"Limited LRT Connections" with the General Railroad System

How Small-Scale, Shared-Use Arrangements Advance U.S. Joint Operations Practices

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A principal conclusion of *TCRP Report 52* is that there is potential in North America for joint light rail–railroad operations, but under limited and controlled circumstances. The question of where these circumstances could exist in the United States that would be similar to Europe and Japan remains difficult to answer. It is argued that U.S. light rail transit agencies, by obtaining approvals and abilities to design, construct, operate, and maintain light rail–freight rail shared-use arrangements on small scales, are North America's counterpart to Europe's extended evolution toward mixed traffic on shared track.

San Francisco's new Third Street light rail extension illustrates this trend. The median running alignment crosses two lightly used freight industry leads. Unique operating, safety, and cost challenges exist at each rail-to-rail crossing. Shared-use arrangements were possible because of low freight volumes and a 3-year negotiated willingness by the Class I railroad to lease the two primary crossings in exchange for maintenance of the freight track and shared liability. The project outcome is a blend of railroad and transit design and operations. This outcome is possible because the transit agency expanded its capability to manage shared assets with both railroad and transit regulatory standards. By building expertise to manage assets shared by the general railroad system, light rail agencies are incrementally advancing U.S. capability to implement more complex shared systems at a future stage.

INTRODUCTION

TCRP Report 52 examines European and Japanese joint operations where incremental integration has achieved acceptable crash avoidance systems for short headway mixed traffic operations. With safety satisfied, integrated controls, common signal systems, regulatory rules, and operating practices are now achieving investments economies with enhanced service opportunities for both modes.

Few U.S. transit agencies are pursuing the major step of joint operations on shared track during normal service hours. This paper explores where several light rail transit (LRT) agencies have undertaken an elementary integration of freight railroad and light rail controls, regulatory rules, and operating practices that is advancing the capability to consider joint operations in the future. This national trend is comprised of both new lines and light rail extensions that must go

through, around, or share freight railroad corridors and infrastructure in order for the transit project to go forward.

The core of the thesis is that small scale shared-use programs, such as San Francisco's rail-to-rail crossings, raise substantial portions of the regulatory and technical challenges found in larger, shared track projects with the exception of vehicle compatibility. Vehicle clearances, crash worthiness, compatible controls, and wheel track interface can be seen as a mature stage of mode integration. The examples of small scale arrangements presented here focus on shared track with temporal separation, shared rail crossings, and shared grade crossings. The efforts to address only shared infrastructure can be seen as an initial stage of mode integration in the United States today.

In this context, the relief from the major vehicle issues and costs helps make possible this acquisition by individual LRT transit agencies of railroad design, maintenance, and operating expertise on a manageable scale for all parties involved. This bottom up national development is also largely without the benefit of a coordinated national program that is found in many *TCRP Report 52* examples drawn from Europe and Japan.

As a result, new working relationships are being developed between light rail agencies and their counterparts within railroads, the Federal Railroad Administration (FRA), and state oversight staffs in discussions that merge transit and railroad issues. What is today a somewhat ad hoc trend may take a more explicit national role as agencies, railroads, and oversight authorities increase cross communication and familiarity.

The growing experience base suggests an explicit development strategy by agencies, railroads, and regulators for more ambitious joint operations. Similar to the training and experience qualifications for individuals to be FRA qualified under various 49 CFR Parts (e.g., Parts 213 Track Safety Standards and Part 214 Roadway Worker Protection), one scenario from this thesis is that transit agencies could become FRA qualified for graduated levels of joint operations based on degrees of prior training, experience, and records of safety with small scale, shared arrangements. To give credit to this trend, examples of emerging, small scale shared infrastructure and larger scale joint operations covered by *TCRP Report 52* are compared.

Third Street LRT Project Overview

The San Francisco Municipal Railway (Muni) obtained environmental clearance for the first new surface alignment extension in a decade in 1998 after a 3-year environmental impact review and statement and conceptual engineering program. When completed in 2005-2006, the project will extend the 35-mi light rail system 5.4 mi from just south of the downtown at Caltrain's northern terminus, to the Bayshore Caltrain station at the southern boundary of the city near Candlestick Park.

The at-grade alignment is primarily in a semiexclusive median on Third Street, one of San Francisco's longest north–south streets that runs on its eastern waterfront. Single-cars will operate on 6-min peak headways. Figure 1 shows the Third Street LRT project and the locations of the two rail crossings. Figure 2 shows the Arthur Avenue–Third Street Rail Crossing with proposed signal locations. Table 1 presents the Third Street LRT rail crossing's existing and proposed conditions as well as the extensive features common to the two crossings. Due to these similar features, the Muni submitted to the FRA a Petition for Approval of Shared Use in June 2003 for both crossings in a single petition.

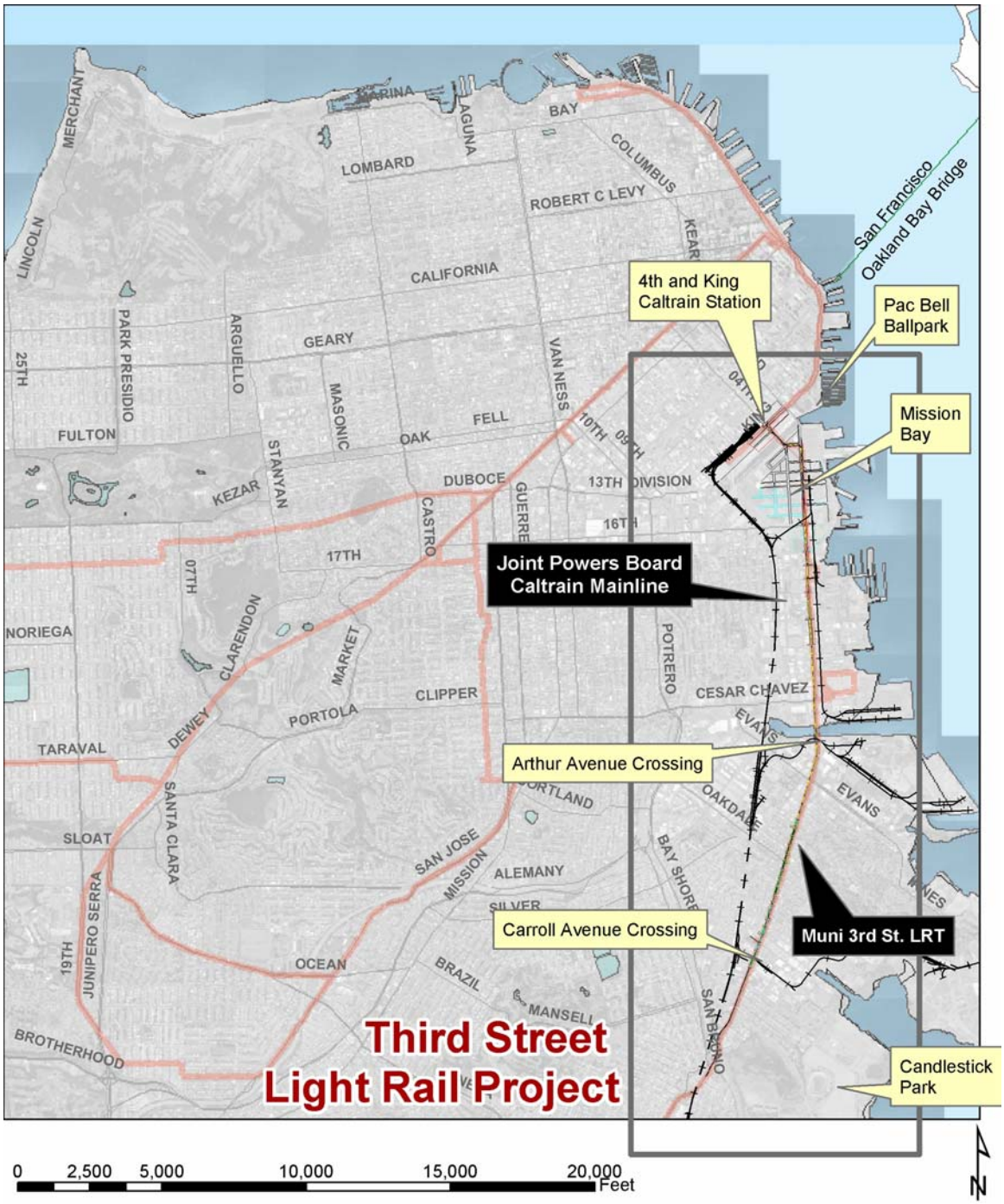

FIGURE 1 Area map of Third Street LRT Project and two Rail Crossings.

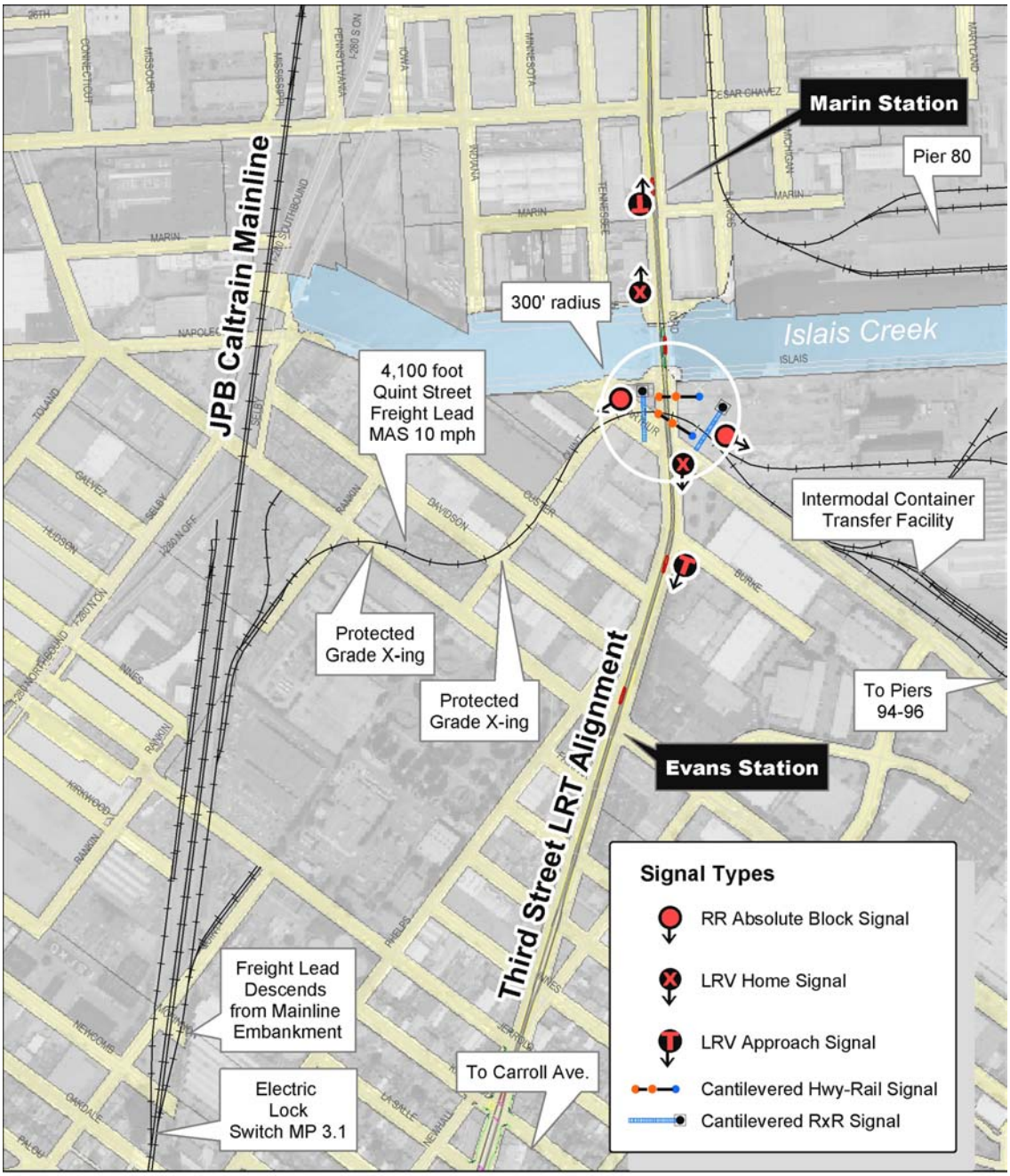

FIGURE 2 Arthur Avenue Rail Crossing at Third Street with interlocking signal locations.

TABLE 1 Third Street LRT Project Rail Crossings—Physical Plant Conditions

Crossings	Existing Conditions	Automatic Interlocking Dimensions From IJ to IJ of Approach Circuits	Track Systems	Signal Systems and Warning Devices	Freight Equipment, Frequencies and Speed In each direction	LRT Equipment, Frequencies and Speed In each direction
1. Arthur Avenue and Third Street LRT TL & TR crosses Quint Street freight lead 80 ft north of Arthur Ave. (at Cargo Way) within existing highway grade crossing **2. Carroll Avenue and Third Street** LRT TL & TR crosses freight lead in center of highway grade crossing	**Existing Traffic Lanes**: 6 **Planned Lanes**: 4 **ADT**: 25,000 **Accidents (Vehicle-Freight Train)**: 0 in prior 6 years (San Francisco Dept. of Parking and Traffic and FRA data through 2001) **Grades**: None **Vehicle -LRT Sight lines**: +300 ft north and south of each crossing down Third Street	• **Railroad:** About 250 feet to east and west of each crossing Occupancy circuits within Third Street spanning diamond east and west • **LRT**: About 600 ft north and south of crossings Occupancy circuits within Third Street spanning diamond north and south	• **Railroad:** 1 Class 2 quality track - yard lead • **LRT:** 2 tracks 2 diamonds in street median Near 90 degree crossings 119 lb rail	• **Railroad:** Cantilever AREMA two aspect Home signals about 140 ft each side of crossing • **LRT:** 2 Way-side LED **Approach** signals with repeaters – 12 in. "T" diameter 1 **Home** signal about 150 to 300 ft each side of crossing LRT and Traffic: LRV **Traffic** signal priority via Vetag RXR Pavement Stencils Cantilever flashers Cross bucks and bells **Pedestrian**: LED Count Down Signals at each crosswalk.	1 GP40 engine and 2-8 cars Arthur Ave: 1 train move in and one move out 3-5 times each week+/- Carroll Ave: 1 train makes one move in and one move out each weekday Operates within the same approximate a.m. time period 9:30 to 11:30 10 mph restricted speed No freight moves currently at night or weekends	1 car LRV train 6-min Peak 10-min Off Peak 150 trains per week day 25 mph restricted speed 20 h of operation per week day 5:00 a.m. to 1:00 a.m.

The geometry and geography of the alignment made grade separations of the rail crossings almost impossible regardless of costs. The railroad that owns the freight leads stated in extensive preliminary contacts that its design, construction, and maintenance resources were committed to higher priorities. Furthermore, the very small scale and benefits of the crossing schemes did not fit the railroad's return-based programs. As a result, the railroad warned, they could not commit to when they would construct any improvements to support the project and would not be bound by private sector standard costs. Finally, potential jurisdictional conflict also loomed between having the railroad's maintenance unions and Muni's separate unions working essentially on common track and signal systems.

After an extensive review of legal and policy alternatives, along with precedents in other cities, Muni elected to approach the railroad headquarters staff directly (bypassing the railroad's local field representatives) and propose a lease agreement that gave responsibility for the crossings to Muni. Muni proposed to rebuild a segment of railroad track and signals at the crossings, to upgrade the crossings and highway warning devices, to undertake the railroad and grade crossing maintenance, and to assume the costs for the major portion of the new risks and insurance. A specific course was developed to use high-level contacts to approach the railroad headquarters senior management. In a positive turn of events, the railroad headquarters staff agreed to consider the proposal and, in the first stage of agreement, stipulated that they wished to see a design standard for a Class 1 Railroad automatic interlocking system.

Railroad Issues

Shared-use arrangements in the United States today are largely led by transit agencies that have purchased a railroad line and the railroad is either an invitee shortline or a willing subordinate in exchange for the payment from the right-of-way purchase. The rapid increase in the number of transit agencies that control freight railroad assets indicates that, armed with sufficient funding during the time Class 1 railroads were shedding branch lines, a major window of opportunity opened. With less funding and options to acquire right of way, San Francisco's rail crossings may represent a possible forerunner of future arrangements where shared assets are leased between equal parties.

However, crediting San Francisco's lease of railroad right of way for use by both parties as a precedent must be qualified by the "limited and controlled circumstances" raised in the conclusion of *TCRP Report 52*. Shipping volumes drive U.S. railroad relationships with all external parties, transit systems included. High-volume freight operations—long trains at any time of the day—produce safety concerns, design criteria, maintenance, and operating agreements that assure control by the railroad, such as Sound Transit's Tacoma Link original agreement with Burlington Northern Santa Fe (BNSF) at Pacific Avenue and Southeastern Pennsylvania's Transportation Authority's (SEPTA's) historical LRT 11 line–CSX Corporation crossing at 6th and Main.

For lower freight volumes, particularly on industrial leads, a major or shortline railroad may consider advantages to ceding control of right of way to a transit agency in exchange for benefits at the project site or within the transit agency's sphere of influence. Building on *TCRP Report 52's* Screening Matrix for Joint Use Feasibility, operating conditions that would appear to be most favorable for railroad and FRA acceptance of a rail crossing shared by light and heavy rail are roughly bounded by the following parameters (*3*):

Condition	Criteria and Operating Parameters
Freight line importance	Should be industrial leads, spurs, or sidings. Mainline triggers FRA's "steep burden."
Speed of freight moves	May need to be less than 15 mph.
Freight train frequency/day	< 4/day between 6:00 a.m. and 8:00 p.m.
Average freight train length	< 15 cars.

SHARED-USE PRACTICE AND PRACTIONERS

Small scale, shared-use arrangements are variations of three types. The most common and largest in scale is shared track with temporal separation. A middle ground of integration complexity is rail-to-rail crossings with a common interlocking. These are relatively rare but are likely to increase in the future. Shared highway–rail grade crossings along parallel light rail and freight rail lines are the most conventional arrangement of shared assets. These types typically are in a combination with one another. San Francisco's rail to rail crossings, in the center of large highway intersections, are also shared grade crossings. Shared track generally includes shared grade crossings and, at a minimum, shared interlockings at the connection points between the railroad and light rail systems. As short hand, these three types are also referred to here as shared track, shared signals, and shared grade crossings. A summary of the transit agency shared arrangements surveyed for this paper follows.

The well known shared track operation with temporal separation in San Diego, California, is now only the first of several similar systems: Santa Clara Valley Transportation Authority (VTA; Moffett Field Drill Track), Utah Transit Authority (UTA) and Maryland Transportation Authority (MTA) also share track with freight rail operations—similarly protected by temporal separation. UTA also includes ones of the first rail-to-rail crossings where two former single track freight lines crossed and one became an LRT alignment. In 2003, Santa Clara, California, expanded its in-house railroad capability with a larger scale program on the Vasona LRT Line that is nearing completion on a right of way purchased by the VTA from a Class 1 Railroad. For the Vasona Line, the transit agency is responsible for maintenance of the freight railroad track including major rail bridge overpasses, maintenance of the several shared highway-rail grade crossings and freight-LRT operations at the interlocking point of connection. This followed the 1988 commitment by Sacramento, California, to undertake maintenance of shared railroad–light rail grade crossings on the lightly used freight railroad single track that parallels the Folsom (largely) double track LRT line as part of Sacramento's purchase agreement with the railroad. Following this trend, San Francisco LRT maintenance forces are training to assume maintenance of their freight rail–light rail crossings and automatic interlockings.

A common thread in these arrangements is that all of the above light rail transit systems are responsible for a portion of the freight track and signal system maintenance within the shared-use arrangements. Most of the transit agencies surveyed evaluated whether to contract out or use in-house maintenance forces. In every case the decision has been to train and use in-house LRT maintenance forces to achieve FRA qualifications and carry out FRA standard practices.

All agencies surveyed with shared track (MTA, UTA, San Diego) use in-house FRA qualified radio communications that at a minimum oversee the check in and check out of freight trains at the interlocking connection to the light rail system. All of the LRT agencies surveyed acquired sufficient training and approvals to address FRA requirements without benefit of an in-

house, FRA-compliant commuter rail organization. Indeed, at the time of this paper, UTA was considering the use of its FRA-trained LRT maintenance forces to cover the proposed commuter rail service maintenance needs projected to begin after 2005.

The acquisition of FRA qualified maintenance of track, signal, and grade crossings, as well as limited dispatching represents an important expansion of light rail agency qualifications and credentials—aside from expanded external oversight. The revised LRT system maintenance training programs along with the establishment of specific qualifications, manuals, data collection, record keeping, and supervision practices that are required to maintain shared track, signals, or grade crossings generate new structures and standards within light rail systems. At the center of this change are new relationships with the FRA and state oversight agencies. This process is formally initiated with submittal of an FRA Petition for Approval.

FRA PETITION PROCESS

Shared arrangements such as an at-grade rail crossing operated and maintained by a transit agency and "shared" with a freight railroad may appear too limited to provide useful comparisons to larger issues of mode integration. A core point of this paper is to testify to the parallels between large project joint operations and small scale, shared-use arrangements. Muni's experience is that a FRA petition process involving railroad negotiations and agreements is a major undertaking spanning 3 years from the first formulation of the FRA-railroad crossing specifications in final design through final approval of design by the railroad and subsequent approval of the petition by the FRA. Sound Transit's Tacoma link approval process covered a similar time from initial design in 1999 to approval in 2002. This duration begins to approach larger scale project approvals such as New Jersey. While the 2000 FRA Policy Statement guidance for shared use suggested a "brief" FRA Petition for "limited connections" to the general railroad system such as rail crossings, it is unlikely the processes for small projects will be significantly shorter than large ones until more precedents are established nationally.

Approvals to operate shared rail crossings on Third Street required concurrent effort on three fronts: the railroad, stakeholders, and oversight agencies. Table 2 summarizes the coordination required for San Francisco's shared-use arrangements.

During 2001 and 2002, Muni project staff simultaneously pursued design review, operating plan discussion and real estate lease negotiations with both the railroad's regional and national office staffs. Field inspections and a design review were conducted with track and signal staff from both offices. Presentations were made with shippers who use the industrial leads, the port of San Francisco that is a primary freight and cargo broker, a railroad museum that uses one of the tracks periodically, and Caltrain staff who control all San Francisco freight railroad access on its passenger rail mainline. Periodic briefings and site inspections were held with state oversight staff at the California Public Utilities Commission (CPUC), and regional FRA staff to provide updates and obtain guidance for the breadth and depth of the Petition submittal.

The results of this process at Muni were similar to the other transit agencies that were surveyed. Overall, the process strengthens light rail organizations in three areas: design, maintenance, and operations. A fourth area that is strengthened implicitly is the transit agency's overall transit-railroad system management. The latter is discussed briefly under Risk Management.

TABLE 2 Third Street LRT Project Rail to Rail Crossing Reviews and Approvals

Stakeholders	Review Transaction
Railroad[a]	Railroad Engineering Departments Real Estate Property Lease Insurance and Liability Agreement
Interagency Coordination	Port of San Francisco Local Freight Rail Shippers Caltrain Joint Powers Board Staff Golden Gate Railroad Museum
Internal LRT Project Review	Engineering/Construction Change Order Safety Deptartment/Project Safety Committee Department of Traffic Fire Department and Department of Public Works
Oversight Agencies	FRA Approved Petition and Operating Plan FRA Approved RWP Safety/CM Program FRA Approved Maintenance Program CPUC Overhead Height Clearance Waiver CPUC Approved Crossing Intersection Design CPUC Approved Crossing Application[b] FTA Oversight Review Of Above

[a] Railroad is the Class I Railroad that is the freight shipping service to the San Francisco Peninsula and Port of San Francisco.

[b] CPUC review of application is done in coordination with the FRA regional office.

Design

For the microcosm of shared track contained in a single shared crossing, the primary design criteria are the same as for large scale projects: certain crash avoidance by means of fail-safe controls and practices. The Muni has strong experience with LRT rail-to-rail crossings, interlockings, and automated train control systems. Based on this experience, Muni was immediately prepared to implement the railroad's design standards for automatic interlockings without manual interface and radio communications and a generally upgraded highway-rail grade crossing. At the end of the design reviews and changes that spanned about 18 months, Muni approved the track and signal design for the freight and light rail systems as well as the operating plans for the crossings.

A key issue for automatic interlocking operations primarily controlled by signal compliance and safe practices is approval by the FRA and state oversight agencies that does not require major enhanced safety devices. Such devices may be inherent to higher risk conditions including mainline, higher frequencies, adjacent active switching and grades in the approaches of the freight alignment. Where necessary, railroads historically use derails at rail crossings tied to the interlocking controller. Derails were required on the BNSF freight line–Tacoma Link crossing due to the grade of the freight track that could have contributed to a run away freight car. Non-mainline railroad tracks with derails previously in place have resulted in derails continuing to be left in place for the point of connection interlocking the remaining freight line and the new LRT lines for VTA and UTA systems.

FRA approval of Muni's approach to use only signals and procedures to achieve crash avoidance is a key measure of the U.S. evolution of small-scale precedents. All such approvals depend in part on the FRA's willingness to recognize the cumulative success of small-scale, FRA-compliant, LRT-freight shared-use arrangements nationally. At the time this paper was submitted, the FRA decision to approve Muni's Petition was expected at the end of November 2003. Construction on the crossings was purposely scheduled to begin in early 2004 in order to achieve CPUC and FRA approvals.

The several revisions made to the initial design as a result of Muni's field inspections and design review improved the dual mode interface:

- The original concept to construct a unique hydraulic liftable overhead contact system mechanism at the crossings to provide historical state mandated clearances of 22 ft above the top of rail cars during freight moves was deleted in favor of pursuing a waiver application before the state oversight authority. After more than a year of review and deliberations, that waiver was granted.
- The location of the railroad approach circuits on each side of the point of connection were extended approximately 50 to 100 ft so that the arrival of a train would trigger the request for a route 200 to 250 ft further from the crossing.
- The interlocking will control the traffic signals at the intersections within the limits of the light rail vehicle (LRV) approach signals north and south of each crossing.
- For the approach intersection signals on the LRT alignment, the corridor integrated LRV-traffic priority system (Vetag) will interface with the interlocking controller to make LRV route requests. The affect is to provide the Vetag system with a vital back up.
- The railroad crossing pavement stencil will be applied to the guideway approach to the intersections as well as the parallel highway lanes.
- A freight rail spur on the northern side of Carroll Avenue, east of Third Street, will be removed to avoid conflict with the freight approach circuits. Flasher signals will be added as warning devices at Carroll Avenue for freight moves across Third Street per CPUC standards.
- LRV dwarf signals will be installed at the approach zones to warn against light rail reverse moves on the opposite track.
- Tactile warning devices will be inserted across the sidewalk path of travel consistent with the Americans with Disabilities Act requirements for freight tack flange width in sidewalks on each side of the rail crossings.

Table 1 shows the considerable physical space and design features in the Third Street interlockings. The freight track is being completely replaced with new rail, ties, insulated joints and signal system for several hundred feet beyond the diamond crossings. The LRT track and signals linked to the interlocking controller reach approximately 1,200 ft. Taken together, the total interlocking track and signal system for both crossings is nearly ⅔ mi if stretched into a linear path. At the most complex of the two crossings, the microprocessor controller is connected to two new AREMA railroad signals, a railroad wayside push button route request box, two sets of cantilevered flashers and bells, four-way vehicular LED traffic signals, pedestrian LED countdown signals, a draw bridge preemption override, a fire station preemption override, four LRT approach signals and two LRV home signals (spanning several blocks) each with repeaters to signalize the near and far side of the three intersections leading to the crossing.

Table 3 shows that across the three types of shared use there is a common set of about a dozen railroad design issues and FRA rules that apply to both shared track and shared crossings

where the light rail agency is responsible for the shared assets. A smaller number of issues apply to shared grade crossings.

Maintenance

In interviews with LRT safety and maintenance staff at the five agencies surveyed, every participant credited the presence of FRA rules with strengthening the agency safety mission among employees and management (see contacts at bottom of Table 4).

TABLE 3 LRT-Freight Issues, Design, and Regulations for Three Types of Shared Use

Issues	Shared Track	Shared Crossing	Shared Grade Crossings
Regulatory Approvals			
State Oversight Approved Application	X	X	X
FRA Approved Petition	X	X	Brief Petition
Track, Structures, and Signals			
Design Standards			
Interlockings and Controls	X	X	
Title 49 CFR Rules			
213 Track Safety Standards	X	X	
235 Modification of Signal Systems	X	X	X
236 Signal and Train Control QC	X	X	
Grade Crossings			
Design Standards			
CPUC Interface/Warning Devices	X	X	X
Title 49 CFR Rules			
234 Grade Crossings	X	X	X
Procedures & Operating Practices			
Joint Operating Plan/SSPP	X	X	Brief Reference
Title 49 CFR Rules			
209 FRA Jurisdiction, 211 Waivers	X	X	X
212 State Safety Participation	X	X	X
219 Control Drug and Alcohol	Waiver	Waiver	Waiver
225 Railroad Accidents Reporting	X	X	X
228 Hours of Service	X	X	X
Total Factors	14	14	11

TABLE 4 Transit Agency Railroad Responsibilities and FRA Qualifications for Shared Use

Shared Asset	Transit Agency and Alignment	Maintains Freight Assets	Freight Frequencies	Interlockings: Automatic (A) Manual (M)
SHARED GRADE CROSSINGS/TRACK	**1. Santa Clara VTA** **6 mi side-by-side Vasona freight track ROW; shared grade crossings**	1. Yes, all	1. < 5 trains/week	1. 2 M
	2. San Diego Trolley **15 mi Shared "Mainline" track, signals, grade crossings**	2. Yes, all	2. > 1 train nightly	2. 2 M
	3. Sacramento RTD **7 mi side-by-side Folsom freight ROW and LRT track; shared grade crossings**	3. Yes, grade crossings only	3. < 5 trains/week	3. None
SHARED RAIL CROSSINGS	**4. Municipal Railway** **2 Rail to Rail Crossings - Third Street within highway-rail grade crossings**	4. Yes	4. 5 trains/week	4. 2 A
	5. Sound Transit Tacoma Link **1 Rail Crossing—Tacoma Link and BNSF Lakeview line at Pacific Ave.** ST – BNSF crossing agreement revised as this paper was finalized.	5. NA. LRT staff not involved in FRA qualified work	5. Possible future commuter rail connection.	5. TBD

Sources (unpublished data): Direct interviews, email exchanges, or phone interviews were conducted with a minimum of two staff members at each Transit Agency between July 2002 and July 2003. Primary contacts were as follows:

1. Anthony Bohara, Manager of Track and Civil Engineering, SEPTA. Phone discussion of SEPTA Line 11 rail crossing history and protocols.
2. Fred Byle, Manager of Track and Signal Maintenance, San Diego Trolley, Inc., fbyle@sdti.sdmts.com, (619) 595-4926. Also, Andy L. Goodard, System Safety Administrator, San Diego Trolley, Inc., (619) 595-4986, regarding updating of SSPP and training to meet FRA expectations.
3. Larry Davis, Supervisor of Maintenance, SRTD, (916) 648-8422. Phone discussion regarding Folsom line.
4. Jim Middleton, Rail Safety Supervisor, Santa Clara Valley Transportation Authority, (408) 952-8972, jim.middleton@vta.org - phone and on site visits regarding Moffett Field drill track and Vasona line shared corridor and crossing.
5. Yoav Arkin, Senior Program Director, System Safety and Assurance, Earth Tech, Inc. 7 Saint Paul Street, Suite 900, Baltimore, MD, 21202, (410) 637-1603. Email correspondence regarding Baltimore LRT maintenance with Arkin,who in turn, spoke directly with MTA LRT MOW supervisor, Fletcher Hamilton to verify information.
6. Hamid Qaasim, Program Manager of Safety and Assurance-Link Light Rail, Sound Transit, (206) 398-5129, qaasimh@soundtransit.org. Direct interview at APTA 2002 Rapid Rail Conference in Baltimore and email exchange regarding Tacoma Link rail crossing. Also, Bill Whitbred, at LTK, wwhitbred@ltk.com, consultant to Sound Transit; email correspondence regarding BNSF change of position and the staffing program to meet FRA qualifications for Sounder.

Table 4 shows the FRA compliance and maintenance capability at these transit systems and Muni. At the time of the interviews with Sound Transit staff, the original agreement with BNSF illustrated a railroad's firm ownership interest to protect high train volumes and limit transit agency responsibility for railroad functions. However, it is interesting to note that in 2003 Sound Transit was able to achieve abandonment of the BNSF freight line that crosses the Tacoma Link alignment, and after 3 years of difficult negotiations, FRA approval and construction of the crossing was achieved under the assumption the transit agency would not be responsible for the shared asset.

Four Title 49 CFR Parts provide FRA's national standards that extend most light rail transit agency maintenance practices today to the point of significantly recreating the agency Standard Operating Practices (SOPs):

- Part 213, Track Safety Standards, spells out standards for track maintenance, inspection, and reporting, including qualifications for track inspectors and maintainers and documentation by the agency management to show that maintenance staffs meet their assigned positions. Pending adoption of new American Public Transit Association (APTA) standards, the details of Part 213 represent a level of effort in SOPs not seen at many light rail agencies absent the need to achieve FRA compliance.
- Part 214, Roadway Worker Safety, governs construction and maintenance worker on site safety and procedures to assure protection from collisions or falls from bridgework. From an employee safety perspective, 214 is a comprehensive source of standards (similar to Occupational Safety and Health Administration guidelines) for accident prevention, investigation, and employee safety that otherwise might not always be in place for public transit agency staffs that carry out maintenance duties.
- Part 234, Highway–Rail Grade Crossing Signal System Safety, governs the standards for designing and maintaining grade crossings including prescribed inspections and maintenance by grade crossing system component. For light rail agencies with LRV speeds above 35 mph through highway–rail grade crossings and existing equivalent state oversight requirement, much of Part 234 may already be in place for grade crossing maintenance. Where those conditions have not triggered the comprehensive approach prescribed in Part 234, new, more definitive practices are likely to result from its application.
- Part 236, Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signals, covers the scope expressed in its title. The presence of shared interlockings maintained by a light rail agency introduces a new set of tests and inspections to assure safe operations that are not always present on conventional light rail surface operations.

While APTA is rapidly advancing light rail system standard maintenance practices that parallel those of the FRA, only a small number of APTA or FTA standards are comparable to FRA's tested experience on a national scale, level of detail, and resulting authority as a source of best practices. Examples of rail transit safety standards or practices that are currently equivalent to FRA precedents include System Safety Plan Program documents, glazing for LRVs, and drug and alcohol control of safety critical employees. In the case of the latter, virtually all transit agencies with shared-use arrangements have submitted Petitions for Waivers—and received approval—for Part 219 Drug and Alcohol based on the equivalent sufficiency of the FTA mandated program.

Sources of FRA training used by LRT agencies are commonly a combination of existing employees who are former qualified railroad workers, consultants who provide insights on best

practices and technical materials, and FRA and state oversight staff who are sources to classes and field exercises. Training a cadre of most experienced employees first is a common practice, but the vast majority of agencies are training all maintenance employees, from top to bottom, to become FRA qualified as part of their job growth and qualifications. Within this trend there appears to be a concurrent commitment to use FRA standards to achieve a higher level of light rail system performance regardless of the mandates inherent to FRA jurisdiction.

Operations

For transit agencies that control track used for freight moves that are made during a temporal separation, Part 220 (Radio Communications) applies and prescribes the uses, format, and content of radio communications between central control and employees in the field and between employees working in the field together. Part 228 (Hours of Service), which prohibits work beyond 12 h consecutive without 12 h off, applies to the light rail control center dispatchers, supervisors, and signal maintainers. Both of these rules take common LRT agency practices to a more prescribed or exact level than would otherwise have been the norm in many cases.

The experience of Muni parallels most if not all of the light rail agencies reviewed here: Operator training, the Operating Rule Book, management job descriptions, and the System Safety Program Plan have been revised to document commitments to FRA standards and to incorporate the existence of railroad assets within the transit agency's responsibilities.

When the total effort for a light rail agency to institute railroad and FRA standards across the organization is considered, the most important internal impact of the petition process is the ground work the process puts in motion to prepare for the new organizational responsibilities, to conduct detailed training, to carry out start up testing, and then safely operate with confidence.

Risk Management

The FRA Petition process required Muni to conduct a Risk Assessment of the rail crossings to determine if the interlocking plant design and operating rules would achieve FRA standards, such as operations that are equal to or safer than a no-build scenario with no probability of catastrophic collisions. Few FRA rules spell out light rail to general railroad crossing operating standards. In the short history of FRA review of light rail–freight rail crossings, a Petition for Approval of Shared Use is a case by case approval of the controls, operating rules, and practices proposed at the crossings much more than a specific waiver of any FRA rules contained in Title 49 of the Code of Federal Regulations.

The freight railroad and the transit agency's risk management staffs are sources for the transit agency's Risk Assessment. The respective Risk Management staffs are the immediate parties to the railroad–transit agency liability agreements and advisors to the concurrent real estate agreements. The difficulty to integrate railroad operating, safety, liability, and insurance issues with transit agency risk management precedents represent the benefit of achieving small scale, shared arrangements without the steep burden of fully integrating vehicles and operations. In San Francisco's case, a period of becoming conversant and able to translate two technical languages and respective traditions across modes was a prerequisite to LRT–railroad design cooperation. Similarly, considerable effort was required to achieve mutual understanding across modes of liability, probable and perceived risks, and the range of possible protections prior to proceeding with shared risk management agreements.

CONCLUSION

Implementation of limited shared infrastructure by a light rail system and a railroad contains virtually every regulatory and technical requirement found in shared track projects with the exception of vehicle compatibility issues. The first benefit of smaller, manageable shared arrangements is that the absence of vehicle issues makes possible a still considerable level of effort to begin integrating light rail and railroad issues.

New integrated or share arrangements generate a microcosm of intense cross mode cooperation, planning, and engineering that must accommodate a wide range of stakeholders and approvals. Representatives negotiating for the light rail system and railroad will learn about the other's industry practices and issues that are often not always transparent across modes. In addition, many specialized, mode-specific details must be shared and understood across departments within the railroad or light rail organizations before a consensus can be reached for external discussions.

The Third Street LRT project overcame a variety of gaps between the transit agency and the railroad during the 3-year development and negotiation period to submit a petition to the FRA. These mutual interactions across modes, business cultures, rules, terminology, and practices represent the first tier or initial increment of shared use. The growing efforts to integrate technical and institutional light rail and freight rail expertise across the United States are setting the foundation for the next generation of integrated traffic in a shared track world. While no one U.S. light rail system touched on here represents an uniform, industry trend, together they are providing a proving ground effort just as Karlsruhe did at the start of the European trends toward complex arrangements documented in *TCRP Report 52* (*3*).

Finally, the trend of transit agencies to carry out FRA and railroad standards expands the criteria for the FRA to evaluate the ability to manage more extensive U.S. joint use systems of shared track, common signals, and joint timetable operations. The cumulative safety record of FRA approved small scale, shared arrangements may influence the evolution of the FRA's assessment of more complex proposals.

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