TRANSIT COOPERATIVE RESEARCH PROGRAM

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TCRP Report 52

Joint Operation of Light Rail Transit or Diesel Multiple Unit Vehicles with Railroads

Transportation Research Board
National Research Council

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Joint Operation of Light Rail Transit or Diesel Multiple Unit Vehicles with Railroads

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The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academy of Sciences, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

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The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, the Transit Development Corporation, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

To save time and money in disseminating the research findings, the report is essentially the original text as submitted by the research agency. This report has not been edited by TRB.

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FOREWORD

By Staff
Transportation Research Board

This report will be of interest to transit managers, planning and operations professionals, policy makers, and others interested in the potential for joint operation of light rail transit (LRT) or lightweight diesel multiple unit (DMU) vehicles with freight and/or passenger railroads. For the purposes of this report, joint operation is defined as co-mingled, simultaneous train operation on shared track by railroad trains (freight and/or passenger) and rail transit vehicles that are not fully compliant with current Federal Railroad Administration (FRA) regulations. The report identifies and discusses issues associated with such joint operation, focusing on the current regulatory and institutional environment, railroad and rail transit operations, infrastructure, and rolling stock. In addition, substantial information concerning joint operation overseas is presented and discussed. A risk analysis guide is also provided to assist decision makers in assessing the appropriateness of applying joint operation to particular circumstances. The report concludes that there is sufficient evidence that joint operation can be applied in the North American environment on a case-by-case basis, conditioned on satisfactory risk analyses accompanied by appropriate safeguards.

Many urban areas in the United States are considering new or expanded rail transit services. In a number of these areas, active railroad trackage provides an opportunity for a potentially cost-effective joint-use rail transit alternative.

Of particular recent interest has been the potential joint operation of LRT or lightweight DMU vehicles with railroads. Thus far, technical, institutional, and regulatory issues have limited consideration of such operations in the United States. In other countries, however, joint operation of LRT or lightweight DMU vehicles with railroads has been achieved through incremental research, institutional change, and safety applications of technology. As such, questions have been asked about its potential feasibility in the United States.

Under TCRP Project A-17, research was undertaken by Edwards & Kelcey, Inc., to (1) identify and examine issues relevant to the safe operation of rail transit services with railroads; (2) prioritize the most critical issues affecting such joint operation using LRT or lightweight DMU vehicles that do not meet current U.S. railroad regulations, standards, or practices; and (3) offer potential guidance on the most critical issues pertaining to implementing joint operation using LRT or lightweight DMU vehicles. The objective of this research was to offer insights as to whether the joint operation of LRT or lightweight DMU vehicles with railroads is a viable transportation option in the United States and, if so, to offer guidance that could facilitate its implementation.

To achieve the project objective, the researchers obtained information regarding the regulatory, institutional, operational, and physical (infrastructure and vehicle) issues associated with joint operation. On the basis of this information, key issues were identified and assessed.

Significant information concerning the characteristics of European and Pacific Rim joint operation experiences was also obtained. Over 30 examples of joint operation were assessed and their applicability to North American circumstances evaluated. In addition, three European case studies (including Karlsruhe, Germany—recognized as a pioneer in joint operation) and six Pacific Rim case studies were examined in detail to describe the broad scope and variety of shared track practice and technology.

In addition, a risk analysis guide was developed to help decision makers assess the appropriateness of applying joint operation to specific circumstances. This guide presents extensive safety and accident data supporting conclusions that railroads and rail transit are among the safest travel modes and that there is a trend toward increased safety and reduced exposure.

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S. David Phraner was the Principal Investigator and William Redl, James Palmer, and Richard T. Roberts in turn were the Principals-in-Charge. Other investigators, research associates and/or authors making significant contributions include Paul Stangas (EK/BA&H), Richard Whitehead (EK), Robert Keith (EK), Aaron James (BA&H), Alex Curmi (BA&H), T. Frawley (BA&H), Kenneth Korach (TRA), John Tucker (TRA), J. Klein (TRA), John Shortreed (IRR), Diana Del Bel Belluz (IRR), D. Berndt (RC), M. Stumpe (RC), and Charles Lietwiler.

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JOINT OPERATION OF LIGHT RAIL TRANSIT OR DIESEL MULTIPLE UNIT VEHICLES WITH RAILROADS

SUMMARY

Rationale: Rising transport congestion, increasing costs, and greater environmental sensitivity compel transportation practitioners to consider new ways of achieving more system capacity. Joint use of facilities is one means of wringing more use out of transportation investment. Physical, operational, and regulatory differences between rail users, though, tend to suppress potential economies of joint track use.

Definitions: "Rail transit," for purposes of this research, is defined as light rail (streetcar derivative), rail rapid transit (subway and elevated type urban railways), and DMU (diesel multiple units including rail buses, which are bus or light rail derivative). Railroads are part of a national system with compatible physical and operating standards which permit interchange of rolling stock, personnel, technology, and practice.

The Problem: *Joint Operations of Light Rail Transit or Diesel Multiple Unit Vehicles with Railroads* is directed at the feasibility of one of the most timely and controversial aspects of facility joint use, that of shared track between railroads (typically heavy locomotive-hauled train consists) and rail transit (light rail cars, etc.). At issue is that none of the above rail transit modes are considered compliant with U.S. Federal Railroad Administration (FRA) standards for railroad interchange service. Rail transit is therefore prohibited from running on railroad tracks and railroad trains are prohibited from running on transit tracks.

Joint passenger and freight use of tracks is, however, a long-standing tradition among individual railroads. Railroad managements once provided comprehensive (passenger and freight) services together on common tracks in all but the most congested environments. As railroads in North America were reorganized and deregulated, passenger and freight systems tended to become separated, both physically and institutionally. Rather than complementary businesses under common management sharing tracks, public-sector deficit passenger services now compete with private profitable freight railroads for track space. Railroads also grant trackage rights to one another when it is in their common business interest to do so (or when compelled to do so by regulation). The resulting competition for track space is manifest in a track tenant/landlord relationship, whether the competitors are freight/passenger users or transit /railroad entities.

Co-mingling railroad trains and light rail transit on common tracks introduces additional complication because these rail modes are regarded as mutually incompatible by rail carriers and regulators. Safety, risk, and liability are often cited for keeping railroad and rail transit separated. Cost savings, safety, and public convenience are popular reasons among advocates for shared track between rail transit and railroads. Historical domestic and overseas precedents, however, successfully demonstrate the validity of shared track when accompanied by regulatory safeguards. **The central dilemma is that the standards accepted by railroad and those of rail transit are considered to be incompatible in four major joint use characteristics:**

1. ***regulation***
2. ***physical plant***
3. ***operations and***
4. ***rolling stock***

Approach: The four rail system characteristics above comprised the core research structure of this report. All joint use issues fall within one or more of these four features. From a comprehensive investigation of the four characteristics, the research team identified key issues governing joint use. These issues included:

- Quantifying joint use exposure, liability, and risks,
- Identifying mitigation to reduce any joint use risks to levels acceptable to rail carriers, regional decision makers, and regulators,
- Balancing requirements for rail system safety, capital cost savings, efficiency and public convenience in a joint use context
- Transferring and applying overseas joint use experience, practices and technology.

Ancillary issues were also identified, such as crashworthiness (ability to sustain a crash) versus crash avoidance (ability to prevent collisions). These key issues provided a policy overlay to the four major joint use features above. Each of the four joint use features was treated separately for purposes of information gathering and surveys.

Regulation: Railroads are part of a common standard, regulated, interconnected national system of tracks, interchangeable rolling stock, and operating rules. Rail transit has none of these characteristics. Rail transit systems are separate metropolitan or state-based entities, whose standards and rules (and even track gauges) can vary. Rail transit vehicles (commuter rail excepted) are considered non-compliant with Federal railroad standards. Railroad tracks, therefore, may connect the metro areas, but not with rail transit systems within the metro areas. Railroads are regulated by the Federal *Railroad* Administration (FRA) and the Surface Transportation Board. Rail transit regulation is being reorganized by those states with or planning rail transit by Statewide Safety System Program Plans (SSPP). The SSPP effort is directed at all modes of rail *transit* organized by the carriers largely through the American Public Transit Association (APTA) with the sanction of the Federal *Transit* Administration (FTA). Rail transit regulation, as it will exist, may be largely performed regionally, applying Federal guidelines. Temporary waivers (for demonstrations of non-compliant equipment and special circumstances) and exceptions are granted by FRA. Two examples are instructive.

In North America, only two light rail systems, in San Diego and Baltimore, currently host railroad freight operations on their tracks, but host light rail and tenant freight trains are separated temporally. Freight trains run only during night hours, when light rail service is curtailed. Often cited as "joint use," these two contemporary shared track arrangements are not considered joint use for purposes of this research, since freight trains and light rail vehicles do not co-mingle or operate concurrently on the same track.

Operations: Joint use in North America can be viewed from two institutional conditions:

- What is currently operationally achievable (trackage rights, joint operating agreements, temporal separation and temporary waivers, such as in Baltimore and San Diego, for the operating convenience of both carriers), and

- A future joint use operating ideal (co-mingle operations applying overseas practices and stringent risk assessments to make rail "new starts" affordable where they are considered otherwise feasible).

While historic precedents exist for various operating practices on shared track, particularly in the now defunct North American interurban railway industry, these have disappeared along with the corporate culture and motivation that fostered these practices. There are, however, contemporary cooperative track sharing operations which provide useful North American operating experience. Notable among these is the Northeast Operating Rules Advisory Committee or NORAC. Nine trunk freight and passenger operators (and 27 associate member carriers) adopted common operating rules governing any member employees when they are operating on another member's tracks.

Freight railroad concerns center around initiating joint use, liabilities, revenue implications and the ability to expand on limited shared track space if freight and rail transit businesses prosper and grow simultaneously.

Physical Plant: Freight railroad and light rail have different performance and operating characteristics. They impact track and rail infrastructure in different ways. Beyond contrasting wear and tear, dimensional differences created by wayside transit structures (such as high platform stations) can restrict a railroad's physical operating envelope. Technological solutions (such as gauntlet tracks for high platform stations) exist to resolve these physical plant incompatibilities, but applying them in the case of light rail and railroads is challenging. Some signal technologies under development, such as positive train control (PTC) and positive train separation (PTS), hold promise as mitigation to reduce safety risk and accident exposure in future joint use scenarios.

Vehicles: Contrasting railroad and rail transit vehicle design standards are the cause of most prominent safety concerns by rail operators and regulators. For purposes of dealing with the family of diesel multiple unit (DMU) car types, it was necessary to propose three categories of DMU cars:

- DMU Category 1 - Railroad derivative designs, *FRA compliant* rail cars (example Budd RDC) capable of mixing with conventional railroad train movements.

- DMU Category 2 - Light rail, railroad or bus technology derivative designs, *FRA non-compliant* for low-density railroad, isolated branch line, or regional rail new start applications, but prohibited from mixing with railroad operations in the U.S.

- DMU Category 3 - Light rail derivative design, *FRA non-compliant*, capable of operating on railroad track and streetcar track geometry with dual (diesel and electric) traction power. Though definitions vary, this might be termed a "diesel light rail vehicle (DLRV)," since it can perform in streetcar and railroad environments, but is now prohibited from mixing with U.S. railroad movements.

Light rail vehicle (LRV) and DMU (all three categories) car manufacturers were surveyed by the research team, and from their responses an inventory of current rail car models and types was assembled. None of the category 2 and 3 cars were FRA compliant and some of the category 1 cars were provisionally compliant. The North American rail safety emphasis on *collision protection* (in contrast to European emphasis on *collision avoidance*) came into focus in reviewing the performance and physical characteristics of various car types. For example, railroad buffing (car body compressive) strength for overseas railroads is in the 300-400,000 lb. range while North American railroad requirements are nearly twice that at 800,000 lbs. Typical light rail car buffing strength is in the <200,000 lb. range. Making cars stronger to sustain collision forces (collision protection) creates a heavier car that is unable to stop in shorter distances, thereby sacrificing performance (collision avoidance).

<u>Key Joint Use Issues:</u> The major issue emerging from the data collection phase of the research revolved about balancing public interests. Can public safety (reduced risk), public convenience (more and better rail transit), and public cost (savings by using existing track rather than constructing parallel redundancy) be balanced? Once information and data collection were completed, the team addressed the analytical portion of the research by considering two broad types of remedies to the key issues:

- <u>Risk Assessment Process and Guide</u> to estimate the risk of case-by-case joint use scenarios and then apply risk mitigation to reduce risk to acceptable levels.

- <u>European and Pacific Rim joint use experience</u> and transferability of their technology and practice to North American railroad and rail transit environments.

<u>Risk Analysis:</u> Risk assessment is an accepted practice in the U.S. and overseas in evaluating the feasibility of joint use between railroad and rail transit and between railroad trains of different types. A Federal regulatory framework is appropriate to ensure that any local analysis and decisions are valid (as done in Germany). Information from the German Ministry of Railways (Düren, Chemnitz, and Cologne proposals) and FRA (Northeast Corridor and Florida Overland eXpress proposals) revealed that fundamental risk assessment processes are used by both organizations to evaluate exposure of joint use. In the U.S. high-speed and low-speed railroad joint operations are risk evaluated. Overseas, risk analysis is applied to railroad and light rail shared track practices. Safety data on accidents, injuries, and fatalities were assembled from National Transportation Safety Board (NTSB), FRA, and other sources. These revealed that railroad and rail transit show a trend toward increasing safety and favorable accident experience. This proved to be a "fortunate dilemma" for the research team, because the increased fortunate absence of accident experience unfortunately suppressed the ability to conduct data-dependent risk analysis.

A risk assessment guide was developed for purposes of reducing possible misunderstanding of risk assessment for state and metropolitan transportation practitioners. The research team concluded that risk analysis is an *optional* device for practitioners wishing to introduce or expand rail transit. Risk assessment may not be appropriate to apply where joint use is infeasible for reasons other than risk, or there may be no right-of-way assets available on which to apply shared track practices.

<u>European Experience:</u> While the debate will continue on the transferability of Germany's joint use practice to North America, research disclosed that:

- similar conditions did exist overseas that were barriers to joint use;
- these barriers were overcome or mitigated;
- attitudes of railroad and transit managements underwent a change;
- risk analysis played a key role in regulatory change;
- regulation of railroads and rail transit overall did not relax but became a major determinant in joint-use achievements. Unlike the U.S., Germany regulates its rail transit systems (BOStrab regulations) in addition to its railroads (EBO regulations); and
- metropolitan, "bottom-up" joint use innovation influenced the speed and direction of shared track developments.

Most innovative and advanced among joint use practices were those found in Germany, specifically at the city of Karlsruhe. Three case studies were investigated which represented three different, modest-sized metropolitan areas in three distinct stages of joint track use implementation:

- Karlsruhe: Joint use growth, expansion, and diversification over a decade
- Saarbrücken: Joint use in first year of operation
- Luxembourg: Joint use in planning and implementation phases.

Joint use concepts are being investigated widely in Western Europe. Several metropolitan areas have implemented or were about to embrace joint use. Eighteen joint operations in various nations were briefly profiled and over twenty other European cities in early planning stages of joint use were listed. All of the metro areas listed experienced changes in institutions (privatization), regulation (E.C. transition), funding (regionalization of rail transport), and other environmental conditions that accompanied and helped bring about joint use innovation in Europe.

<u>Pacific Rim Experience:</u> Japan is a major practitioner of joint use, more extensive and diversified than Germany, in fact. Over 160 operations were examined by the research team. From these, six joint use case studies were selected for analysis. Each demonstrated different types of joint use, including:

- Railroads extending through rapid transit subways in CBDs to distribute their passengers
- Rapid transit (subway) extending their reach over railroad lines in reciprocity of above
- Combinations of the above, with interurban railways starting and ending their trips in subways of neighboring metropolitan areas while running on

their own tracks. Rapid transit trains sharing tracks with the interurban at the periphery of their respective urban areas in reciprocal running

- Third Sector (public/private venture) railway rail buses operating on Japan Rail tracks and reciprocally with a mix of rail buses, freight, and passenger railroad trains on third sector railway tracks
- Light rail and interurban operating jointly on streets in high and low platform modes as part of a system of comprehensive and varied rail services and
- Local light rail operating with locomotive-hauled freights under common management.

The Japanese (and the two other Pacific Rim examples profiled, Hong Kong and Seoul) demonstrate a successful ability to fulfill their rail transit plans by employing reciprocal (joint) running between railroads, interurbans, and rapid transit operations. In Japan, among the metropolitan areas covered, over 789 *route* miles of rapid transit service expansion (over railroads) was achieved in the last two decades. In Seoul/Inchon metropolitan areas, almost 230 miles of rapid transit "subway" service expansion was accomplished using joint use with the national railroad as a tool for service expansion. The Japanese rail rapid transit service expansions would have been totally unaffordable at an estimated $79 billion (790 miles x $100 million). The lesson learned is beyond saving construction money with joint use; its real value is that it enables expediting rail projects that would otherwise never happen.

In Japan joint use is a matter of business practice rather than regulation. Japanese federal regulators focus their attention on licensing and controlling potential monopolies. As a matter of routine, they do not regulate rail car performance and specifications. The distinction between rail modes in Japan has become blurred largely because joint use practices encourage standardization of rolling stock and operating practices over time. Some Japanese joint use experience has already transferred to North America. Japanese *Daisan*, or third sector, ventures have a near North American equivalent in Joint Venture/DBOM and public-private enterprise currently being proposed here.

Curiously, there is no direct Pacific Rim equivalent for Karlsruhe or the common other European joint use case studies above. This may be because Germany retained and developed its light rail systems to a higher degree than Japan. In that respect alone, the Japanese experience may be more applicable in North America.

<u>Conclusions:</u> The principal conclusion from this research is that joint use has potential for implementation, in North America, but under limited and controlled circumstances.

Those circumstances can be defined and managed primarily by a risk assessment process. As a tool, risk assessment measures the (risk) exposure of various physical alternatives and operating plans and tests mitigation options to reduce risk to a tolerable level (for regulators and joint operating partners). Accompanying the risk assessment are other analysis techniques and a policy framework by Federal and state regulatory entities. The planning structure to accomplish risk assessment is already in place with the Major Investment Study/Alternative Analysis (MIS/AA) technique under the state- and Federally-sanctioned Metropolitan Planning Organization (MPO) comprehensive planning process. The regulatory structure is coming into place with the renewal of state safety regulation of rail transit (SSPP) and Federal railroad safety rule making.

The research team was urged by those interested in the study to produce "the last word" on joint use. It has instead uttered "the first word" by reintroducing the concept of genuine joint use in North America. Clearly, more research is needed in the specifics of German regulation, specific operating practices, and use of risk assessment, focusing intensive investigation on Karlsruhe's technology and operating practices. Most of the physical aspects of German joint use are already well known through existing literature. The institutional and regulatory aspects however are more obscure. The German Railway Ministry provides useful examples of assembling and tabulating accident data, in support of risk analysis. These techniques are fortified by safety data, which is another area deserving more attention. Risk analysis techniques need further testing and validation with actual case studies. There is more to learn from the Japanese third sector business experience applied to a variety of ventures, joint use of tracks being only one. Expectations for this research varied widely. The research conclusions may be more assertive than some would have wanted, and more timid than others would have expected. Like all research, this report may arouse more questions than it answers. To the extent that this report makes joint use of tracks a subject of productive debate and encourages and directs subsequent research into the topic, it might be considered useful.

CHAPTER 1: CURRENT REGULATORY INSTITUTIONAL ENVIRONMENT FOR JOINT OPERATIONS

1.1 OVERVIEW

Most current and emerging rail system regulations are based on achieving and enhancing safety for the general public, customers, and employees. In its zeal to promote safety, this regulatory process often inhibits or even conflicts with contemporary economic, technical, or operating conditions that provide greater travel opportunities. Proposals for joint operations between railroads and lightweight, lower-cost transit rail vehicles are especially vulnerable to contrasting objectives between safety regulation and improved transit service.

Formerly, rail transit and railroad regulatory scope encompassed both safety and business practices of carriers. At present, "deregulation" emphasis has shifted to safety, while business considerations (market entries, competition, rates, and service) have diminished. It is important therefore to evaluate the status and impacts of current regulations and identify adequacies and deficiencies in balancing conflicting interests that confront joint operations on shared rights-of-way.

Introducing prototypical or experimental light weight rail car technology to railroads means researching the means by which regulatory approval can be obtained for FRA non-compliant equipment. While the scope of this research focuses on joint use between freight railroads and rail transit vehicles ranging from light DMU to LRV, some discussion is presented on the compatibility between DMU and LRT and other types of rail transit operations.

To fully understand issues that might affect any combination of joint operations between Light Rail Transit, Diesel Multiple Units, and railroads, it is necessary to identify current and emerging regulations governing these operations. A major objective of this investigation has been to provide a framework for assessing the regulatory issues that most influence the possibility of joint operations.

To describe the regulatory framework that influences joint railroad and rail transit operations, a survey was initiated of those regulatory bodies that issue regulations and recommend practice. The rationale behind the regulations has been reviewed and interpreted relative to the joint operations concept. State and local codes have also been examined for their impact. A survey of car builders' products was also conducted.

Most of the recent innovation in balancing streetcar, rail rapid transit, and railroad technology and service has originated overseas. Pertinent European and Asian experience has been reviewed, noting regulatory reform, technology and practices that may be transferable. These are assessed with an awareness of their differences from our domestic operations and infrastructure. Privatization of foreign railways is sometimes accompanied by separation of track ownership from operations, resulting in multiple users of track and time share or other fee basis which has encouraged forms of joint use.

San Diego and Baltimore LRT systems have been reviewed relative to institutional steps taken and especially the freight operators' role and perspective. The contract operations that were developed to facilitate joint operations on these two properties have been reviewed.

Risk and liability are inherent in joint operations. Unless risk can be reduced to levels that reflect a tolerable liability exposure for the rail line owner and operators, progress on joint operations is likely to be difficult and its full potential not realized.

Management and ownership arrangements have also been reviewed to identify competing and complementary aspects of joint operations. Benefits to both owner and tenant parties using a single corridor, which can create an incentive to cooperate, are also identified.

1.1.1 Evolution of Joint Use Rail Issues - Historical & Overseas Precedents

Characteristics by which rail transit technologies are defined are becoming more complex. As a result, the distinction between rail transit modes is becoming physically and functionally blurred. Light rail transit (LRT) and rapid transit are sometimes hard to distinguish

Rail car designs are being adopted as transitions between rail transit modes. Some diesel multiple unit (DMU) designs are light rail derivative, others are based on railroad scale and performance. Joint use (or related "reciprocal running" as practiced in Europe and Pacific Rim) further blends the distinction among rail transit modes. It is more than a research exercise in technology application or potential regulatory reform. Joint use provides new, cost-effective opportunities for seamless, barrier-free, one-seat, no-transfer trips for rail riders. The more specialized rail transit becomes, the more hybrid forms seem to arise that cross between traditional rail modes. Hybrid forms, such as the Diesel Light Rail Vehicle (DLRV), derived from Diesel Multiple Unit (DMU) and Light Rail Vehicle (LRV), offer greater opportunities for operating reciprocity between adjacent or end-to-end rail carriers.

A form of joint use is practiced extensively among railroad freight carriers through trackage rights and haulage agreements. Freight railroad systems infrastructure and rolling stock are more uniform and mutually compatible, making freight car interchange and equipment pooling common. Attempts to classify or define rail modes are becoming increasingly difficult but it is important to define contemporary rail proposals, for as rail modes are classified, so are they regulated and operated. Regulation and operation are key determinants in accomplishing joint use.

The history of U.S. track joint use and recent overseas experience demonstrates the potential for joint use practice in the United States. Given the North American freight railroad and rail transit status, the central issue becomes the means by which joint use service can be implemented, regulated, and practiced at no sacrifice to safety or risk. Historical and overseas experience provide examples of the way it has been accomplished. Overseas experience and application to North American environment is more fully described in Chapters 7 and 8.

Large Japanese cities (Osaka, Tokyo, Kobe, Kyoto, Nagoya, and others) have developed reciprocal running practices among various metropolitan railways regardless of type or ownership. Japanese cities use joint running effectively to extend heavy rail or rapid transit into the suburbs without requiring the large investment associated with heavy rail transit. Through use of reciprocal running, Tokyo was able to triple its rapid transit mileage reach into the suburbs since the late 1950s. Over 50 examples of current reciprocal running services are in place in Japan that include six geographic Japan Rail Group (formerly JNR) corporations, in addition to JR interurban lines, private railway companies, third sector railways, rapid transit companies and authorities, municipal systems, light rail companies, and street railways. Three track gauges common to Japan, four traction voltages, three electric current delivery systems, and four car widths, plus diesel propulsion, all represent considerable diversity, but do not prevent operating reciprocity among diverse passenger operators. Freight/ passenger reciprocity is also prevalent in Japan. See Chapter 8 for detailed review of all Pacific Rim joint use practices.

Paris and its Regional Rail or RER system overcame the institutional barriers to joint use by exchanging train crews at the jurisdictional boundaries between SNCF (French National Rys.) and RATP on RER tracks. The equipment operates from a common dedicated pool.

Karlsruhe, Germany integrated its local streetcar and DBAG (German National) railroad service on selected lines. Special dual-voltage LRVs negotiate the transition between streetcar and railroad trackage. LRVs and commuter trains not only run jointly, *but also provide joint service on an integrated public timetable*, with freight and intercity trains interspersed in the operating schedule. Saarbrücken, Germany has implemented a similar arrangement which crosses the border into France. Luxembourg and other European cities are actively exploring the joint running concept.

Historic and contemporary U.S. examples include rail transit modes that change character along their route. While not an example of joint running, Niagara Frontier Transit Authority's Buffalo "LRT" begins downtown as a surface streetcar and transitions into a rapid transit-like subway at its outer end. The Chicago, North Shore and Milwaukee "Railroad," abandoned in 1962, in its Chicago/Milwaukee corridor exhibited perhaps the most change in character along its 90-mile route. The "North Shore" is also a frequently cited example of joint operation. It emulated heavy rail rapid transit/elevated, commuter railroad, intercity high-speed railroad, and streetcar operating in mixed traffic, each overlaid on an active interchange railroad freight business. The North Shore also shared tracks jointly with local streetcars, elevated trains, and interline freight trains, all with an enviable performance and safety record.

Are the Staten Island Rapid Transit (SIRT) and Port Authority Trans Hudson (PATH) rapid transit operations or railroads? Both once shared track with freight and passenger trains. Neither has joint operation with real railroads now, but both remained regulated as railroads long after joint running and criteria for railroad designation had ceased to apply. SIRT has since been successful in being declassified as a railroad, but PATH's request was recently denied by the FRA. This administrative decision is being appealed in court. What differentiates these two "railroads" from Port Authority Transit Corp. (PATCO) in the Camden, NJ-Philadelphia area, which is regulated as an interurban electric railway?

Joint railroad and LRT operations of the San Diego and Baltimore LRT systems, though not co-mingled or simultaneously operated, are detailed elsewhere in this report.

Against the backdrop of modal typology, the quest for seamless travel, and research, on integrated rail systems continues. The newest issue to be confronted is the physical, operational, regulatory, and institutional integration of the rail modes. Within this issue, an emerging focus is the joint use of facilities including tracks and interchange of rolling stock.

Advantages of Joint Use Operations

Joint use operations are attractive for a number of reasons:

- Cost Avoidance - to avoid building, maintaining or operating separate parallel tracks and infrastructure where there is sufficient capacity to share one set of tracks.

- Enables expansion of rail transit services and capacity without creating additional facilities, public takings, or environmental/social disruption.

- Encourages service integration providing extended routes or reciprocal running, thus reducing passenger transfers.

- Increases the probabilities for new starts in metro areas where rail transit is absent, but desirable.

- Can be made consistent with other railroad business practices, such as development of cost centers, as in current U.S. and European experience.

- Increases spectrum for incremental financing of rail transit on rail infrastructure that is underused or disused.

In summary, the downside is risk. Within the next few years, case-by-case risk analysis will likely govern joint use protocols until a sufficient body of data, precedent, and legislation is established. This research is intended as a curtain opener.

1.1.2 Joint Use - A Context

Consider the joint use concept and regulation applied to highways instead of rail transit. Joint use is not regarded by highway managers as the vexing problem that it presents to rail system operators and regulators. Highways have no positive vehicle guidance system or uniform vehicle or system standards to provide railroad-level operating discipline. Professional drivers vie for road space with novices. Railroad vehicle operators are trained professionals operating in a highly rule-book-managed and regulated environment. Sight-distance reactions are the rule on highways. In contrast, rail systems are centrally controlled and dispatched. Cab signals, fail-safe devices and dead-man controls are unthinkable in highway vehicles. Roadways are public domain and driving is considered a citizen's right. Nevertheless, the U.S. highway accident fatality rate of .97 per 100 million passenger miles exceeds by a large margin the commuter rail fatality rate of .03 per 100 million passenger miles. The public is willing to accept a higher risk of accidents on highways; however, though rail is safer, the public expects to be protected by a regulatory system. Also, it cannot be dismissed that a single railroad incident could involve many more persons than any likely highway incident, and liability claims would be much greater.

1.1.3 Scope

The joint use rail issue is broad in scope and covers a range of joint use opportunities. The following matrix shows the extensive range of the subject and provides a preliminary comparison of the degree of compatibility between rail transit rolling stock types and facility or modal types (Table 1-1).

Note that the scope of this research is between light DMUs and LRVs with railroad freight branch lines, railroad freight main lines, and railroad commuter and freight combined. Also listed is the compatibility between the two non-FRA-compliant vehicles, LRVs and Category 2 and 3 light rail derivative DMUs. Category 2 and 3 DMUs are of the scale and weight similar to LRVs. The degrees of compatibility between these modes are also shown on the matrix.

Table 1-1
Joint Rail Use Compatibility Matrix

Facility	ROLLING STOCK				
	LRV Hi Floor	**LRV** Lo Floor	**DMU** Cat. 3	**DMU** Cat. 2	**DMU** Cat. 1
RR Freight Branch	B,C	B,C,D	B,C,D	B,C,D	A,B
RR Freight Main	C,D	D,E,F	D,E,	D,E	A
RR Passenger Commuter	C,D	D,E	D,E	D,E	A
RR Freight/ Commuter	C,D,E	D,E,F	D,E,	D,E	A
RR Passenger Hi-Speed	D,E	D,E	D,E	D,E	E
LRT Mixed Traffic	A	A	C	D(F)	D,E,F
LRT R-O-W Exclusive	A	A	A	C	D,F
LRT Grade Separated	A	A	A	A	C

<u>Degree of Compatibility</u> (in descending order)

A. No Unmanageable Constraints (Fully Compatible)
B. Time Separation Permissible (Limited Temporal Compatibility)
C. Potential Design Remedy Applicable (Possible Design Compatibility)
D. Buffing Strength Mismatch (Regulatory Incompatibility)
E. Performance, Station Spacing, Functional Mismatch (Operational Incompatibility)
F. Track Geometry, Clearance Constraint (Irreversible Physical Incompatibility)

<u>DMU Categories</u>

Category 1: FRA-compliant (or near-compliant) internal combustion or turbine **Railroad Car**
Category 2: FRA-non-compliant internal combustion **Light Rail Type Car**
Category 3: FRA-non-compliant dual-power (diesel or turbo-electric/electric) **Light Rail Car**

<u>Notes</u>:

1. For purposes of this analysis, Category 2 and 3 DMUs assumed to be low-floor design.
2. Comparative numerical scores in the matrix can be derived from assigning numbers 0 to 5 in place of A to F and adding the values in each matrix box.

( ) denotes a dependency on car design features

For purposes of this matrix DMU cars are divided into three categories, explained within. These categories dispel the notion that DMU describes a generic rail mode. Railroad-based DMU designs (Category 1) are more railroad-compatible than other designs of DMU adapted from LRV technology.

The degree of compatibility between modes depends on more than joint occupancy of track. A decisive factor in regulatory matters may be the nature and ownership of the track. For example, the FRA accepts the conditions under which LRVs and freight trains operate *on LRT transit tracks* at San Diego and Baltimore. A modern precedent of LRVs and small-scale DMUs operating *on an active freight railroad*, with the railroad being the host, has not been established in North America. The vulnerability to risk may be the same, assuming the same number of conflicting train movements, but the regulatory attitude may differ with rail transit migrating onto the general railroad system.

1.2 REGULATIONS AND REGULATORS

1.2.1 Background of Safety Regulations

Regulatory Objectives

The safety regulatory structure associated with the domestic railroad industry is based on ensuring the safety of the public and employees. Balanced with the necessity of risk management is the public convenience of joint operation. Joint operations complicate the issue of safety and create risks that would be tolerable and commonly accepted on an exclusive freight or passenger line. Joint operation can impose competing demands on the freight and passenger operators that are mutually exclusive. The railroad is federally regulated, while rail transit is largely state, local, or self regulated.

The domestic approach to regulation by authorities, driven by political concerns relative to accidents and fatalities, has been to issue detailed specifications covering aspects of rail transportation infrastructure, systems, employee responsibilities, equipment, and maintenance. Violations of such specifications are punishable in various ways. Safety regulation has emerged and grown over the last century to meet a variety of needs as follows:

Protecting the General Populace: Initial safety regulations were established to protect the general populace largely from steam locomotive boiler explosions. In fact, the requirement for regular safety inspections of locomotive boilers (an early action of the Interstate Commerce Commission) was the first federal safety regulation of any kind whatsoever. From boiler inspection, regulations have expanded to a number of areas to ensure that railroad operations are in accordance with public expectations for safety.

Avoiding Equipment Failure: One of the chronic causes of accidents is the physical failure of crucial components. Accordingly, detailed regulatory requirements have evolved to govern inspection and maintenance of safety-critical elements of railroad motive power, rolling stock, and physical plant.

Avoiding Employee Failure: Safety of railroad operations depends heavily on having qualified employees that understand their job responsibilities. Development of good operating practices relies not only upon safety regulation, but especially on having a "Book of Rules" designed to provide checks and balances against carelessness or inadvertent error. The underlying principle of these rules is that at least two simultaneous errors must occur for any mishap to be possible. Human failure predominates as the cause of accidents.

Survivability: Recognizing that no level of regulation can guarantee averting train collisions, regulations have also focused on developing rolling stock of sufficient crashworthiness to allow passengers and crew to survive. Effectiveness of this approach (both in FRA-regulated passenger trains and rail transit systems) has been suggested by the fact that while passenger death is a near certainty in airplane accidents, it is a comparative rarity even in the worst railroad or rail transit collision or derailment. In recent years, there has been particular interest in minimizing risks to train operators in multiple-unit equipment or push-pull cab cars, particularly in instances of grade-crossing collisions. Any joint operations proposal must explore this topic thoroughly by examining a variety of accident scenarios with particular emphasis on grade-crossing collisions.

There are limits, of course. Vehicle structures cannot be reinforced to withstand every conceivable accident scenario. Furthermore, such modifications would impact performance, capacity, maintainability, functionality and capital and operational costs in unanticipated ways. Therefore, this approach is not a remedy for all situations, particularly train-to-train head-on, offset or rear-to-front collisions.

Elements of Safety Regulation

To successfully accomplish the various purposes outlined above, a number of different rail elements are regulated to minimize inherent or known risks.

Regulation of Physical Designs: Engineering designs of rolling stock and fixed plant (especially track, signals, and radio equipment) are subject to meeting a wide variety of regulatory requirements.

Regulation of Inspection and Maintenance: Rolling stock and fixed plant must be inspected and maintained in accordance with regulatory standards. These standards often set specific calendar intervals at which inspections must be accomplished, and specific rail modes require different inspection schedules. Designating a carrier "railroad" requires 92-day rolling stock inspection intervals. A rapid transit organization is allowed greater discretion with regard to inspection intervals.

Many of these requirements, such as a daily safety inspection of locomotive braking equipment, remain in effect from steam railroading origins. Interestingly, the FRA treats each multiple-unit car and push-pull cab cars as locomotives for regulatory purposes. However, structural requirements for cab-car and locomotive are not the same. There is a difference in maximum shear load, longitudinal load on collision posts, and anticlimber load. The requirements for passenger coach posts are identical to the requirements for locomotive rear collision posts.

For joint operations, this condition has a significant impact on maintenance costs, operational availability, and flexibility for equipment. Other requirements, such as the safety classification of track into six distinct categories, are more contemporary in nature and more meaningful to daily operational safety.

Regulatory Process

Developing safety regulations for railroads and rail transit has been a continuous process for more than a century. Largely, development of transportation safety standards and regulation is a reactive, cyclical process, wherein an unforeseen catastrophe occurs, its causes are closely analyzed, and regulations are then developed or modified to prevent a recurrence of the incident, or at least to mitigate its consequences. Over time, this has resulted in more complex and stronger regulation. Now, after a century of evolution, basic safety needs have been met and major failures in the operation of railroads and rail transit systems are fortunately infrequent. Nevertheless, occasional incidents still slip through unperceived loopholes in the regulatory base, and the process of analysis and prevention recycles.

Notwithstanding this regulatory process and technical development of sophisticated safety appliances, the primary achievement of safe operation remains the responsibility of rail operating employees. A very strong safety ethic has become embedded in the railway culture and is cardinal to the safe operation of every railroad and rail transit system in the nation. Observe that on any rail holding, safety signs, slogans, and bulletins dominate the workplace.

This process is evidenced by progress towards the application of advanced train control technologies to support train separation requirements. In the past, regulation has focused on detail and specific components. These evolving requirements appear to be moving towards performance/results-oriented system standards. Skepticism by operators continues, since new regulation typically requires change and thus additional cost.

The regulatory process is cyclic in that planned systems or technology applications are evaluated by FRA as they evolve. Comments are provided and then the proposals can be revised to reflect FRA suggestions as "proposed rule making". Subsequently, regulations and interpretations can be issued that reflect these prior deliberations. This situation can complicate the evolution of technology because technology and applications are constantly changing and regulatory bodies are not always capable of rapid response to technical development. Nevertheless, this approach can impede implementation of new technology because requirements and systems performance often "leapfrog" regulation. The temporary waiver or exception can mitigate any such regulatory evolution. Some operators may be reluctant to invest in long term equipment and service under waiver conditions which may be withdrawn or may never be converted to permanent status.

1.2.2 Framework of Regulatory Authority

With the existing regulatory environment, a plan for joint operation is a bottoms up process, originating locally and culminating with discussions with FRA and state regulatory review where they exist. Understanding the environment for joint operation of LRT/DMU with railroads, those parties interested in these operational issues will be equipped to establish worthy policies. Note Table 1-2 which summarizes the regulatory framework. This information can then be utilized to construct and respond intelligently to a variety of issues as they arise.

- Are any of the regulations so rigorous or operationally difficult to comply with that they would render an otherwise promising prospective joint operation impractical or financially impossible to achieve? The form of a joint operation is usually quite site-specific and this aspect must be appropriately tailored per situation.

- Does application of these safety regulations deny provision of cost-effective rail transit to the public in a manner such that the public good is jeopardized? (public safety vs. public convenience and necessity).

- If existing regulations are virtually impossible to comply with (by an objective and/or economic standard), what are options for waivers (short-term) or regulatory relief (long-term)? Railroads will likely object to any long term waiver or waiver-based solution that fails to adequately protect their interests or fails to limit their liability.

- Do operational issues or situations exist within the concept of joint operation that justify modifying existing regulations?

- Is there a need for new regulations that focus solely on LRT/DMU joint operational issues? At what level of government should such regulations be promulgated?

- What are operational and physical constraints of joint use between light rail and DMU, since neither is necessarily part of the general railroad system of the United States?

- In joint use cases where transit and railroad regulations conflict, which will prevail? Will this decision be based on the specific case or on whose property the issue arises?

- What are longer-range implications of joint use on railroads, transit operators, car builders, the riding public, and system designers?

- Do new and novel issues presented by LRT/DMU joint operations suggest the need to restructure regulatory distinctions between FRA and other Federal or state entities? How is an isolated DMU operation that may be integrated with a railroad or rail transit property at a later time classified?

- Are there any regulatory models or practices outside the United States for joint operation that would possibly be appropriate for this country?

Federal Railroad Administration Regulations

The Federal Railroad Administration (FRA) is the agency with primary regulatory authority over both passenger and freight railroad operations that are considered to be part of the "general railroad system" of the United States. As codified in 49 CFR Part 209.3, the term "railroad" is defined as: "[any] means or form of non-highway ground transportation that runs on rails or electro-magnetic guideways." This includes:

- commuter or other short-haul railroad passenger service in a metropolitan or suburban area and commuter railroad service that was operated by the Consolidated Rail Corporation on January 1, 1979.

- high-speed ground transportation systems that connect metropolitan areas, without regard to whether these systems use new technologies not associated with traditional railroads.

This definition is critical to examination of the regulatory environment for potential LRT/DMU joint operation since *FRA, while having regulatory safety jurisdiction over passenger and freight railroads, does not have jurisdiction over rail rapid transit systems or LRT not connected to the general railway network*. In the United States, LRT systems have been considered for the most part to be classified along with rail rapid transit systems not connected to the general railroad system. Two light rail lines in the United States have joint operation with freight railroads: the San Diego Trolley, Inc., and the Baltimore Central Light Rail Line. Basically, neither of these lines falls under the jurisdiction of

FRA since they are both considered to be rail rapid transit. The safety exceptions are signals, switches, and crossing gates.

In areas where light rail lines have been established on railroad rights-of-way (other than in San Diego and Baltimore), the railroad rights-of-way are abandoned, legally transferred to the LRT operator, or sufficient space exists on the railroad right-of-way to permit adequate spacing between the railroad and light rail track centers (the railroads often dictate the amount of separation on a case-by-case basis where right-of-way is shared). As such, they are no longer "connected" to the general railway system and are not considered to be within FRA jurisdiction. Regulatory treatment of rail transit modes in joint use issues may not be consistent, however. Within New Jersey, for example, Port Authority Trans-Hudson (PATH) and Port Authority Transportation Company (PATCO) are similar transit authorities, but the former is regulated as a "railroad," while the latter as an "interurban electric railway," not part of the general railroad system of the U.S.

Implications for Joint Operations: It is suggested that joint operations issues include consideration of a management, financial, labor, and ROW structure that minimizes the role of FRA in development and approval. Appendix A contains a listing of key FRA regulations taken from the Code of Federal Regulations (49 CFR 200-299), Federal Railroad Administration that may affect joint operation of light rail transit or diesel multiple-unit vehicles with railroads.

Waivers from FRA Regulations: While FRA regulations identified above may apply to LRT/DMU joint operation, waivers are available depending on the circumstances and temporary duration of the requested waiver period. Obtaining waivers from FRA regulatory requirements is fairly complex and is also highly dependent on the subject matter of the waiver. An administrative process and proceeding for request of waivers is administered by FRA. Waivers are specific to operating entities (including railroads) and can either be equipment or procedure-based (see Appendix B).

While it is clear that these waiver requirements are essential for ensuring the highest levels of safety, the level of detailed compliance may preclude this form of "waiver" operation on a routine basis. The waiver scenario appears to be best suited for demonstrating experimental, prototypical, or foreign non-compliant equipment of a specified duration. If the vehicle covered in the waiver is to run exclusively on a right-of-way distinct from the general railroad system, then a long-term waiver would probably be unnecessary.

Second-Tier Regulatory Entities

For analysis purposes, "second-tier" regulatory entities are defined as those technical and professional societies that set joint standards, recommend practices, and propose technical operating guidelines. Usually a complex committee system of leading specialists in the field is formed. Their issuances constitute an "imprimatur" for technical features or operating practices, and are, in effect, "de facto" standards. This situation results from the fact that professional society standards are frequently incorporated in Federal regulation, thus contributing to the regulatory cycle. Furthermore, as technology evolves, Federal authorities will rely more on these "secondary agencies" to create the foundation for regulation, taking advantage of their highly skilled staffs and specialized expertise.

Federal regulatory staff will often research existing technical standards for applicability in pursuit of its objectives. Groups such as American Railway Engineering Association (AREA/ AREMA), Association of American Railroads (AAR), American Public Transit Association (APTA), Institute of Electrical and Electronic Engineers (IEEE), American Society of Civil Engineers (ASCE), Construction Specification Institute (CSI), American Society of Mechanical Engineers (ASME), and American National Standards Institute (ANSI) (see glossary) publish a variety of technical standards affecting railroad design, engineering, construction, vehicles, and operation. AAR has standards such as S-580 for Locomotive Crashworthiness (see glossary). While not enacted into law, the standards are construed as recommended practice, and deviations are carefully considered. Federal agencies even encourage these groups to develop or revise standards because of the availability of specialized knowledge and the "self-regulatory" approach. Other examples of these standards are AREA's (now AREMA) Manual for Railway Engineering; APTA's PRESS program and involvement of IEEE in PRESS program development.

Government agencies and transit operating authorities will create their own specification or standards manuals that provide a measure of self-regulation of their individual holdings.

Other Federal Agencies and Regulatory Participants

Other Federal agencies having a peripheral, but influential, role in the regulatory process include FTA, TSC, NTSB and the STB (formerly ICC). The Federal Transit Administration (FTA) is not a primary regulatory agency, but expects its grantees to comply with current safety standards. It relies on other agencies (Federal, state, and local) to enforce rules, except for its recent requirement for the 19 states with rail transit systems to establish safety oversight agencies. FTA issues "administrative regulations" on such matters as ADA, drug use, civil rights, and emergency preparedness. Enforcement for FTA is a matter of withholding funds.

Volpe National Transportation Systems Center (TSC) provides research into a variety of technical issues associated with transportation. It pursues specific research topics at the request of certain Federal agencies. An example is the "Locomotive Crashworthiness and Cab Working Conditions" Report to Congress. This effort preceded the NJ TRANSIT and MARC collisions in 1996. Suggestions in that report are likely to result in revised regulations pertaining to locomotives. Topics affecting joint operations this or other research could conceivably be routed to TSC for detailed testing and research.

National Transportation Safety Board (NTSB) has no direct regulatory authority and exists as an independent agency within the executive branch (not part of USDOT, however). It reports the results of accident investigations and reports findings. The NTSB has a broad mandate and can investigate any incidents deemed worthy of attention. It performs a reactive role in that it makes recommendations that will often generate regulatory action only after the accidents have occurred.

The Surface Transportation Board (STB) is the successor agency to ICC as of January 1996, but with a somewhat reduced role. Legislation for this action was passed as one more step in Federal efforts, begun a decade and a half ago, to streamline its economic regulatory oversight of the railroad, trucking, and bus industries. STB is "organizationally housed" in the U.S. DOT, but with independent jurisdiction over certain surface transportation economic regulatory matters such as railroad mergers. Technical and safety regulatory roles of ICC had been previously transferred to FRA. It is relevant to understand that, despite its reduced interstate commerce role, STB might still play a part in reviewing certain aspects of proposed joint transit-railroad operations where there could be current or future economic impact on the ability to provide railroad freight service desired by shippers. For example, just as ICC had a role in reviewing the need for rail freight shipping services and reviewing proposals for acquisition and disposal of (and line construction on) railroad holdings, so does STB. Therefore, just as ICC had a critical role in developing the San Diego LRT program, so too the STB might be an important party to certain new joint use projects. This one-year-old board is still in a formative stage and its overall mission and scope have not necessarily been seen in practice. However, STB's proposed emphasis on conflict resolution may further joint operations between railroad and transit service providers.

It is recommended that the above agencies be contacted early by prospective joint operators in the planning stages of a potential joint operation. All have been contacted in the conduct of this research. They are excellent sources of information and can educate applicants regarding administrative and technical requirements of rail passenger systems. TSC is a significant source of primary information about many aspects of railroad systems and equipment technology and is well informed about the latest technologies. NTSB can provide incident reports, enlightenment as to the causes of failure, and corrective actions.

Federal Transit Administration

On December 27, 1995, the Federal Transit Administration (FTA; previously the Urban Mass Transportation Administration) issued its final rule (49 CFR Part 659) for Rail Fixed Guideway Systems; State Safety Oversight. This rule mandates that states with defined rail fixed guideway systems need to enact and operate safety oversight programs to improve safety of these systems. Rail fixed guideway systems do not include systems under the jurisdiction of FRA.

In January 1981, the National Transportation Safety Board issued report NTSB-SEE-81-1, which urged the then Urban Mass Transportation Administration to issue regulations for safety standards for rail transit cars, along with minimum safety standards for rail rapid transit systems. These 31 recommendations were based on NTSB's assessment of the U.S. rail rapid transit industry, and its concern with the "fragmented" and "ad hoc" approach to safety in the industry. Specifically, NTSB suggested (NTSB has no authority at U.S. DOT to issue regulations, only to recommend actions) that the "Department of Transportation should set Federal safety guidelines for rail rapid transit equipment and operations, use grant authority aggressively to promote these guidelines, and keep a substantially increased watch on the safety of all Federally assisted systems." The Board also found, however, that the rail rapid transit industry has had a "very good" safety record.

NTSB efforts and recommendations did not stem from any one particular accident or incident in the rapid transit industry, but was the result of reviewing a five-year period of incidents on such systems. This work culminated in a number of public hearings in 1980 to explore means by which the "safety record of the Nation's rail rapid transit systems can best be maintained". While full findings and comments of NTSB are beyond the intent of this analysis, several critical issues within these findings/comments are important to joint use possibilities.

Historically, oversight of safety of rail rapid and bus transit systems has been at the State or Local level (Public Service or Utility Commissions). With the exception of interurban electric railways, which had been under the economic jurisdiction of the Interstate Commerce Commission (ICC), and with the exception of 14 interurbans specifically cited as "railroads" under the Railway Labor Act (amended 6/21/34), there was no Federal regulation of rail rapid transit systems.

In many states, regulatory bodies, such as State or Public Utility Commissions (PUC) had authority over transit operation. However, most of these regulatory entities were concerned more with economic regulation than safety and operations. In addition, with the shift of local private transit system ownership to public agencies, most of these regulatory agencies ceased to have jurisdiction over transit and concentrated on other types of utility regulation such as private carting. Exceptions are the California, New York, Pennsylvania, Florida, and Massachusetts Public Utilities commissions. In the case of New Jersey, vestiges of PUC economic/transit regulation were transferred to NJ TRANSIT, the statewide public bus and rail operator. 49 CFR 659 applies to 19 states with existing or impending rail transit systems. States are moving to comply by reestablishing oversight.

Prior to 1978, the Federal Railroad Administration (FRA) had some responsibility for rail rapid transit safety oversight. Under the Federal Railroad Safety Act of 1970 (Public Law 91-458), FRA was authorized to regulate "all areas of railroad safety," which theoretically included rail rapid transit. This interpretation was upheld in Federal District Court in 1973 involving the Boston Rapid Transit System (United States v. Massachusetts Bay Transportation Authority, 360 F. Supp. 698 (D. Mass 1973). During FRA rulemaking in 1975, however, the agency decided to exclude rail rapid transit systems (acting upon a petition for reconsideration from the American Public Transit Association-APTA), because of the "... many differences between urban rail rapid transit operations and railroad operations." At that time, it was expected that the rail rapid transit industry would voluntarily furnish safety information to FRA.

Before this in 1974, and acting upon NTSB recommendations, FRA issued regulations covering reporting of accidents and incidents, and for the first time, extended applicability of reporting regulations to rail rapid transit systems. This regulatory requirement was short-lived, since the Chicago Transit Authority successfully challenged FRA jurisdiction. The Federal Court held that the "FRA's regulatory authority with respect to railroad safety does not extend to rail rapid transit." (Chicago Transit Authority v. Flohr, 570 F. 2d 1305 [7th Cir. 1977]).

In a 1977 policy decision, FRA decided to reevaluate (even prior to the court decision noted above) its approach to rail rapid transit safety. FRA determined that it should not have a traditional regulatory role in rail rapid transit, but should be "supportive" and suggested that "UMTA be assigned the lead role within the Department." FRA also posited that states should have primary responsibility since transit agencies are generally instruments of the states.

A final report published in 1978 by DOT agreed with FRA's approach identified above and the Secretary of Transportation assigned UMTA the responsibility for addressing rail rapid transit safety. While UMTA (now FTA) has taken the lead with regard to rail rapid transit safety since that time, there is an important distinction between UMTA/FTA and FRA. FRA, similar to FAA, Coast Guard, and FHWA, is a traditional regulatory agency with specific jurisdiction to oversee railroad safety. FTA, however, is a funding agency with much more limited authority to issue safety regulations and operate as a regulatory agency.

As an example, FTA was the only DOT agency that lacked general regulatory authority to issue substance abuse regulations in 1989. The United States Court of Appeals for the District of Columbia determined that FTA lacked such jurisdiction (Amalgamated Transit Union v. Skinner, 894 F. 2d 1362 (D.C. Cir. 1990), and as such, required specific authority as contained in the Omnibus Transportation Employee Testing Act of 1991.

Because of this distinction, along with policy objectives of FTA, this agency had not issued safety regulations for operation of rail rapid transit systems. It did, however, as a result of a requirement by the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, ultimately issue a rule requiring the state to oversee the safety of rail fixed guideway systems not regulated by FRA. These rules, mandated by FTA, but developed and managed by the states, form the foundation for any new regulations that could potentially affect operation of LRT/DMU, not connected to the general railway system (therefore outside FRA jurisdiction). A reasonable interpretation of this state regulatory scope extends to DMU and LRT, and DMU with LRT.

FTA State Safety Oversight Final Rule for Rail Fixed Guideway Systems

ISTEA was enacted into law on December 18, 1991. It added Section 28 to the FTA Act and required FTA to issue regulations creating a State oversight program for defined rail fixed guideway systems except for those regulated by the Federal Railroad Administration (FRA). To further this law's effect an Advanced Notice of Proposed Rulemaking (ANPRM) was published on June 25, 1992. Comments were solicited and three public hearings were held. The NPRM was published in the Federal Register on December 9, 1993. This identification of program requirements is based on the Final Rule, which was promulgated by FTA and issued on December 27, 1995.

The Section 28 statute, also referred to as the Rail Fixed Guideway Oversight Program, or simply "the Program," requires each state to designate a state oversight agency to be responsible for overseeing rail fixed guideway system safety practices. Each state can also designate more than one agency to perform this function, based upon its own particular needs. The Program describes responsibilities of the state and its designated agency in conducting the oversight process, along with responsibilities of the transit agency.

If a state does not meet the requirements of the regulations, or does not undertake adequate efforts to comply by the stated implementation date of January 1, 1997, FTA may withhold up to five percent of the amount required to be apportioned for use in any state or affected urbanized area in such state under FTA's formula program for urbanized areas beginning after September 30, 1997. (These funds were previously referred to as Section 9 funds.)

The following is a listing of the key provisions of FTA regulations for implementation by the states.

- Role of the State - For a transit agency or agencies operating within a single state, that state must designate an agency of the state, other than a transit agency, to serve as the oversight agency and to implement these requirements. For a transit agency operating a system within more than one state, those states may designate a single entity, other than the transit agency, to implement requirements of this rule.

- Adoption of System Safety Program Plan Standard - The oversight agency must develop and adopt a system safety program standard which, at a minimum, complies with the American Public Transit Association's (APTA) Manual for the Development of Rail Transit SSPP and includes a section that addresses personal security of passengers and employees.

- Requirement for Transit System Safety Program Plan (SSPP) - The oversight agency must require that the transit agency adopt and implement an SSPP that conforms to standards defined by the oversight agency (discussed in the previous section) by January 1, 1997. The oversight agency must approve in writing before January 1, 1997 the transit agency's SSPP. The SSPP required to be adopted and approved by the date listed above DOES NOT have to include the security portion of the SSPP. This portion of the SSPP must be in place by January 1, 1998, and approved by the oversight agency prior to January 1, 1998. After December 31, 1996, the oversight agency must review and approve, in writing, the transit agency's SSPP, as necessary, and require the transit agency to update its SSPP as necessary.

- Transit Agency Annual Safety Audit Reports - The oversight agency must require that the transit agency submit, on an annual basis, a copy of the annual safety audit report prepared by the transit agency, as a result of the internal audit process identified in APTA guidelines (APTA guidelines checklist number 9). In addition, the oversight agency must review annual safety audit reports prepared by the transit agencies.

- Conduct Triennial Safety Reviews - The oversight agency must, at least once every three years, conduct an on-site safety Review of the transit agency's implementation of its SSPP. The agency must then issue a report containing findings and recommendations resulting from that review. At a minimum, the analysis must include an evaluation of the effectiveness of the SSPP and a determination as to when it should be updated.

- Transit Agency Report on Accidents and Unacceptable Hazardous Conditions - The oversight agency must require that the transit agency report accidents and unacceptable hazardous conditions to the oversight agency within a specified period of time.

- Investigations to be Conducted by the Oversight Agency - The oversight agency must establish procedures to investigate accidents and unacceptable hazardous conditions occurring at a transit agency under its jurisdiction, unless the National Transportation Safety Board (NTSB) has investigated, or will investigate, an accident.

- Corrective Action - The oversight agency must require the transit agency to minimize, control, correct, or eliminate any investigated hazardous condition within a time period specified by and in accordance with a corrective action plan approved by the oversight agency.

It is important to note that FTA safety oversight requirements are to be viewed as a base document for the minimum requirements a state must implement to remain in compliance. Further, these activities deal directly with only operating rail systems. Design standards and construction issues are essentially absent, other than by inference, and FTA oversight will not likely come into play in planning and project development. States are free to develop more extensive programs with additional policies, procedures, and regulations for governance of rail rapid transit within their jurisdiction. Several states, including California and Pennsylvania, have existing programs that extend beyond these minimum requirements, but only in California are design and construction standards provided.

The two programs, different in scope and methodology, are the Pennsylvania Department of Transportation Rail Safety Review Program and Public Utilities Commission of the State of California program. FTA requirements represent the "minimum" and the California program represents the most highly regulated. Pertinent examples of regulatory authority from PennDOT and California PUC are included in Appendix C. Regulatory framework for state and Federal jurisdiction is summarized on Table 1-2.

State and Local Role

State and Local Highway Agencies are of interest because they influence grade crossing design, maintenance, and coordination with traffic signals (via preemption or override), and often are the source of funding for crossing protection improvements. These agencies have no direct role in joint operations, but are to be notified about proposed operational changes. They are also a data source of traffic volumes and patterns that can be applied in analysis of proposed crossing protection techniques. Their role is usually minor, but coordination with them should occur early in the planning process.

Grade crossings cannot always be viewed as secondary or minor project issues. Industrial areas with heavy trucking, complex railroad operations, LRT, and heavy street traffic cannot be treated lightly. Not all can be given satisfactory protection and remain at-grade, and the cost of grade separation could be difficult for a low-cost LRT/DMU project. The California PUC, acting for a variety of state interests, has extensive standards for protection and has as keen an interest in protecting the trucking industry as it has also in supporting new transit facilities.

Local plans, codes or regulations and plans for resumption or implementation of service need to be reconciled. Otherwise, noise, speed, and operating restrictions can be enacted that can become obstacles to service objectives or burden the operator with excessive costs. In San Diego, for example, the City Traffic Department provides a staff engineer to work on the LRT design team as the system expands.

1.2.3 European Practice Summary

Management, ownership, operation, regulatory climates and even culture are different in Europe. Therefore, a word of

TABLE 1-2
Joint Operation of LRT or DMU Vehicles with Railroads

Regulatory Framework Matrix Analysis for Joint Use

	FRA Non-Conforming Veh. Regs 49 CFR 229	Railway Labor Act 45 USC & 151	Railroad Retirement Act 45 USC & 228(a)	Federal Employers Liability Act 45 USC & 51	State Safety Oversight Program 49 CFR 659
1. Federal Law	Yes	Yes	Yes	Yes	Yes
2 Federal (FTA) Funding Requirement	No	No	No	No	No
3 Applicability to Commuter Rail	Yes	Yes	Yes	Yes	No
4. Applicability to non-Commuter Rail Rail Fixed Guideway	No	No	No	No	Yes
5. Federal Administration	Yes	Yes	Yes	Yes	No
6. State Administration	Potential/Partial	No	No	No	Yes
7 Would regulation apply to DMU/EMU use on joint-use railroad r-o-w (shared "windows")	Yes	Probable	Probable	Probable	No
8. Would regulation apply to DMU/EMU use on joint-use railroad r-o-w (no shared "windows")	Probable	Possible	Possible	Possible	No
9 Would regulation apply to DMU/EMU use on abandoned r-o-w	No	No	No	No	Yes
10. Potential implications on liability claims	Yes	No	No	Probable	Yes
11. Potential implications upon freight-owner indemnification strategies	No	No	No	No	N/A
12. Potential implications upon operational strategies	Yes	Yes	No	No	Yes
13. Potential implications upon vehicle/infrastructure maintenance strategies	Yes	Yes	No	No	Yes
14. Potential implications for vehicle engineering standards	Yes	No	No	No	Yes
15. Potential implications for co-mingling of railroad and transit employees	No	Yes	Yes	Yes	No
16. Are "waivers" from regulations available	Yes	No	No	No	Probably
17. Applicability to San Diego Trolley, Inc. (shared trackage, segregated "windows")	No	No	No	No	Yes
18. Potential implications for transit system labor unions	No	Yes	Yes	Yes	No
19. Entity responsible for determining applicability/compliance	FRA	NMB	RRRB	Federal Court	State Designated Entity

caution is in order to be aware that situations and technological features are neither analogous nor readily transferable among foreign and domestic systems. For a thorough understanding and assessment of potential applications, it is essential to clearly highlight differences where they exist. This subject is treated in greater depth in Chapters 7 and 8.

The European approach to mixed operations is significantly different from the U.S. approach. European operations maximize utilization of the "track resource" through scheduled, on-time freight and passenger operations. Another factor which helps to provide harmonious operations is that the typical, shorter European freight train has higher acceleration/deceleration characteristics than its typical North American counterpart.

Therefore the European freight is likely to increase track occupancy that can be used for LRT/DMU or other train movements. With few exceptions, the typical European freight train is relatively short and has a high horsepower-per-ton ratio as compared with a typical domestic freight train. This fact allows the European freight train to achieve acceleration and braking performance that approaches a typical European passenger train. High-speed rail operations are sometimes mixed with these conventional passenger and freight trains, but segments exist where separate rights-of-way have been constructed for very high-speed rail trains to achieve the unique track geometry required for reducing trip time. This type of segregation is motivated by the perceived incompatibility between high-speed passenger trains and freight, not between conventional passenger/transit and freights.

Europe (and Japan) has proven that proper train scheduling and precision on-time performance of trains provide much greater line capacity for mixed operations than has been demonstrated domestically. Put another way, more capacity can be achieved from a double-track railroad operated as a single entity than as two separately dispatched parallel single-track operations.

Karlsruhe, Germany provides a good example. Mainline and suburban railroad tracks of the German Federal Railway (DBAG), on several radial lines, are jointly used by DBAG services and Karlsruhe LRT services (VBK). The main train station is located near but not in the center of Karlsruhe. LRT service leaves the railroad lines at the edge of the urban core and operates over existing tram tracks that have provided a network of routes in the established central business district. On each joint use route, the principal section of radial track is shared in a co-mingling operation by different train types in a way not permitted by current U.S. regulations. It should also be noted that short sections of separate parallel track dedicated to LRT use have also been built on these routes due to railroad heavy traffic needs. Both the track and the public transit schedule are shared, with some runs being covered by LRV and others by DBAG trains. The LRV/freight ownership is split between VBK and DBAG.

Joint use of this type is being accepted elsewhere, including Saarbrücken, where operation commenced in October of 1997. It has also taken the form of light DMUs (Category 2 DMU, not LRVs) as in the Düren branch line, although there was little freight in service per day when the DMU operation began.

It took the better part of two decades (early 1980's-1990's) to reach agreement on Karlsruhe's co-mingled operation. Its success offers no hint of backing away from shared track policy. New routes are being added and original routes expanded. The primary issues in its implementation/ operation were collision/impact between railroad stock and the light LRVs, different power voltages, and different wheel profiles. Lesser concerns were dealt with as well, such as fare collection, station platforms and level, and at-grade crossings. Track capacity was also a concern, but not a serious one. Karlsruhe is not the only example; over thirty others exist. Karlsruhe, however, is the most prominent, dramatic, and growing example of joint use practice in Europe. Chapter 7 provides additional details.

Dual-voltage systems and modified wheel tread and flange designs were eventually developed through technical studies and field testing. The vehicle/train collision safety issue was resolved by a risk analysis-driven change in policy by DBAG management. At the outset, the common narrow institutional environments at DBAG and at VBK produced a difference of opinion on joint use. Ultimately, the argument of accepting the principle of "collision avoidance" rather than the traditional "minimize impact and damage" (as is the crashworthiness policy in the U.S.) was accepted. Collision avoidance, based on risk assessment, is a sound approach because the increased braking and acceleration performance of the LRVs rendered a tradeoff between collision avoidance and crashworthiness. This policy is reinforced by installation and use of the latest and most appropriate signaling and telecommunications equipment. It might be noted, as an institutional item of interest, that reorganization of the DBAG Railway over the last decade may have helped to provide the incentive for DBAG to accept this situation. Full regionalization of DBAG services commenced in January 1996, and much local control and separation into private and "third sector" operating companies has resulted. A combination of safety measures or mitigations reduced risk to tolerable levels for DBAG and VBK. This is treated fully in Chapter 7.

The German attitude on collision avoidance is important and is being accepted elsewhere in Europe. However, the contrasts between current U.S. and European joint use experience are apparent. These include liability, freight train characteristics, social demand for passenger service, ownership of lines, (private vs. public), and a split safety regulation (FRA, FTA, and others). As far as safety regulation is concerned, personal liability claims and insurance expenses growing from accidents have not been the major item of expense in Europe that they have become in this country. Domestic joint use regulation should take European accident experience into account.

1.2.4 Institutional Aspects of Domestic Pioneering Joint Use

While regulations can stop an otherwise desirable project, ways to accomplish joint use do exist, although only in limited ways. Being innovative, creative, and sitesensitive in institutional arrangements is fundamental to any U.S. success to date. Understanding the regulations and the procedures, together with awareness of local railroad owner-management-operator factors and other specific local conditions, is important background. Several different approaches are described, and the different physical solutions that have resulted are grouped in this order: time-separation of LRT and railroad operations, completed projects; time-separation, projects in advanced planning; shared right-of-way, separate tracks; and relocation of freight service to nearby railroad right-of-way.

The recent Canadian-U.S. demonstrations of FRA non-compliant European DMUs have attracted the attention of many planners and community/political leaders. It has spurred optimism of local interests at many new potential sites that low-cost rail transit can be installed and operated in their community. Their optimism is tempered by barriers to use of non-compliant vehicles and total cost of preparing the roadbed for joint service. Yet this concept is undoubtedly going to introduce new institutional pressures on regulatory and rulemaking agencies.

Two transit operations in the United States where light rail trains and freight trains share use of common trackage, but are completely time-separated in their operations, are the Baltimore Central Light Rail Line (BCLR), Baltimore, Maryland and the San Diego Trolley, Inc. (SDTI), San Diego, California. Representatives of these two operating agencies were interviewed to learn the structure of their present agreements, and understand operational implications pertaining to joint use of the facilities. Although in most cases, light rail operation is predominant and FRA does not seek regulatory authority, the two authorities interviewed indicated that comingled operations on their systems have been avoided to limit FRA interest. Appendix D provides additional detail on these two systems.

San Diego LRT

Early details of the well-known San Diego LRT program demonstrate the special sitespecific opportunities that were seized to render the program possible. A key step was acquisition in 1979 of the railroad that now provides joint use tracks for San Diego's LRT and freight, under complete control of the LRT system's parent organization, the Metropolitan Transit Development Board (MTDB). In turn, the MTDB contracted with a freight railroad operator in 1979 to provide local freight service, and these steps were approved by the ICC. In 1984, MTDB changed its freight operator with the approval of ICC, but not without dispute with the first operator. The new operator continues today, working in harmony with the LRT operator to smoothly handle day-to-day joint use problems. Figure 1-1 shows the basic structure of the San Diego organization.

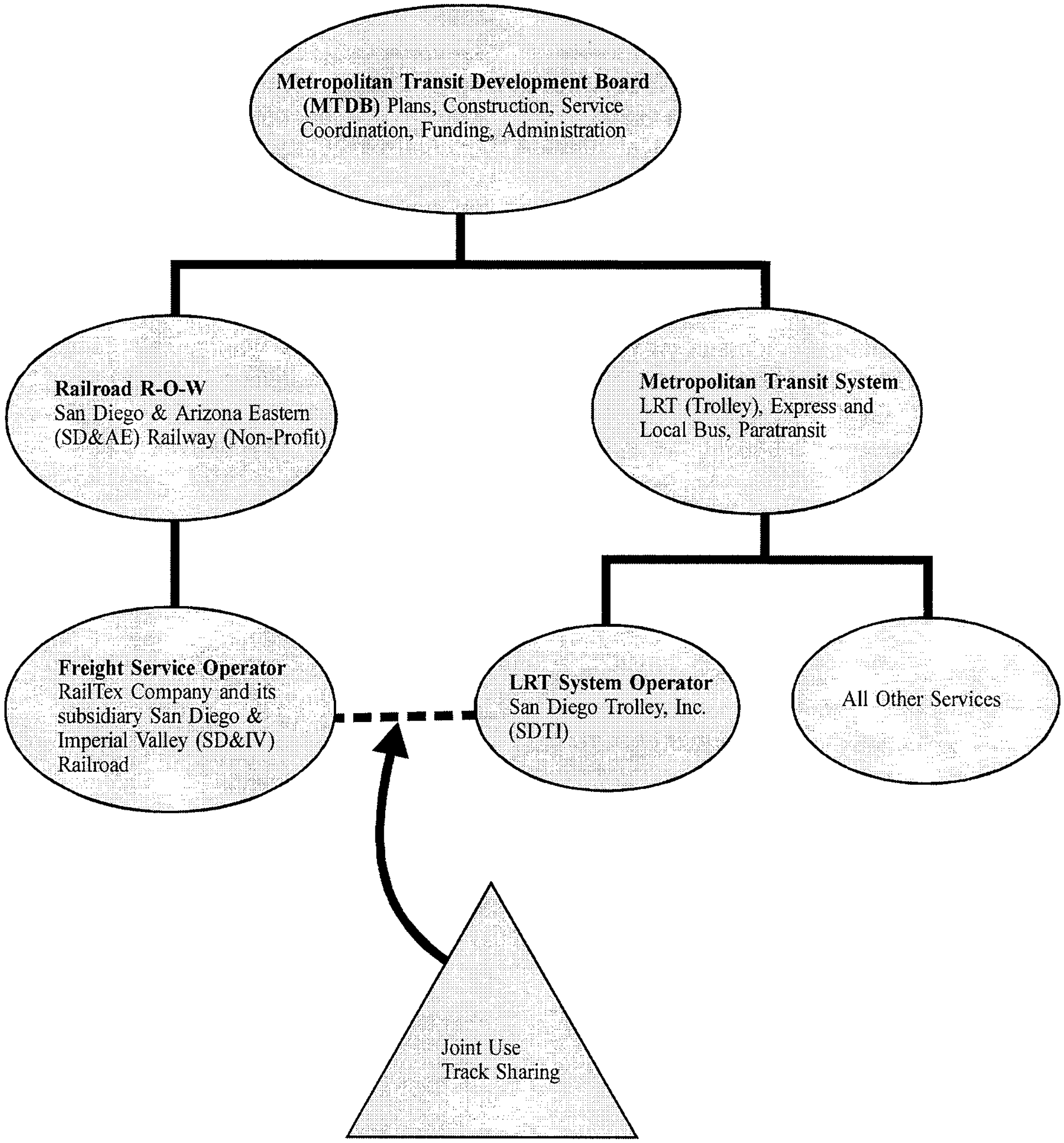
LRT operation began on a portion of the South Line in 1981, two years after acquiring the railroad and beginning freight service, and gradually expanded every few years in successive steps along the East (now Orange) Line and the South Line (now referred to as the North-South or Blue Line). Today, freight service operates over about 35 miles of LRT line when the LRT service does not; generally from about 2 AM to 4:15 AM. Peak headways are 7.5 minutes.

Organizationally, the former railroad company, the San Diego and Arizona Eastern (SD&AE) Railway Company was a Nevada corporation and a subsidiary of the SP (Southern Pacific) since 1932. The MTDB began the acquisition goal by first buying into the subsidiary company equity shares. Ultimately, it gained control and total acquisition was achieved, but Nevada incorporation was continued to simplify the sale. MTDB now contracts with RailTex, a Texas railroad firm that operates the SD&AE property for MTDB through a RailTex subsidiary, the San Diego and Imperial Valley (SD&IV) Railroad. In 1980, the MTDB created the San Diego Trolley, Inc. (SDTI) as a wholly-owned subsidiary of MTDB, to operate and maintain LRT service and railroad property as an entity separate from the MTDB.

Freight railroad service consists of shipments along the LRT Blue Line between the Burlington Northern Santa Fe RR (BNSF) operating from San Diego to the north and connecting with general U.S. railroad system, and the Mexican FNM (National Railroad of Mexico) at Tijuana, six nights per week, and local distribution along the LRT East Line on three nights per week. The San Diego and Imperial Valley is the freight operator.

San Diego LRT Program Simplified Structure - Figure 1-1

SAN DIEGO LRT PROGRAM SIMPLIFIED STRUCTURE



Freight business is increasing and placing pressure on the after-midnight time slot available to the SD&IV. The time slot has been narrowed to less than three hours. More challenging for MTDB/SDTI, however, will be the greater freight demand expected over the next few years as the out-of-service "Desert Line" section of the original SD&AE in Mexico is brought back into service following current repairs. The line section has not operated since 1983, but is considered important to the general San Diego economy. NAFTA also is generating more freight traffic. Negotiations are under way to deal with competing joint use traffic demands.

Baltimore LRT Compared With San Diego

Another example of successful joint use is Baltimore LRT. Baltimore's MTA (Baltimore Central Light Rail) owns the tracks. On the north end of the system, Conrail was the prior owner and now is the freight service operator with trackage rights. Conrail operates after midnight in the usual brief period before morning LRT service begins.

Baltimore's operations personnel noted that no FRA control is present, nor is there a waiver or any other document that effectively sanctions their joint operation. Their understanding is that FRA does not have any official jurisdiction over operations because predominant train operation is light rail, rather than Conrail freight train movements. Discussions with Baltimore and Conrail operations personnel, as well as field observations, substantiate the fact that light rail is by far the dominant user of the line, as is the case in San Diego.

The Baltimore Central Light Rail (BCLR) does, however, take full advantage of FRA-published standards for maintenance of their track and signal systems, as is the case in San Diego. Although FRA does not have any official jurisdiction to enforce these standards, a cooperative effort between FRA inspectors and BCLR personnel is in effect, with FRA serving essentially in an informal advisory role. A minor operation by the Canton Railroad to the south is currently dormant.

These two light rail systems have developed successful programs for joint freight and light rail operations over the shared trackage. FRA has decided not to assume jurisdiction over operation of these two systems, primarily because freight trains do not constitute a significant part of the total operation when compared with light rail operations. Also there is a well delineated time separation of freight and LRT operations. While FRA policy is clear in applying regulation to railroads, gradations of joint track use require more discreet application of policy and regulation. In the cases of Baltimore and San Diego, time separation defines a jurisdiction boundary better than comingled operation. Similarities in safety measures and degree of separation of joint users on the two LRT properties and conditions specified in FRA Waiver H-96-2 (governing the RegioSprinter U.S. tour) can be seen in Appendix B. Further information on Baltimore's and San Diego's operations and track control procedures is also provided in Appendix D.

The relative success of the Baltimore and San Diego systems can be attributed to a number of reasons:

- Freight service is not "time-sensitive" and does not require daytime switching.
- Freight shippers and consignees can tolerate nighttime switches at their industries.
- No through or local freight connecting service is required during daytime hours.

- Light rail service is not required throughout the night.
- Freight train horizontal and vertical clearance issues have been resolved.
- Engineering standards can satisfy both freight and light rail.
- Maintenance of track can be scheduled around freight and LRT windows.
- In both cases, the transit operator is the host, not the railroad.

Under normal circumstances, time-of- day separation works well for both parties, although the constraint on operating hours restricts expansion of freight service.

It should also be noted that the two agencies are of the opinion that it is to their advantage to avoid co-mingled operations because of potential service interruptions from freight trains and increased potential for attracting renewed FRA interest. Both systems desire to avoid any formal FRA involvement in their operations.

Utah and New Jersey Projects

Two time-separate joint use projects are underway in the U.S., one in the design stage and one in planning. In Salt Lake City, the Utah Transportation Authority proposes to build an LRT system on the Salt Lake Southern railroad and to have the current freight service contractor, another subsidiary of the same RailTex firm under contract to the San Diego MTDB, provide freight service in a time-separated operation, from about midnight to 5 AM. Requests for bids for civil construction have been advertised, and the work is receiving (up to) 80 percent FTA funding.

In Southern New Jersey, NJ TRANSIT is in advanced planning for a joint use project that would operate light DMUs in a time-separate freight-transit arrangement. This project may be the first light DMU use to be implemented in the U.S. The ultimate plan is to operate between Trenton and Glassboro via Camden, but in stages of development, the first stage being Trenton and Camden. Some affected track is owned by AMTRAK and most by Conrail (on which NJ TRANSIT has trackage rights elsewhere), and ultimate details may depend somewhat on the outcome of the acquisition of Conrail by CSX and NS. Freight service will, however, continue the Conrail shared asset operator under contract to a short-line railroad operator endorsed by the successors to Conrail. The line in question is part of one of the joint "shared asset" terminal railroad areas. In North Jersey, the Hudson-Bergen LRT will share right-of-way and, for a short distance, tracks with a freight railroad. This project is in the property acquisition and early construction phase.

Other Relevant Projects

Two other examples of LRT projects that use railroad right-of-way without the usual abandonment of freight service are noted. Each is different, and adds to the view of possible arrangements/operations for such service.

In San Diego, the latest LRT extension on the North Line is not located on its own SD&AE Railroad, but along busy former BNSF right-of-way now owned by North San Diego County Transit Development District. In this case, new and separate LRT-only tracks have been built, as preexisting tracks are used by freight, intercity Amtrak, and "Coaster" commuter rail services.

In New Jersey, the Hudson-Bergen LRT project is to use extensive amounts of former Conrail railroad property. In this case, rather than joint use, Conrail was encouraged to relocate its freight service to a nearby, parallel line and free up sections for exclusive LRT use, including a one-half mile tunnel.

A further example of interest in railroad rights-of-way is in Marin and Sonoma Counties, California, where the Northwestern Pacific (now California Northern) Railroad is in public ownership and there is a desire for offering improved transit service in the right-of-way, coordinated with the Golden Gate Bridge Authority. A bi-county study considering light and heavy rail and busway was completed.

Other examples of streetcar and railroad systems coexisting in a vintage trolley environment include Charlotte, NC; Boone, IA; East Troy, WI; Elgin, IL; French Lick, IN; Mason City, IA; Mt. Clemens, MI and Yakima, WA.

Factors Influencing Joint Use Decisions & Regulation

Joint use regulation depends on:

- nature and design of vehicle(s)
- nature and dimensions of rail infrastructure
- what type of interchange exists between systems
- the method by which the connecting carrier is owned and classified by regulator
- the agency that regulates the system with which the new rail transit connects
- nature and extent of riders estimated
- what jurisdiction(s) it crosses
- whether resulting new rail operation creates an operating precedent.
- the frequency of freight service and location of line side shippers.
- All of the above synthesized in a Risk Assessment.

1.3 RISK AND LIABILITY

Risk is a predominant issue in joint operations plans and crosses various technical and institutional boundaries. These risk factors, and their comprehensive influence on the feasibility of joint operations plans, need to be defined to ensure clarity and common appreciation for these concerns by affected participants.

In North America, liability is the single biggest institutional obstacle to joint operations between freight and passenger trains operated by separate entities. Liability is a legal concept used to measure financial value of potential damage. Insurance or other means of indemnification can be used to limit and control but not eliminate liability. Freight railroads will typically seek to be held harmless, regardless of fault, as one important condition to their yielding track space to a transit or commuter tenant. A freight railroad owner will seek indemnification as a condition of permitting use of its rail corridor by tenants (passenger operations). The clearest example was that an act of Congress was required to indemnify Conrail to permit Virginia Railway Express (VRE) commuter rail operations on the same mainline tracks within the same right-of-way, even though the tenant passenger service is fully FRA-compliant. Control and quantification of risk factors may influence assessment of liability and cause an insurance arrangement to be more attractive. As tenants, freight railroads do not routinely expect to hold harmless light rail transit operators as a condition to using LRT tracks.

Another example of liability protection is taken from a 1983-84 NJ TRANSIT/ Conrail trackage rights agreement where some lines were owned by each party. The agreement assumes a "no- fault" approach; whichever party has the accident is responsible for liability and cleanup. Negligence is essentially ignored. The right-of-way owner is responsible for third-party accidents (e.g., trespassing), while the user must pay liability insurance to cover the owner. This arrangement is common where the interests of the freight and the transit carrier are balanced and where both stand to gain from reciprocal running.

A systematic approach is used to evaluate risk, resulting in measurement of system design features that increase or reduce risk. The level of risk can influence the necessity for liability. As risk increases, concern for liability coverage increases. Where passengers are involved, risk increases drastically and liability can become excessive by current standards. No freight owner is willing to risk assets of the railroad. The owner of the prospective ROW seeks indemnification and an equivalent return on investment to find joint operations attractive. The opportunity cost of capital associated with freight or passenger operation needs to be equivalent. However, risk is considerably higher for passenger operation and this situation creates the dilemma.

1.3.1 Risk Analysis/Assessment: An Overview

Risk analysis is designed to focus on the impacts that proposed changes to equipment, service, and infrastructure exert on the safety of a specified corridor. As a baseline, existing safety/accident data from present operations needs to be obtained. The process produces sitespecific results tailored to characteristics of service and equipment. The assessment technique is transferable to different circumstances, but the quantification of risk and conclusions are not.

Application of non-compliant equipment in joint operations is viewed with concern and skepticism by FRA. Even joint operations using conventional FRA-compliant equipment causes concern. FRA observes that, in spite of many concerns arising from joint operations, its primary fear is a catastrophic event resulting in major loss of life and damage (e.g., the MARC and NJT collisions that occurred in 1996). These events involved fully FRA-compliant equipment operating in a busy freight or commuter environment using standard railroad signal technology. Both collisions, however, were between passenger trains.

FRA representatives have suggested that preparation of a Risk Analysis (RA) that carefully identifies hazards and incorporates features that mitigate risk factors is essential to a favorable review for non-standard service. RA results are then compared to current accident data, with the goal that any proposed service plan should show improvement over the present record. There is no single number or value that serves as a go/no-go cutoff, but the airline industry record of safety is cited as an overall goal. An RA is integral to this research and appears in Chapter 6 of this report.

Parties to a new service must recognize that any increase in service on a light density freight line will increase hazard to passengers, employees, and the public, particularly where grade crossings are involved. Such proposals need to recognize and manage risks so that no degradation from current levels of safety occurs.

Service planners, local officials and politicians, and advocacy groups should understand that the decrease of risk comes at a price. Operating entities can then justify applications of appropriate technology, selected improvements to infrastructure, and effective management and controls of the operation that are vital to reducing risk, enhancing safety, and fulfilling FRA objectives.

1.3.2 Risk Analysis (RA) - The Process

The RA is an objective and thorough step-by-step process that involves some subjective assumption and statistical analysis techniques. Some general steps include:

- Defining rail equipment, service, and infrastructure alternatives.
- Selecting analysis cases of a base and a target year.
- Allowing for sensitivity adjustments based on addition or elimination of features or service mix and speeds.

Findings should reflect little change in the normalized safety performance measurement criteria of accidents per million train miles and persons at risk per billion passenger miles. Results may show accident and fatality increases due to higher traffic density, speeds, and more local freight, but normalized risk can decrease. The sensitivity analysis should not show significant change due to variations in parameters. Increased risk can be offset by reductions in severity due to improved crashworthiness (impact reduction) and signal systems (crash avoidance) and improved grade crossing protection. Regarding secondary collisions (i.e. a consequence of the initial accident), at present no systems or techniques are available to avoid or offer protection save the exclusive use of right-of-way. Methodology for a typical risk assessment technique includes the following steps as applied to joint use:

- Establish route segments.
- Identify accident scenarios and types of exposure (including collisions, derailments, grade crossing, movable bridges, stations, right-of-way trespass, and other exposures).
- Characterize scenarios, along with the frequency, severity of damage and casualties, and causes.
- Estimate baseline corridor safety performance by route, accident scenario, user, overall.
- Estimate impact of changes to train design, traffic levels, traffic quality, speeds, signal system.
- Estimate safety performance by train services, route segment, accident scenario, corridor user, overall.

Factors and criteria in risk analysis and likely input and/or output of the analysis include (assuming the availability of an ideal database):

- Scenarios including train/train collisions; derailments, subsequent collisions after initial accident, grade crossing, movable bridge, station accident (Historical data can be selected from NTSB and FRA records).
- Exposure measures including train-miles, traffic density (i.e., trains per day), crossing passes, bridge crossings, and station movements (origination, termination, through).
- Probability of different collision events are calculated using the traffic mix and segments; weekday and weekend; crashworthiness can be used as a separate variable.
- RA model is prepared including historical, present, and planned rail traffic and consists, details of

infrastructure improvements, present and future train speed, and accident frequencies as a function of train type and infrastructure, and speed.

- Influences on traffic are noted, e.g., commuter rail or freight growth; log train mile increases by service, note increased crossing, bridge and station movements, add the planned infrastructure improvements such as signal system and track improvements or rule changes.

- Existing accident frequency data are obtained by accident type and location (major terminal or main line) and severity (minor or more serious). FRA types are: derailment, head-on, rear-end, side, raking collision, obstruction, other; relate to train miles/year and accidents per million train movements.

- Accident causes are reviewed, to estimate the extent of prevention by planned changes, calculate new accident frequencies, and compare to other data for "calibration".

- Number of persons at risk as a passenger safety measure is computed, derived from the average seating capacity and load factors.

- Examine track class over the route and train movement over segments. Obtain annual train miles and passenger miles for operating data. Obtain accident rates by freight trains by track class such as: FRA Class 4- 1.0 per million train miles; FRA Class 3- 2.5 per million train miles; FRA Class 2- 5.0 per million train miles. These data reflect low-class track adjacent to higher-class passenger track.

- Adjust grade crossing accident values by traffic volume and type of protection provided. List by protection type or train speed and set priorities for improvements.

1.3.3 Risk Mitigation Techniques

Several remedies exist to reduce risk in railroad operations. These include:

- Rearward facing seats/padded or breakaway surfaces on car interior.

- Crush zones on DMUs, LRVs and cab cars, operator refuges.

- Imposition of compatible rule book operating requirements by corridor owner (e.g., passenger service operator). These requirements would include control of speeds, train lengths, service and stopping patterns, dispatching priorities, and signal and train control technologies.

- Freight locomotive buff strength (longitudinal compressive strength) and collapsible coupler modifications when operating in a joint operations corridor.

- Compare railroad safety records to highway safety records and estimate changes if no rail service is provided ("level the playing field" with cross modal comparisons).

- Enhanced efforts directed at operational rule enforcement and oversight plans which focus on operational rule compliance assessments.

- Improved signal, communications, and train control systems.

- Improved grade crossing protection.

- Temporal separation including train spacing, operating windows, and scheduling.

- Collision Avoidance Systems.
- Consideration of overseas regulatory requirements imposed as conditions to co-mingled light rail and railroads on shared track.

FRA is more apt to consider a joint use operating plan or waiver where strong risk mitigation efforts are incorporated. Particular concern has been expressed for single-point failures or procedures dependent upon human actions. Therefore, plans should include redundant safety features and systems that preclude modes of failure.

A full, quantitative treatment of RA is accomplished in Chapter 6.

1.4 MANAGEMENT AND OWNERSHIP ISSUES

1.4.1 Ownership and Management, Historical Perspective

It is worth remembering that at one time, a single entity managed the railroad, its employees, passenger and freight services, maintenance, and equipment. Regulation was shared by FRA and ICC. Under the regulatory era (controlled by the ICC), this arrangement was a moderately successful endeavor. Once development of highways encouraged changes in development and the concomitant growth of automobile traffic, rail passenger service was no longer economically viable. Recently, management and ownership of freight and passenger services have been segregated, with profitable freight retained by the private sector and the passenger responsibilities going to the public sector. This situation complicates use and control of the resource (railroad line capacity) by increasing potential demand and competition for track access. A host/tenant relationship has replaced the single, intermodal rail management.

Joint use of railways was once commonly and routinely practiced in the United States. Fundamental changes in railroad ownership, legislation, and evolution of the rail transportation industry into separate businesses have created the impression that joint use is an obsolete practice, impractical or difficult to restore.

The notion of railroads being uniformly designed, operated, and maintained only for a single commercial purpose (as in freight) is a rather recent philosophy. This restrictive concept emerged in the 1970s, as the consequence of several almostsimultaneous developments in the railroad industry. Joint use became contentious and adversarial rather than a cooperative venture. Tenant rail carriers sought their own rail routes that they could exclusively control and manage. General purpose track, routes, and even railroads evolved into exclusive and specialized domains with the following milestones:

- Creation of Amtrak in 1970 by the Rail Passenger Services Act, as an entity separate and apart from freight railroads, as the national operator of long-distance passenger services. Despite this definition, Amtrak trains off the Northeast Corridor Line continued to physically traverse what had long been multi-purpose railroad lines, even though contract operators came to view their business exclusively as freight railroading. Now Amtrak is a tenant on those lines with its own train crews.
- Transfer of selected railroad rights-of-way and facilities most crucial to passenger/commuter services to states and regional transit agencies.

- Bankruptcy of several major northeastern United States railroads, whose physical plant was badly deteriorated and the subsequent consolidation of surviving freight operations into Conrail by the 4R Act of 1976. The regulatory relief granted under the Staggers Act of 1982, passed the bankrupts' passenger service assets to Amtrak and commuter agencies.

- Commercial deregulation of the freight railroad industry, which effectively ended the concept and responsibilities of a "Common Carrier," and which led to the sell-off of lesser-used freight lines to newly-created regional freight railroads. States, councils of government, and local economic development agencies moved in to rescue essential, light-traffic branch lines forsaken by the large, burgeoning Class I carriers.

- Substantial downsizing of the general railroad network, nationwide, both on bankrupt and prosperous properties. For the first time since the mid-Nineteenth Century, communities of substantial population and economic activity found themselves isolated from the nation's railroad network. Railroad employment plummeted from over three million at the close of World War II, to barely a quarter-million in the early 1990's.

- By Federal mandate, in 1983, commuter railroad services became the direct operating responsibility of state and local government, mainly through regional transit organizations, many of which also operated bus and rail rapid transit services.

- Designation of Amtrak as the owner and direct operator of the inter-city services in the Northeast Corridor (Washington to Boston), investment of over a billion dollars in the restoration of that railroad to a state of good repair, and its upgrading to higher-speed operation.

- Increasingly frequent use of railroad rights-of-way for development of rail transit corridors. These improvements emerged in several different formats: total abandonment of conventional railroad operations, and construction of a new rail rapid transit line, isolated from the national railroad network, on vacated right-of-way; construction of separate rail transit tracks or transitways on or alongside conventional active railroad right-of-way; and development of rail transit as the predominant use, and reconstruction of the railroad toward that primary purpose, but with continued accommodation of rail freight operations at particular times of day, and under specific operating rules.

In the northeastern United States, former railroad freight and passenger services were so integrated that total physical segregation was seldom practical and corporately unnecessary. Following Conrail, Amtrak and the commuter rail agencies' multi-purpose rail ownerships were split up and assembled as functional ownerships: intercity passenger, freight, and commuter rail. Many shared uses were forced to continue on crowded tracks in a new tenant-host relationship. For example, SEPTA, NJ TRANSIT, and MARC operate many of their commuter rail lines utilizing Amtrak-owned and Amtrak-dispatched lines. Amtrak supplies electric traction power, signal power, and power-dispatching services for many SEPTA operations, even including some branch lines that are not operationally used by Amtrak. Amtrak operates many trains over lines that are owned, maintained, and dispatched by Metro North. In fact, advancing an Amtrak Northeast Corridor train from Boston to Washington involves physical facilities and/or employees of not just Amtrak, but also of the MBTA, Connecticut DOT, Metro North, LIRR, NJ TRANSIT, and the Washington Union Terminal Company.

Conrail expended money and effort to segregate itself, as greatly as was physically practical, from passenger railroads. Nonetheless, freight operations must continue to co-mingle with passenger services in several segments of the network. There are even some instances where Conrail, while landlord, is not the predominant operator, and where the commuter agencies provide the dispatching and signaling services (e.g., SEPTA West Trenton Line in Pennsylvania known as the "New York Branch"). Some of the newer regional freight railroads' operations require entering upon, or interchange with, Conrail or other Class I freight railroads via Amtrak or the commuter lines.

So, rather than former full-service railroad companies competing with one another for business; specialized, market-dominant rail users now compete for track space and capacity, with the host carrier making decisions. Without the need for different functions to share tracks, the rail infrastructure could be rationalized downward. Formerly competing and now redundant facilities could be liquidated. Track that provided sufficient capacity to operate joint rail services simultaneously could be dismantled without jeopardizing a level of service adequate for the host carrier's single line of business. The possibilities for joint use become more remote unless dismantled track is replaced and then operated as a separate railroad from the host on a common right-of-way. Operating synergies, as well as operating conflicts, were lost. Operating two parallel tracks as two railroads, rather than one double track railroad, reduces capacity.

By tailoring each railroad route to the specialty of its owner, the track could be rebuilt to freight or to passenger standards exclusively. Joint use became problematic for freight trains on lines with track geometry designed for 100+ mile per hour passenger trains or high platform stations. Passenger trains were limited in performance on lines converted and maintained to freight track geometry standards.

While joint use has been regarded skeptically by some large Class I railroads, some regional and short-line railroads see opportunities for increasing revenue by optimizing their infrastructure through joint use schemes. They also see potential upgrades of their track and signals at the expense of a public-sector passenger carrier tenant.

The conditions described above are most apparent in large metropolitan areas. Some specializing of the railroad infrastructure is clearly appropriate in view of advances in railroad technology and demands being placed on the rail network. It is clear, however, that some opportunities for beneficial joint use are now more difficult to achieve since the era of tumult and disinvestment in the railroad industry, particularly in the northeast U.S.

Overseas in Europe and Japan, the circumstances have been somewhat similar. The greatest difference has been that U.S. freight railroads have been and still are private enterprises. Overseas railroads have typically been nationally owned and operated, but several large national systems are currently undergoing "privatization" or "regionalization." England's open access will be discussed subsequently. But the commonality with respect to Joint Use is that the two uses – intercity freight and passenger and commuter/suburban services – have been under common policy guidance and management. Zürich's exemplary city-suburban rail network (with ten times more mileage than enjoyed by huge New York City) required only intra-agency coordination to implement.

1.4.2 Implications of Joint Operations for Management and Ownership (and Cost Sharing)

Note what follows is an outline of issues, most of which relate to, but are beyond the scope of, this research.

Typical issues arising from management and/or ownership of a prospective right-of-way and equipment include:

- Initiation of discussion of joint ownership with host railroad and explanation of principles of joint ownership.
- Addressing and resolving the principles of liability indemnification and risk protection to the host railroad.
- Resolution to the right-of-way ownership once joint operations agreement is developed.
- Resolution to control, management, maintenance, and daily operations issues, including joint dispatching.
- Separate ownership of equipment and track. Operation of equipment and ownership of equipment can also be separate.
- Determination of payment methods and levels to cover incremental/ avoidable costs, continuous operating and maintenance costs, opportunity cost of capital (and plant), and indemnification. And determination of who pays whom, depending upon ownership and degree of use.

TCRP's Legal Research Digest No. 1 discusses these and other related railroad property matters of interest to transit agencies. Current payment methods supplied elsewhere are traditionally based on the share of car-miles used by each entity. There is a potential equity problem when rail cars of differing sizes and characteristics share the right-of-way. This situation is further complicated when freight operation involves such components as "double stack" or high/wide loads. One approach is to use gross ton-miles; another is to add an adjustment factor for freight loads. This arrangement can weight the proportion of wear and tear more fairly for passenger operation or speed differentiation more fairly for freight operation, and may be suitable for a heavy use corridor but not entirely adaptable to a light density line where passenger traffic may predominate.

In these cases, uniform operating routines can be transected into a negotiated lump sum. There may need to be a reimbursement for maintenance and capital improvements essential for passenger service. Important to the passenger service operator are incentive and penalty clauses based on performance (e.g., on-time, reliability, cleanliness) to ensure that infrastructure and equipment are adequately supported.

Contract operations are an attractive solution to some of these problems. The prospective transit operator contracts with the freight rail owner or Amtrak to provide equipment, crews, maintenance, and infrastructure to specified requirements. This approach was taken by VRE and MARC and is quite suitable for a low-volume, low-frequency operation. It is best for a start-up service since it minimizes staffing and resources (personnel skills, training, and maintenance equipment) required to commence a service. This arrangement provides potential economic benefits in addition to revenue from management fees to the right-of-way owner. While these arrangements have proven successful between different railroad entities, their application between railroad and rail transit operators is more problematic.

The disadvantage of contract operations is a loss of control by the transit agency. This agency simply becomes a contracting authority to monitor service performance and authorize payment. There are two structures possible. The first is operation by the freight right-of-way owner. The second is operation by a third party such as Amtrak which then provides the resources, technical, management, and labor to run the service. Service standards and incentives can be incorporated to monitor performance. This approach can leave customers and the public without adequate input into the service and therefore limitations of contract operations must be understood by the rail transit agency.

While these trackage rights arrangements apply to the relationships traditionally held between two or more railroads, they provide a foundation of precedent for railroads and rail transit track sharing.

Minimizing FRA involvement could be an objective of proposed joint operations plans, which can be achieved by ownership, compliance with safety standards, administrative/bureaucratic structure, labor agreements, and other mechanisms. Reducing regulatory participation can speed development, provide more flexibility, control costs and resource requirements, and ease administrative and management burdens.

Application of the open access concept to joint use in the context of this research is possible, but not included in the scope of this research. Forms of open access are practiced in a free-market or controlled case-by-case basis as trackage rights and haulage agreements. Though rules governing joint access to common tracks may be codified, enabled, and regulated on a national level, it is not suggested here that it be mandated from the Federal sector.

1.5 CONCLUDING COMMENTS

Clearly, joint use in the U.S. can be seen and analyzed as two different institutional conditions:

- Currently Achievable - Light freight traffic operating on a light rail transit agency's rail line in time-separated track sharing (e.g., San Diego).

- Future Ideal - Light rail transit (LRV or DMU) operating on a lightly trafficked freight or passenger line, in co-mingled track sharing (e.g., Karlsruhe, or Saarbrücken, Germany). Joint passenger services might share a timetable as in Karlsruhe, or operate long, locomotive-hauled trains in the peak and DMU shuttles in the off peak in an uncommon form of temporal or physical separation.

Railroad industry safety practice, experience, and FRA safety regulations determine the current regulatory climate. Co-mingling in a railroad environment, as accomplished in Europe, can be accomplished in our North American regulatory environment, but only with innovative operating, train control, and/or vehicle design breakthroughs. In Germany, full joint use was achieved within a decade following a previous decade of proposals and studies. It would require similar time and effort and most likely an adoption of North American "collision-avoidance" principles in regulations and operating practices. This achievement, in turn, would necessitate coordinated efforts of regulators, light-traffic railroad operations, transit agencies, and, not the least of these, engineering and manufacturing developments to support the collision-avoidance concept.

Not to be omitted from the conclusion are the realities that *separate* tracks might be built in a railroad right-of-way, thus accomplishing the goal of joint use of an existing transportation corridor, or "light transit" vehicles might be re-designed to become FRA-compliant under current regulatory practice. While the joint use of right-of-way is not strictly within the scope of this research, overcoming problems associated with joint occupancy with parallel separate tracks is an incremental step to achieving prudent shared track practices.

A brief statement on new technology modes of transport is appropriate in joint use context. New technology and proprietary modes of guideway transit–such as monorailways, people-movers, or non-standard rail systems–obviously cannot participate in joint use with freight railroads because they either do not use conventional standard-gauge track, or they have wayside appurtenances that would intrude into the railroad's clearance envelope (such as guide beams higher than the top of running-rail surfaces, or electrification conductors with contact surfaces too close to the track). Such incompatibility reduces new start alternatives and subsequent expansion options for these proprietary fixed guideway systems.

Finally, this research is based on the optimism that risks that may arise from joint use can be mitigated down to a comfort level acceptable to both rail operators and the agencies that regulate them. The potential benefit is reduced capital costs to the extent that rail transit becomes affordable in areas that would otherwise be denied its advantages.

European practice demonstrates the affordability feature and lends encouragement to the possibility of achieving satisfactory joint-use arrangements here. European success with joint use offers impetus for pursuit of the physical, institutional, and regulatory means to implement such arrangements as an alternative to costly, all-new facilities.