail costs can vary dramatically from one urban area to another (largely contingent upon right-of-way availability and costs).

Cost differentials between proposed systems become very significant as elevated or subway structures are added to provide grade separated rights-of-way, as stations become more elaborate, and as automatic controls are introduced. The costs of individual vehicles and of trackwork (ballast, ties and rails) are quite comparable for Hybrid Light Rail and Rapid Rail systems and are not apt to influence mode selection appreciably. However, right-of-way acquisition and preparation costs can vary significantly with RRT systems usually requiring much more expensive facilities (i.e., subways). The mode choice rests to a large extent on trade-offs between increments of investment and quality of service to be provided, although the possibility of staged construction has often been overlooked by planners of new transit systems. The lesser cost per mile of the light rail mode also means it can serve a much wider area than an RRT system of equal cost. In addition, a less sophisticated Hybrid LRT line might be financed and constructed more readily and be placed in service more quickly than a heavy rail alternative.

Unless carefully planned for during initial construction, the conversion from a Hybrid Light Rail System to a Rapid Rail Transit operation can be complex and will require careful analysis. The upgrading of an operating system is governed in great measure by the nature of the existing facilities. A planned conversion, to be accomplished by upgrading staged-segments of a first phase system, may alter some investment needs, but can also affect initial design concepts and construction costs significantly. Matters such as power collection, access control, vehicle characteristics, and requirements for structure design, need to be considered early in the planning process.

In summary, Hybrid Light Rail may be a good choice for an initial Rail Transit system for cities such as Houston and Dallas, giving the somewhat greater cost-effectiveness during initial construction and startup. As ridership increases, however, care must be taken to avoid extensive reconstruction cost if a higher capacity system is required at sometime in the future. Value engineering analyses should be performed and the results made available to the local decision-makers.

Rapid Rail Transit (RRT)

RRT has the greatest hourly passenger capacity of any transit mode (exceeding 40,000 passengers per hour) and is also the most expensive per mile of all systems considered herein. Operating only in Catagory A rights-of-way, most RRT systems are designed to maximize the number of standees, to operate on short headways, and to use electric power and its high acceleration abilities. The areas served by RRT systems are nearly all less than 1,000 square miles in size and most are less than 500 square miles. Population figures for these areas are seldom less than 1,000,000. Most of the RRT systems are less than 50 miles long and very few exceed 100 miles in length.

The RRT cars are often built to Association of American Railroads (AAR) freight railroad standards with a buff (compressive) strength of 1.25 million pounds without underframe damage (Car and Locomotive Cyclopedia, 1980), making heavy rail relatively safer than light rail even in a possible collision with a freight train. Thus, if joint operations with freight trains are planned within the same time window, RRT vehicles built to AAR standards or commuter rail would be the best choice from a safety standpoint.

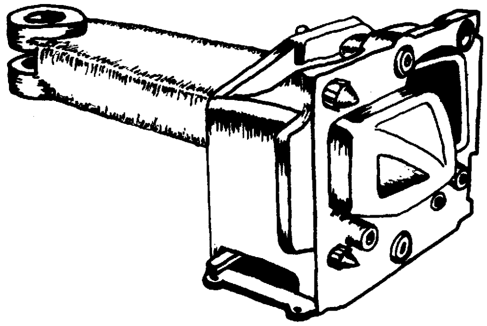
Like Hybrid LRT, most RRT vehicles use a different type of coupler than standard freight operations (See Figure H-15) which not only couples the cars but often connects air and electrical lines. Adapter couplers are available to enable a standard railroad diesel engine to pull a RRT train, which can be a great advantage in case of breakdown or power failure.

Most RRT trains use high-level platform loading through multiple doors, with off-board fare collection, to take advantage of the high capacity, which can exceed 40,000 passengers per hour. Notice the proportion of car side area dedicated to doors plus internal clear space to facilitate standees and passenger movement in Figure H-16.

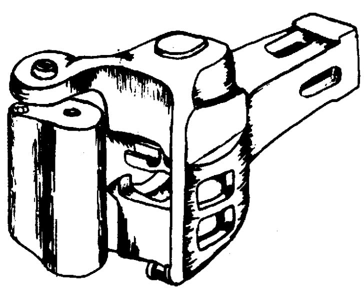
While generally used in shorter trips than Commuter trains, some RRT runs can be quite long; in fact, it is difficult to draw the line between RRT operations and electrified Commuter Rail operations in some cases, such as on some of the Long Island Railroad routes.

Commuter Rail Transit (CRT)

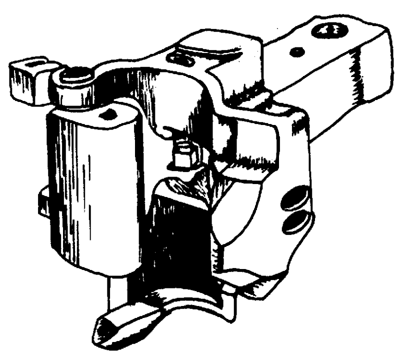
Commuter rail differs from other transit modes in that it is primarily a standard passenger operation scheduled to carry commuters to and from the central business district (CBD) and may be considered as local services of conventional railroads. As such, they usually are subject to Federal Railway Administration (FRA) and Interstate Commerce Commission (ICC) regulations, as well as State and Local regulation. Commuter trains are usually pulled (or pushed one way known as push-pull operations) by a diesel or an electric locomotive, with fewer, more widely-spaced stops. As a standard train, commuter rail allows grade crossings and joint freight operations.



One Type of RRT Coupler with Automatic Air and Electrical Connections



Standard Railroad Type "E" Coupler Used on Many Freight Cars



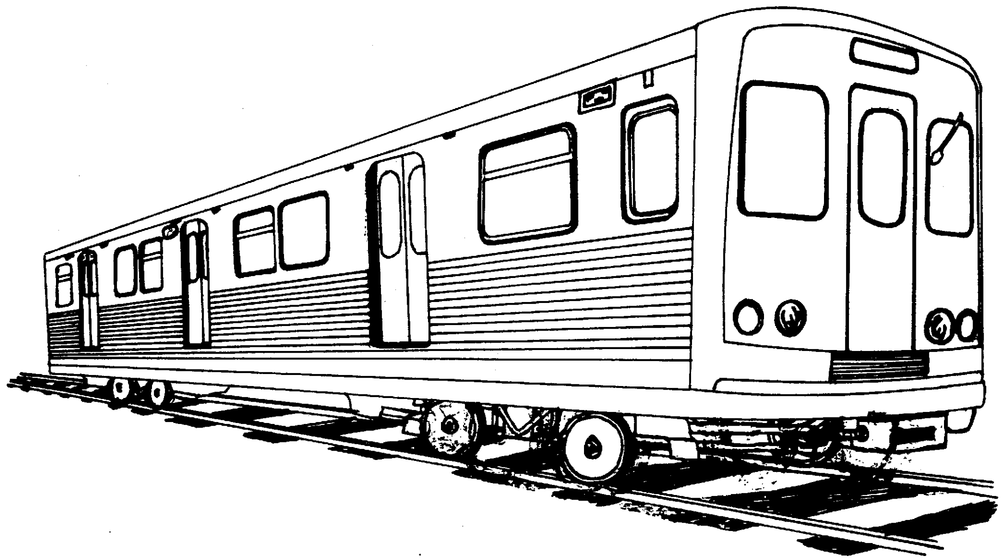
Standard Railroad Type "F" Coupler with Better Fit and Alignment for Freight Cars
(Similar to Passenger Type "H")

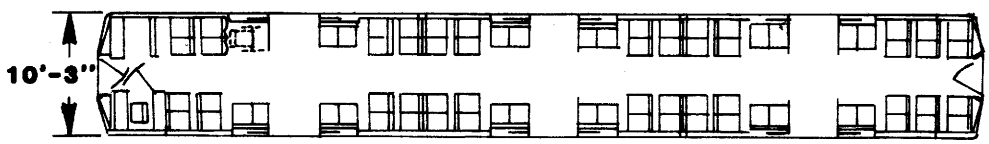
Source: The Car and Locomotive Cyclopedia 1980, 4th Edition, (Simmons-Boardman Publishing Corp., Omaha, Nebraska- Edited by K. G. Ellsworth, F. N. Houser, and D. E. Whitney)

Figure H-15: Typical Rail Vehicle Coupler Devices

RAPID RAIL VEHICLE

Source: Lea, Elliott, McGreen/DeLeuw Cather, Dallas Fixed Guideway Rapid Transit Mode Analysis, March 1983.





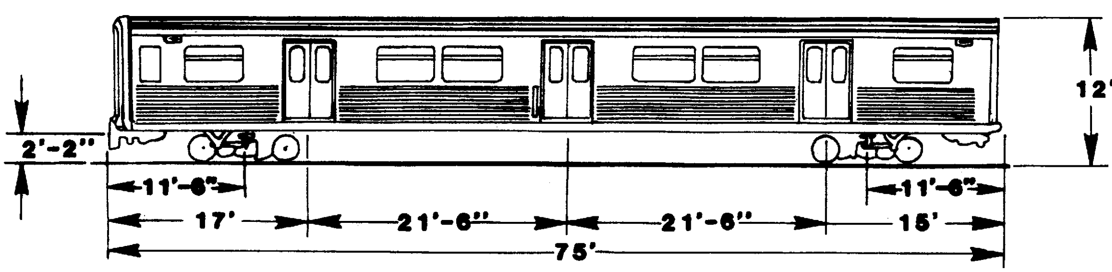
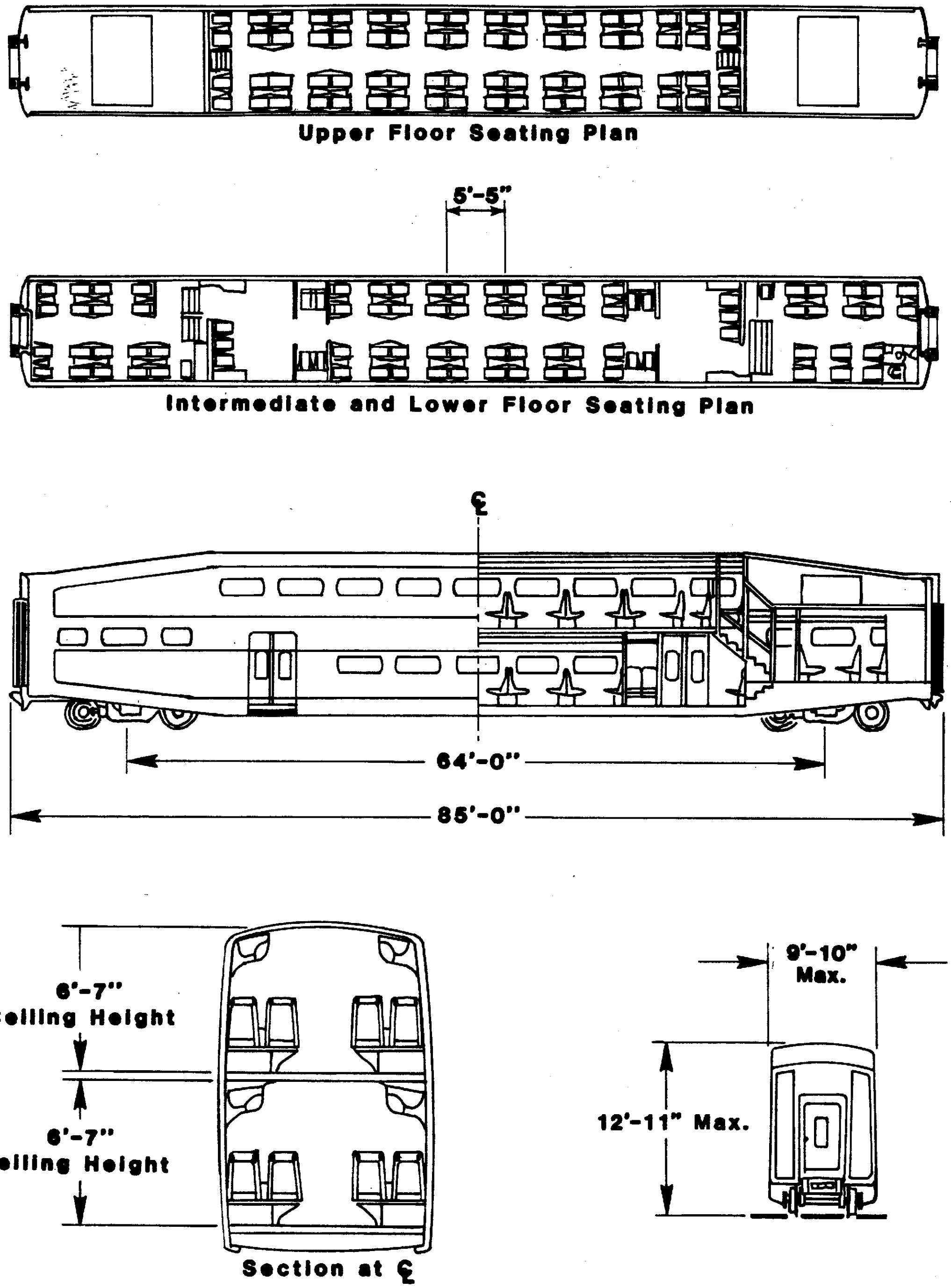


Figure H-16: Typical RRT Design with Multiple Doors and Internal Clear Space for Passenger Movements

While special transit-type couplers may be used, the standard railroad Type H passenger coupler is more common on CRT systems (refer to Figure H-10, Type F Coupler). In fact, some commuter cars are simply old intercity passenger cars which have been refurnished, and which operate on freight railroad track. Other commuter operations use special Bi-level cars to maximize the number of seated riders per car (such as GO Transit in Toronto - see Figure H-17), and may use electrically-powered cars on reserved commuter tracks very similar to RRT (such as the Illinois Central Gulf operation in Chicago).

Operations may consist of one or more inbound trains in the morning, which are stored downtown awaiting the evening return schedule. Reduced commuter service may be run both ways throughout the day on certain lines. To eliminate turnaround time and trackwork, the trains may operate in a push-pull mode, with the engine on one end and a control cab (or an old, inoperative engine) at the other end of the train. The engine would "push" the train one way under control of the cab at the other end; this allows the train to simply shuttle back and forth without turning at either end.

Railroads often operate these trains under service contract with the regional transportation authority. Often these contracts for service use freight railroad crews and dispatchers. Either the railroad or the transportation authority will own the equipment used to run the service. As some commuter runs may be 100 miles long or more, an overlap occurs between commuter operations and intercity passenger trains; generally, however, AMTRAK operates the intercity trains (in fact, it cannot operate commuter service without subsidy or without special Congressional approval) while those operated under regional transportation authorities are commuter trains with multiple fares and/or monthly tickets.



Source: Hawker Siddeley Canada LTD.

Figure H-17: Example of Bi-Level Cars Used for Commuter Rail Transit (CRT) Service

If an existing lightly travelled or multiple-track freight line exists, and if equitable arrangements can be made which will not interfere with freight railroad operations, a commuter operation may be the best choice of transit mode for fairly heavy suburban service. If this mode is chosen, however, adequate downtown and feeder transportation must be available, as commuter operations rarely perform their own gathering service, due to the nature of the operation. If adequate public transit exists (or outlying Park-and-Ride/Park-and-Pool lots), implementation of a commuter train may involve no more than negotiating an equitable agreement with the operating railroad, and obtaining the necessary equipment. Since station spacing is usually quite long (a few miles minimum), diesel power will often prove adequate (even though its accelleration is less than that of electric power) which eliminates the capital expense and construction time needed for a power distribution system. Thus, Commuter Rail Transit may be the most cost-effective and time-effective mode for longer suburban runs. It is certainly the mode which will require the least amount of construction or reconstruction in order to make use of an existing freight railroad right-of-way; especially if the existing track condition and capacity is already adequate.

Closing Remarks

The above descriptions are presented as an overview of the various transit modes commonly used in urban areas. For further information, see the books and articles cited in the Bibliography, especially the excellent texts, URBAN PUBLIC TRANSPORTATION, by Vuchic (1981), and RAILROAD ENGINEERING, by Hay (1982).

Table H-3: Railroad Design Considerations

Tie Plates

Rail Section	CF & I Section	Weight Per Plate (lbs.)	Net Tons Per Mile *	Cant Of Plate	Size Of Plate (in.)
136 RE, 133 RE, or 132 RE	TP-33	21.47	69.78	1:40	7 3/4 x 14
	TP-53	29.45	95.71	1:30	8 1/2 x 16
119 RE or 115 RE	TP-32	19.60	63.70	1:40	7 3/4 x 13
	TP-40	22.90	74.43	1:40	7 3/4 x 14
100 RE	TP-39-1	13.54	44.01	1:40	7 1/2 x 11 1/2
90 RA	TP-13-2	10.98	35.69	1:40	7 x 10 1/2

*Based on 6500 tie plates per mile. Punching and plate size determine weight. Above sizes representative only.

Source: CF&I Steel Corporation Sales Literature.

Table H-4: Railroad Design Considerations

Spikes

Size (in.)	Type	Weight Per Spike (lbs.)	Tons Per Mile*		
			3 Spikes Per Plate	4 Spikes Per Plate	6 Spikes Per Plate
5/8 x 6	High Carbon	.82	8.00	10.66	15.99
5/8 x 6 1/4	High Carbon	.85	8.29	11.05	16.58

*Based on 6500 tie plates per mile.

Source: CF&I Steel Corporation Sales Literature

Table H-5: Railroad Design Considerations

Hi-Guard® Anchors

Size (in.)	Type	Weight Per Anchor (lbs.)	Tons Per Mile		
			6000 Anchors	6500 Anchors	7000 Anchors
5 1/2 or 6	Light	2.15	6.45	6.99	7.53
	Heavy	2.7	8.10	8.78	9.45

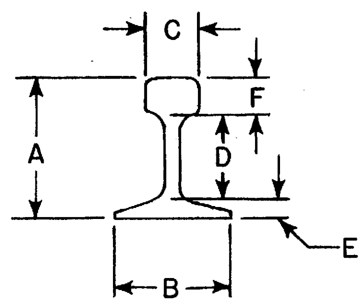
Source: CF&I Steel Corporation Sales Literature.

Table H-6: Railroad Design Considerations

Rail

Rail Section	CF&I Section	Weight Per Yard (lbs.)	Net Tons Per Track Mile	Moment of Inertia (in.^{4})	Measurements (in.)					
					Height (A)	Base (B)	Head Width (C)	Fishing (D)	Depth-Base (E)	Depth-Head (F)
136 RE	1360	136.2	239.7	94.9	7 5/13	6	2 15/16	4 3/16	1 3/16	1 15/16
133 RE	1330	133.4	234.8	86.0	7 1/16	6	3	3 15/16	1 3/16	1 15/16
132 RE	1321	132.1	232.5	88.2	7 1/8	6	3	4 3/16	1 3/16	1 3/4
119 RE	1190	118.8	209.1	71.4	6 13/16	5 1/2	2 21/32	3 13/16	1 1/8	1 7/8
115 RE	1150	114.7	201.9	65.6	6 5/8	5 1/2	2 23/32	3 13/16	1 1/8	1 11/16
100 RE	10025	101.5	178.6	49.0	6	5 3/8	2 11/16	3 9/32	1 1/16	1 21/32
90 RA	902	90.0	158.4	38.7	5 5/8	5 1/8	2 9/16	3 5/32	1	1 15/32

Source: CF&I Steel Corporation Sales Literature.



A - height
B - base
C - head width
D - fishing
E - depth of base
F - depth of head

APPENDIX I

SYNTHESES OF TRACKAGE RIGHTS AGREEMENTS AND
COMMUTER SERVICE AGREEMENTS

Contents:

APPENDIX I - SYNTHESES OF TRACKAGE RIGHTS AGREEMENTS AND COMMUTER SERVICE AGREEMENTS

Legal agreements between railroads and transit authorities illustrate the kind of concerns that are involved in cases of shared railroad rights-of-way. Trackage rights agreements cover the concerns involved in concurrent freight operations by two railroad companies over the same rights-of-way. Commuter service agreements illustrate the concerns of transit authorities and railroad companies that operate transit lines in conjunction with freight traffic. These concerns and supporting agreements are described below.

Section 1 - Concerns in Trackage Rights Agreements

In mutually beneficial cases, two railroad companies will often share the same trackage: one as owner and the other as renter or user. Each company has certain privileges and responsibilities, detailed in a trackage rights agreement between the two parties. There are twelve major concerns found in most railroad-railroad trackage rights agreements, as evidenced in Thomas K. Dyer's Trackage Rights Study (August 1975). The Dyer study is based on eleven trackage rights agreements:

- 1973 Baltimore & Ohio/Western Maryland between Cherry Run, VA and Connellsville, PA; Cumberland, MD and W. Virginia Junction, WV
- 1969 Southern Pacific/Atchison, Topeka & Santa Fe between Mojave and Kern Junction, CA
- 1962 Western Pacific/Southern Pacific between Flanigan and Weso, NV
- 1940 Atchison, Topeka & Santa Fe/Denver & Rio Grande Western between Denver and Pueblo, Co.
- 1971 Atchison, Topeka & Santa Fe/Norfolk & Western between the C.A. Junction-Sheffield, MI and the A.T. Junction-Argentine, KS
- 1972 Burlington Northern/Chicago, Milwaukee, St. Paul & Pacific between Dryad and Raymond, WA
- 1974 Penn Central/Toronto, Hamilton & Buffalo in the Welland Canal Tunnel near Buffalo, NY
- Canadian National/Penn Central in the Welland Canal area, NY
- Penn Central/Canadian National in the Welland Canal Tunnel, NY
- 1963 Southern Pacific/Missouri Pacific between Navasota and Bryan, TX
- 1938 Burlington Northern/Union Pacific between Wallace and Burke, IN; Waitsburg and Dayton, WA.

This section of the appendix is a synopsis of parts of that report (Dyer, 1975).

User Service Rights

In all cases involving agreements between railroad companies, the owning company retains the right to serve customers along the shared trackage. Generally, the user is allowed through traffic only; though in some cases, where the user is abandoning a parallel line, service rights to existing customers may be granted. Also, as in the Southern Pacific and Atchison-Topeka & Santa Fe agreement of 1969 (from Mojave to Kern Junction, California), the user is sometimes allowed local pick-up and delivery of long distance loads or service to consolidated stations.

Control and Management

The owning company usually retains all scheduling and dispatching rights, using its own rules and officials. While dispatching is commonly done on a first-come, first-served basis, most agreements have a clause freeing the owning road from any responsibility for en-route delays. Equipment and employee standards are set by the owning company, and the owning company retains the right to enter into further agreements with other railroad companies. In at least one case (Penn Central & Canadian National in the Welland Canal Tunnel near Buffalo, New York), control over the shared line changes from one company to the other from year to year.

Maintenance

All aspects of maintaining the shared trackage are the responsibility of the owning company. The level of maintenance is either at the owning company's discretion or is defined in the trackage agreement. Usually, the user can request improvement of the line at the user's expense, as in the

1972 agreement between Burlington Northern and the Chicago, Milwaukee, St. Paul & Pacific (between Dryad and Raymond, Washington).

Liability

In the eleven agreements studied, the concepts of exclusive and joint responsibility were present. The men and equipment of each company are considered the exclusive responsibility of each railroad. Men and equipment performing maintenance on the line are usually considered joint responsibilities. Liability for damages caused by exclusive employees or equipment rests with the railroad involved. Each company is responsible for damages to its own equipment and employees in accidents caused by joint men or material, or in cases in which the exclusive men or equipment of both parties was involved. Third party damages in these cases are split equally or according to a scale, such as the respective car or train miles travelled by the equipment, or according to the degree that each party was at fault, as in the Canadian National and Penn Central agreement in the Welland Canal area near Buffalo, New York.

Arbitration

In almost all the agreements having procedures for arbitration between the railroad companies, the methods for choosing the arbitrators is the same. Both parties select a neutral arbitrator, who then chooses a third. In most cases, their decision is then final, though in the 1938 Burlington Northern and Union Pacific agreement (between Wallace and Burke, Indiana and between Waitsburg and Dayton, Washington), if the decision of the first three arbitrators is not unanimous, a second group is chosen and their decision is final.

Term of Agreement-Cancellation Clauses

The term of the agreements in all those studied ranged from 21 years to perpetuity. All except one agreement had cancellation clauses requiring from 30 days to 5 years notice of termination. In cases in which the renting company had abandoned parallel trackage, they are usually given first option to purchase the rented line from the owning company.

Limitations on Use

Few of the trackage rights agreements include any restrictions on the renter's use of the shared line. Exceptions include the 1940 Atchison, Topeka & Santa Fe/Denver and Rio Grande Western Railroad Company agreement (between Denver and Pueblo, Colorado) in which a graduated fee on any traffic in excess of twelve million car miles per year is charged to the using company. Another agreement that includes limitations on the renter's use of the shared trackage is the 1972 Burlington Northern and the Chicago, Milwaukee, St. Paul & Pacific agreement in Washington. The user is surcharged for each car in excess of 35 per train, which insures that user trains will be of a size more suited to the length of the owner sidings and the ideal speed of the line.

User Charges

User charges are commonly computed three different ways: 1) some companies charge the renter a fixed fee per year; 2) others charge the renter a set percentage of the total labor and materials cost of operating and/or maintaining the shared trackage; and, 3) most commonly, a set rate per car mile, train mile, or train is charged. Some agreements include a combination of the three different user charges, such as the 1962 Western Pacific and Southern Pacific agreement (between Flanigan and Weso, Nevada) which includes a fixed fee of $102,000 per year, car miles per month charge, and a set percentage of operations and maintenance costs.

Renegotiation Provisions

Most trackage rights agreements contain a renegotiation provision, ranging in the agreements studied from anytime to five years elapsing between renegotiations. Renegotiations are used to update user charges and change the basic terms of the agreement. By including graduated or indexed user costs, the need for constant renegotiation in trackage rights agreements is negated.

Consideration of Return On Investment (ROI)

Only two of the agreements studied included a user charge linked to the owning company's investment in the line. The 1969 Southern Pacific and Atchison, Topeka & Santa Fe agreement (between Mojave and Kern Junction, California) includes a charge of one-half of 5 1/2 percent interest rental on the value of the joint trackage. The 1962 Western Pacific and Southern Pacific agreement in Nevada includes a user charge of one-half of 5 percent annual interest rental on any betterments to the line.

Additions and Betterments

Generally, the owning company is allowed to make any betterments to the line it deems necessary. In cases where the additions or betterments are jointly used, the costs are usually split 50/50. The renting company is frequently allowed to construct its own additions and betterments at its own expense. In any case, the owning railroad usually retains ownership of all additions and modifications.

Taxes

In agreements with a provision for handling taxes, they are commonly split equally. However, in the 1972 Atchison, Topeka & Santa Fe and Norfolk & Western agreement (between the C.A. Junction-Sheffield, Missouri and the A.T. Junction-Argentine, Kansas), Norfolk & Western's share of the tax burden is included in the train mile charge.

Section 2 - Concerns in Commuter Service Agreements

Most commonly, a commuter service agreement is entered into by a transit authority or department of transportation and a railroad company. The railroad company is retained by the authority as a contract operator for the desired service. The responsibilities of both parties are outlined in the agreement; these responsibilities represent seventeen major concerns.

This section is based upon five commuter service agreements:

- 1982 SouthEastern Michigan Transportation Authority/Grand Trunk Western Railroad Co. between Pontiac and Detroit, MI.
- 1982 Massachusetts Bay Transportation Authority/Boston & Maine Corp. in the Boston area.
- 1979 State Railroad Administration of the Maryland Department of Transportation/Baltimore & Ohio RR Co. between Baltimore, MD and Washington, D.C.; Washington, D.C. and Brunswick, MD.
- 1982 State Railroad Administration of the Maryland Department of Transportation/National Railroad Passenger Corp. (AMTRAK) between Baltimore, MD and Washington, D.C.
- 1980 California Department of Transportation/Southern Pacific Transportation Co. between San Jose and San Francisco, CA.

Control and Management

In the five agreements studied, the railroad is responsible for administering, managing, operating and maintaining the commuter rail service, while the authority is responsible for setting overall policies such as scheduling the trains and setting the fares. In addition, the railroad provides all labor, administrative, professional and supervisory personnel.

Scheduled Trains

The railroad is bound to operate trains of specific content at specified times. Initially, these specifications are established in the agreement; the manner in which they can be modified varies with the agreement. For example, in the 1982 Massachusetts Bay Transportation Authority and Boston and Maine Corporation agreement, covering the Boston area, the authority can request a service change with 60 days advance notice. If the railroad disagrees with the change and the authority continues to desire it, the matter can then be referred to arbitration. Alternatively, in the 1982 Maryland Department of Transportation and AMTRAK agreement (between Baltimore and Washington), the railroad must make every reasonable effort to implement any schedule change desired by the authority.

Maintenance

The railroad is usually responsible for maintaining the equipment, rolling stock, trackage, and stations involved in the commuter service. The standards of maintenance are either specifically outlined in the agreement or a general set of standards is agreed upon, such as the ICC-FRA standards cited in the 1979 Maryland Department of Transportation and Baltimore and Ohio Railroad Company agreement (between Baltimore and Washington; Washington and Brunswick, Maryland).

Emergency Transportation - Special Trains

In three of the five agreements, the authority can direct the railroad to operate additional, special trains at the authority's cost. In addition, in the 1982 Massachusetts Bay Transportation Authority and Boston and Maine Corporation agreement (in the Boston area), the railroad can operate its own special trains, assuming all the risks and costs of such operations. In two of the agreements, the railroad must provide alternate service in case any disruption of the service occurs.

Revenue Collection

In general, the railroad is responsible for collection of all commuter service fares. In addition, they may be responsible for collecting other revenues as well, such as concession, advertising and parking fees, as in the 1980 California Department of Transportation and Southern Pacific Transportation agreement (between San Jose and San Francisco). In all the cases where the railroad collects revenues, the agreement dictates that strict records be kept of such revenues so that the authority can be credited with them.

Promotion

Generally, the railroad is under no obligation to provide any advertising or marketing of the commuter service. If, as in the 1982 Massachusetts Bay Transportation Authority and Boston and Maine Corporation agreement (in the Boston area), the railroad should decide to advertise the line, authority approval is necessary.

Equipment, Stations and Track

The railroad is usually responsible for providing the track, stations and equipment, but not the required rolling stock. A notable exception is the 1982 Massachusetts Bay Transportation Authority and Boston and Maine Corporation agreement (in the Boston area) in which the authority provides all the track, stations, equipment, and rolling stock to the railroad. Rolling stock is usually provided to the railroad by the authority through lease, sublease, or use of its own equipment. Railroad provision of rolling stock, stations, and fixed facilities may be linked with an authority's option to buy, as in the 1980 California Department of Transportation and

Southern Pacific Transportation Company agreement (between San Jose and San Francisco).

Liability

Three methods for dealing with the concern over liability exist in the agreements: 1) The authority holds the railroad harmless from all responsibility for injury to any person or property arising out of the commuter service. Payment of such claims is either the responsibility of the authority or comes from a liability fund specially established for this purpose, as in the 1982 Massachusetts Bay Transportation Authority and Boston and Maine Corporation agreement (in the Boston area); 2) The authority holds the railroad harmless from any claims linked to authority negligence while the railroad holds the authority harmless from claims arising from railroad operation, maintenance, repair or management of the commuter service; and, 3) The railroad agrees to hold the authority harmless if the authority agrees to reimburse the railroad for payment of any and all claims arising from the commuter service.

Costs and Charges

In all five agreements studied, the authority reimburses the railroad for the costs incurred by the operation of the commuter service. In turn, the railroad credits the authority with revenues collected from operation of the service. Methods for determining the actual costs of the commuter service vary, but may include train and engine crew wages, fuel costs, machinery depreciation, a portion of management wages, health and welfare benefits, meals and lodging, material costs, liability insurance costs, station overhead, locomotive and coach rental fees, deadheading expenses, track inspection costs, track maintenance costs, etc. In addition, the authority may pay station rental fees, track use fees, and/or a management or operating fee to the railroad. For example, in the 1982 Maryland Department of Transportation and AMTRAK agreement (between Baltimore and Washington), the authority compensates the railroad for operating costs and also pays a $266,000 operating fee, adjusted annually. Finally, the authority may pay the railroad performance incentives, including on-time, consist compliance, and ridership incentives.

Capital Improvements

In the three agreements addressing the concern of capital improvements, the authority agreed to reimburse the railroad for the portion of any improvements related to the commuter service. In the 1982 Maryland Department of Transportation and AMTRAK agreement (between Baltimore and Washington), the authority may request the railroad to make improvements or modifications.

Records and Audits

In all the agreements studied, the railroad must maintain accurate and appropriate financial and accounting books and records on the commuter service. Also, the authority has the right to inspect, or audit, such materials.

Term of Agreement - Cancellation Clauses

The agreements range in term from three to ten years. Typical cancellation clauses include termination with 30 to 60 days notice, termination only if the agreement is breached, and termination only in specific cases. Some agreements, such as the 1979 Maryland Department of Transportation and Baltimore and Ohio Railroad Company agreement (between Baltimore and Washington; Washington and Brunswick, Maryland), include more than one cancellation clause.

Arbitration

Similar to the previously discussed trackage rights agreements, two of the five commuter service agreements have each party select an arbitrator who then selects a third. If the two selected arbitrators cannot agree on a third, then a specified judge makes the selection. The arbitration method in the 1982 Southeastern Michigan Transportation Authority and Grand Trunk Western Railroad Company agreement (between Pontiac and Detroit, Michigan) is the only one greatly different from the others: a list of five arbitrators is requested from the American Arbitration Association and each party alternately eliminates a name until only one arbitrator remains.

Renegotiation Provisions

In three of the agreements studied, this concern was not addressed. Only in the 1979 Maryland Department of Transportation and Baltimore and Ohio agreement (between Baltimore and Washington; Washington and Brunswick, Maryland) is a comprehensible system of renegotiation layed out. In this agreement, the terms may be renegotiated once a year, starting the second year of the term.

Taxes

In the two agreements that make any mention of taxes, the authority reimburses the railroad for all taxes related to the commuter service: sales tax, payroll taxes, equipment property taxes, etc.

Section 3 - Summary of Agreements

In summary, the agreements studied, both trackage rights agreements (TRA) and commuter service agreements (CSA), serve to illustrate the kinds of concerns both railroad companies and transit agencies deal with in shared right-of-way situations. Some of the concerns outlined herein have little to do with the actual sharing of trackage, but rather are concerned with other factors, such as the competitive nature of railroad companies dictating that "User Service Rights" be dealt with in trackage rights agreements. Other concerns stem directly from the sharing of rights-of-way, such as the "Control and Management" and "Liability" concerns. Such concerns are important enough to be included in all the agreements studied.

Table I-1 presents a summary of the 5 Commuter Service Agreements obtained from the surveys conducted as part of this research. Each of the 5 agreements are discussed in terms of the following 20 contractual elements:

- Involved Agencies and Contract Date;
- Type of Line;
- Route Miles;
- Control and Management;
- Scheduling of Trains;
- Revenue Collection;
- Maintenance;
- Emergency Transportation - Special Trains;
- Promotion;
- Equipment;
- Stations;
- Track;
- Liability;
- Costs and Charges;
- Capital Improvements;
- Records and Audits;
- Arbitration;
- Term of Agreement - Cancellation Clauses;
- Renegotiation Provisions; and,
- Taxes.

Table I-2 provides a comparison of some 20 contractual concerns of trackage rights agreements and of Commuter Service Agreements discussed within this appendix. Nine of the 20 concerns (45%) are mutually included in both types of agreements. Those contractual elements included or addressed in Commuter Service Agreements but <u>not</u> in Railroad/Railroad agreements are:

- Scheduling of trains;
- Emergency transportation - special trains;
- Revenue collection;
- Promotion;
- Equipment;

Table I-1. Summary of Major Elements of Five Current Commuter Rail Passenger Service Agreements

No.	Agreement and Contract Date	Type of Line	Route Miles	Control and Management
1.	SouthEastern Michigan Transportation Authority/Grand Trunk Western RR Co. Pontiac - Detroit, MI March 1, 1982	Double-tracked	55.6	RR is the contract operator for AUTH; RR, as operator, provides all administration and management, labor and supervision necessary for commuter service.
2.	Massachusetts Bay Transportation Authority/Boston and Maine Corp. Boston area, MA February 23, 1982	Most double-tracked	242.0	RR operates commuter service for AUTH. RR provides all administration and management, labor and supervision necessary.
3.	State Railroad Administration of the Maryland Department of Transportation/Baltimore and Ohio RR Co. Baltimore, MD - Washington, D.C. Brunswick, MD - Washington, D.C. March 9, 1979	Most double-tracked	172.0	RR operates commuter service for AUTH without undue interference from freight operations. RR provides all administrative and management, labor and supervision necessary.
4.	State Railroad Administration of the Maryland Department of Transportation National Railroad Passenger Corp. (AMTRAK) Baltimore, MD - Washington, D.C December 1, 1982	Multiple-tracked	80.6	RR is the contract operator for AUTH. RR provides all administration and management, labor and supervision as necessary.
5.	State of California Department of Transportation/Southern Pacific Transportation Co. San Jose - San Francisco, CA July 1, 1980	Double-tracked	940	AUTH responsible for setting overall policies governing the service, maintenance and performance standards, determination of fares, schedules and consists, type of equipment, etc. RR responsible for the implementation of such policies. RR provides all personnel necessary to operate the commuter service.

Table I-1 (Continued)

No.	Scheduled Trains	Revenue Collection	Maintenance
1.	RR operates commuter service according to schedule set forth in agreement.	AUTH responsible for sale of all transportation and collection of all revenue except RR performs all on-train collection of fares.	RR maintains locomotives and coaches; AUTH maintains commuter stations.
2.	RR operates commuter service according to schedule outlined in agreement.	RR collects all commuter service fares, keeping strict records of such revenues.	RR maintains both rolling stock and rights-of-way up to standards listed in the agreement.
3.	RR operates commuter service according to schedule set forth in agreement.	RR collects all revenue from ticket sales and cash fares.	RR maintains all equipment to RR and ICC-FRA standards.
4.	RR operates commuter service according to schedule outlined in the agreement.	RR collects all revenues for sale of tickets attributable to the commuter service.	RR maintains all equipment in accordance with manufacturer's applicable procedures, safety regulations and standard RR procedures.
5.	RR operates commuter service according to schedule outlined in the agreement. No less than 90% of trains will be within 5 minutes of scheduled times. AUTH cannot schedule more trains than the maximums listed in the agreement.	RR collects all revenues from sale of tickets, concessions and advertising, parking fees, etc.	RR maintains track, stations, and equipment to standards set forth in the agreement.

Table I-1 (Continued)

No.	Emergency Transportation-Special Trains	Promotion	Equipment
1.	AUTH may require RR to operate additional trains with 30 days written notice, and assuming all costs for such operations.	None	AUTH provides locomotives and coaches for commuter service and special trains. RR provides locomotives as necessary to protect train schedules.
2.	RR operates special trains as directed by AUTH. RR may operate its own special trains, assuming all costs and risks for such trains.	RR has no obligation to provide any advertising or promotion, but may at its own cost, with AUTH approval.	AUTH provides locomotives and coaches, buildings, maintenance equipment and machinery.
3.	RR provides alternate service, if possible, in case of accident or interference affecting the service.	None	RR provides locomotives and coaches for commuter service until AUTH acquires and provides state-owned equipment.
4.	RR provides substitute service for 24 hrs. at no additional cost if service is disrupted. RR provides substitute service or rescue motive power at no additional cost for completion of a trip when an enroute failure occurs. AUTH may request RR equipment on an emergency basis and may request RR to operate additional trains with RR being compensated.	RR provides appropriate staff and management for marketing.	AUTH provides the necessary rolling stock.
5.	None	AUTH responsible for funding promotion of service. AUTH may direct RR to participate in marketing of the commuter service.	RR leases specified locomotives and coaches to AUTH, granting AUTH option to buy.

Table I-1 (Continued)

No.	Stations	Track	Liability
1.	RR provides stations for commuter service.	RR provides all necessary trackage.	AUTH holds RR harmless from any responsibility for injury to any person or property arising out of the commuter service, regardless of cause.
2.	AUTH provides stations for commuter service.	AUTH provides all necessary trackage.	AUTH holds RR harmless from any loss not fully insured against. Payment for such losses comes from a liability fund established with part of the RR incentive payments.
3.	RR provides stations for commuter service	RR provides all necessary trackage.	RR holds AUTH harmless from any claims, suits, damages and liability arising out of the commuter service. AUTH will reimburse RR for payment of such claims up to $500,000 per year.
4.	RR provides all stations except Halethorpe, Odenton, Bowie, and Seabrook which are the responsibility of the AUTH.	RR provides all necessary trackage.	AUTH holds RR harmless from any claims linked to the commuter service except for RR employees performing train and engine crew service, maintenance of equipment, or station services. RR is solely responsible in these cases.
5.	RR leases stations to AUTH and grants AUTH option to buy.	RR provides all necessary trackage.	AUTH assumes all liability if accident or injury caused by AUTH negligent performance of obligations in the agreement. RR assumes all liability if caused by its operation, maintenance, repair or management of the commuter service.

Table I-1 (Continued)

No.	Costs & Charges	Capital Improvements	Records and Audits
1.	AUTH compensates RR for all costs incurred by RR arising out of commuter service operation and maintenance.	None	RR records are available to AUTH. Any payment to RR is subject to audit.
2.	AUTH compensates RR for all expected direct costs and relevant overhead. AUTH also pays RR monthly On-Time, Consist Compliance and Ridership Incentives and a $500,000 per year management fee.	None	AUTH has right to verify any RR expenses charged to AUTH by examination of RR books of account.
3.	AUTH compensates RR for all costs of the commuter service, less a credit for revenues of the service.	AUTH reimburses RR for portions of capital improvements attributable to the commuter service.	RR keeps accurate accounting books and records for the commuter service. AUTH has right to inspect such documents and RR employees shall cooperate in explanation of the material.
4.	AUTH compensates RR for recurring costs and actual costs attributable to operation of the commuter service. AUTH also pays RR an operating fee of $266,000 adjusted annually, and a commission of 8% on ticket sales revenue.	AUTH may request RR to improve or modify facilities at AUTH expense. RR may initiate improvements if AUTH agrees, and AUTH will pay for portion of improvements linked to the commuter service.	RR maintains appropriate financial and accounting records reflecting revenues and costs of the service. AUTH has right to inspect all such material which supports variable costs and revenues collected. Fixed payment amounts are not subject to audit.
5.	AUTH compensates RR for all directly determined operating expenses including machinery depreciation, health and welfare benefits, salaries, etc. AUTH also pays a portion of RR office personnel expenses, an operating margin of 4% of total operating expenses and $0.08 per revenue passenger, and a trackage fee of $559,000 per year. RR contributes $400,000 per year for first five years towards operating expenses.	AUTH pays for all service related capital improvements.	RR keeps proper books and records. AUTH has reasonable right to inspect and reproduce such material.

Table I-1 (Continued)

No.	Arbitration	Term of Agreement-Cancellation Clauses	Renegotiation Provisions
1.	If AUTH and RR cannot agree on an arbitrator, a list of 5 arbitrators is requested from the American Arbitration Association. Each party alternately eliminates one name until only one remains.	3 years--AUTH may cancel with 30 days written notice.	None
2.	AUTH and RR each appoint one arbitrator. If these two cannot reach a decision, they choose a third arbitrator and the majority decision is final.	5 years--either party may terminate the agreement only in specific cases outlined in the agreement. Notification in these cases ranges from 30 to 90 days.	Some Provision
3.	None	5 1/2 years--AUTH may terminate the agreement with 6 months written notice or immediately if authorized funding is lacking. RR may terminate with 60 days notice only if AUTH fails to perform obligations in the agreement.	The second year and all subsequent years, the agreement may be renegotiated once a a year if either party so desires.
4.	AUTH and RR each appoint one arbitrator. These two arbitrators then pick a third. If cannot agree on a third, a U.S. District Court judge makes the appointment. Majority decision final.	5 years-either party may terminate the agreement with 30 days notice if the other party breaches the agreement Otherwise, either party may terminate on 60 days notice.	None
5.	AUTH and RR each appoint one arbitrator. These two then pick a third. If cannot agree on a third, presiding judge of the Superior Court of San Francisco makes the appointment. AUTH and RR may agree on a sole arbitrator.	10 years--either party may terminate the agreement if, 60 days after notification, the other party is still in default of the agreement. May also be terminated by mutual agreement.	None

Table I-1 (Continued)

No.	Taxes
1.	AUTH will reimburse RR for taxes incurred because of commuter service operation.
2.	None
3.	None
4.	None
5.	AUTH pays all commuter service related taxes: sales tax, payroll taxes, equipment property taxes, etc.

Table I-2. Comparison of Concerns in Trackage Rights Agreements (TRA's) and Commuter Service Agreements (CSA's)

Concern	Concern Included In: TRA	CSA
1. User Service Rights	x	
2. Control and Management	x	
3. Scheduling of Trains		x
4. Emergency Transportation-Special Trains		x
5. Maintenance	x	x
6. Revenue Collection		x
7. Promotion		x
8. Liability	x	x
9. Limitations on Use	x	
10. Equipment		x
11. Stations		x
12. Track		x
13. User Charges (Costs and Charges)	x	x
14. Additions and Betterments (Capital Improvements)	x	x
15. Term of Agreement-Cancellation Clauses	x	x
16. Arbitration	x	x
17. Renegotiation Provisions	x	x
18. Consideration of ROI	x	
19. Records and Audits		x
20. Taxes	x	x

- Stations;
- Track; and,
- Records and Audits.

Elements which are included in trackage rights agreements but <u>not</u> specifically addressed in Commuter Services are:

- User Service Rights;
- Limitations on Use; and,
- Consideration of Return On Investment (ROI).

Several, if not most, of the contractual elements covered in one type of agreement but not the other reflect special characteristics and concerns of the contracting parties. An example would be "promotion" which is included in Commuter Services Agreements but not in Railroad/Railroad contracts.