Integration of Light Rail Transit into City Streets

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Light rail transit (LRT) has become a reality in North America. Nineteen cities in the United States and Canada have systems in operation, in addition to several short starter-line segments. The ability of light rail vehicles (LRVs) to operate in a broad range of environments (both on street and in separate right-of-way), the passenger attraction of the vehicles and service offered, and the capacity provided have made it an increasingly viable public transportation option for many urban areas. LRT, when in semiexclusive or nonexclusive right-of-way, has at-grade crossings with automobile and pedestrian traffic. These crossings have operating characteristics that are different from typical heavy/commuter rail at-grade crossings. These differences derive from the basic operational differences between light rail and heavy/commuter rail. Whereas heavy/commuter rail operates with relatively long headways and train lengths, light rail operates with relatively short headways and train consists. In addition, LRVs interact with motor vehicle traffic and pedestrians more often than does heavy/commuter rail. Because of the inherent operational differences between LRT and heavy/commuter rail and, more important, because of the increased interaction between LRVs, motor vehicles, and pedestrians, LRT systems across the United States and Canada have placed top priority on strategies to minimize collisions and conflicts between LRVs, motor vehicles, and pedestrians. The research methodology that was followed to address these issues in Transit Cooperative Research Program Project A-5, Integration of Light Rail Transit into City Streets, is presented. The project's principles and guidelines for safe integration of LRT into city streets are summarized. Three traffic control devices that were recommended by the Project A-5 research team for possible inclusion in a new part of the *Manual on Uniform Traffic Control Devices* are described: motor vehicle turning movements, pedestrian crossing treatments, and LRT signal systems. These preliminary findings have been presented to the Project A-5 review panel but have not yet been approved by the Transportation Research Board.

In March 1994 the Transit Cooperative Research Program (TCRP) retained a team led by Korve Engineering, Inc., to conduct research with an overall objective to improve the safety of light rail transit (LRT) operation in shared right-of-way where light rail vehicles (LRVs) operate on, adjacent to, or across city streets at low to moderate speeds [about 55 km/hr (35 mph) or less]. Another objective of this research project is to develop material for inclusion into a new light rail–highway grade crossings part of the *Manual on Uniform Traffic Control Devices* (MUTCD). The title of TCRP Project A-5 is Integration of Light Rail Transit into City Streets. Hans Korve, President of Korve Engineering, Inc., served as the Principal Investigator. Subconsultants were Herbert Levinson, Senior Transportation Consultant; the Institute of Transportation Studies at the University of California, Berkeley; and Applied Management and Planning Group, Los Angeles.

The Korve Engineering research team in association with TCRP selected 10 transit properties across the United States and Canada at which extensive operational and accident analysis was conducted. The 10 LRT systems were chosen on the basis of experience with LRT operation in shared right-of-way where LRVs travel at or below 55 km/hr. The LRT systems surveyed were in Baltimore, Boston, Buffalo, Calgary, Los Angeles, Portland, Sacramento, San Diego, San Francisco, and San Jose.

For each LRT system, the research team interviewed representatives from light rail operations, light rail safety, light rail engineering, and light rail planning and from the local jurisdiction's (city or county) traffic engineering department. Following a structured interview guide developed by the research team, key safety issues, problem locations and alignments, and effective or ineffective traffic control devices (active and passive signs, pavement markings, traffic and LRT signals, pedestrian crossing treatments, etc.) were discussed. In addition to this structured interview process, the research team videotaped each system from the forward cab of an LRV to inventory traffic control devices currently being used. At-grade crossings, including cross streets and driveways, and problem locations were also video inventoried.

In addition to the on-site interviews and surveys at each of the 10 transit properties, the research team examined publications regarding the integration of light rail transit into city streets. It reviewed the extensive LRT operational and accident data collected by the Institute of Transportation Engineers Technical Committee 6Y-37, Guidelines for Design of Light Rail Grade Crossings.

The research team reviewed the video inventory and then analyzed the accident data provided by the 10 LRT systems. Each of the systems provided the research team with accident data, some of which is summarized in Table 1. After analysis of the structured interviews and the video inventories, a detailed accident analysis of problem locations, and an extensive review of ITE 6Y-37 data, guidelines and principles were developed for the integration of LRT into city streets. These principles and guidelines would apply to retrofit and extension of existing LRT systems and to the development of new LRT systems. Thus, they enable systems that are currently in the planning stages to learn from the design, operating, and safety experiences of existing LRT systems.

Principles and Guidelines

Five basic principles should guide the location, design, and traffic controls where LRVs operate on, adjacent to, or across city streets at low to moderate speeds (i.e., 55 km/hr or less). They are, in many respects, an extension of traffic safety engineering principles to LRT.

1. LRT system design and control should respect the urban environment that existed before LRT implementation. Both pedestrians and motorists grow accustomed to their urban environment. LRT systems that operate in these environments should conform, as much as possible, to the pedestrian and motor vehicle crossing needs.
2. LRT system design and control should comply with motorists' and pedestrians' expectations. Designs and controls should reinforce road user behavior; they should strive to minimize alterations in the travel patterns and traffic controls that motorists and pedestrians expect.
3. LRT system design and control should simplify decisions that drivers and pedestrians make as they interact with the LRT system environment. Traffic control devices and roadway geometry should be simple and unambiguous; they should clearly convey information to the motorist or pedestrian about the action to be taken.
4. Traffic control devices that are installed specifically to warn and protect motorists and pedestrians who interact with the LRT system should transmit the level of risk associated with the LRT system environment.
5. Forgiving design should be provided. Designs, controls, and operating practices should provide recovery opportunities for erratic or errant motor vehicle or pedestrian movements.

These five basic principles translate into the following planning guidelines for roadway geometry and traffic control design/selection:

- Unless a specific change is desired (e.g., converting a street to a pedestrian mall), attempt to maintain existing traffic and travel patterns. If travel patterns are changed significantly when LRT is implemented, motorists' and pedestrians' expectations may be violated.
- Where the LRT operates within street right-of-way, design LRT to run in the median of a two-way street. If LRT is designed to operate on a one-way street, LRVs should move in the direction of motor vehicle traffic, and all midblock access points, such as driveways, should be closed. Contraflow LRT operations should be avoided.
- Where the LRT operates within street right-of-way, separate LRT operations from motor vehicles by a more substantial element than striping.
- Provide LRT signals that are clearly distinguishable from traffic signals in design and placement without having to provide supplemental signs.

TABLE 1 Accident Summary for LRT Systems Surveyed

LRT System	Baltimore		Boston		Buffalo		Calgary		Los Angeles		Portland		Sacramento		San Diego		San Francisco		San Jose	
Period	4/92 - 7/94		7/89 - 8/93		2/85 - 11/93		5/81 - 12/93		7/90 - 6/94		FY87 - FY94		11/86 - 2/92		FY82 - FY94		1986 - 1993		7/87 - 12/93	
No. of Years	2.3		4.2		8.8		12.7		4.0		8.0		5.3		13.0		8.0		6.5	
Collision Type	No.	Pct.	No.	Pct. (a)	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct. (b)	No.	Pct.	No.	Pct. (c)	No.	Pct.
Auto turns in front of LRV	55	86%	--	38%	0	0%	208	73%	129	56%	76	41%	--	59%	298	85%	--	27%	106	64%
Auto other	2	3%	--	58%	10	100%	(incl)	(incl)	73	31%	81	44%	--	38%	(incl)	(incl)	--	71%	50	30%
Pedestrian	7	11%	--	4%	0	0%	77	27%	31	13%	27	15%	--	3%	54	15%	--	2%	10	6%
Total	64	100%	97 (d)	100%	10	100%	285	100%	233	100%	184	100%	143	100%	352	100%	1,322	100%	166	100%
Mainline Track Miles (approx.) (e)	24		52		12		35		43		27		34		66		53		35	
Average Accidents per Year per Mainline Track Mile	1.16		1.87		0.09		0.64		1.35		0.85		0.79		0.41		3.12		0.73	

Source: Korve Engineering research team
Interview/survey at the ten LRT systems, Summer 1994

(a) Percentages for highest six accident locations.
(b) Percentages for highest two accident locations.
(c) Percentages for highest three accident locations.
(d) FTA 1992 Section 15 Report Year for FY 1992.
(e) Only includes tracks where LRVs operate in revenue service.

- Coordinate traffic signal phasing and timing near LRT crossings to preclude motor vehicles from stopping on and blocking the LRT tracks.
- Control motor vehicle turns that conflict with LRT operations by means of active standard traffic control devices.
- Provide adequate refuge areas for turning motor vehicle traffic and provide separate turn signal indications to avoid conflicts.
- When left turns can be made across median LRT tracks, provide active, internally illuminated Train Approaching signs at left-turn pockets with arrow indications to warn motorists of the increased risk associated with violations of the traffic signal.
- Create distinct pedestrian crossings by providing adequate refuge/safety areas between roadways and parallel LRT tracks.
- Channel pedestrian flows at crossings and at stations to minimize errant or random pedestrian crossings of the LRT track environment.
- At unsignalized crossings, use pedestrian gates and barriers (pedestrian automatic gates, swing gates, bedstead barriers, Z-crossings) appropriate to the type of LRT alignment and operation to make pedestrians more alert as they cross the LRT track environment. Bedstead barriers and Z-crossings should not be used at single track crossings with two-way LRT operations.
- Maximize the visual impact of LRVs in motion.
- Provide the necessary refuge area to unload and load passengers where LRT street running operations occur.

Traffic Control Devices

These principles and guidelines dictate that uniform traffic control devices be implemented to ensure the safe, orderly, and integrated movement of all traffic, including LRVs. TCRP Project A-5 called for the development of material for potential inclusion into a new light rail transit–highway grade crossings part of the MUTCD. Three highlights of the proposed material for inclusion in the manual are presented here: motor vehicle turning treatments, pedestrian crossing treatments, and LRT signals.

Motor Vehicle Turning Treatments

Motor vehicles that make illegal turns in front of approaching LRVs make up the greatest percentage of total collisions for most LRT systems (52 percent of the total collisions with motor vehicles or pedestrians at the 10 LRT systems surveyed). Moreover, because the motor vehicle door is the only protection for the driver and passengers and the LRV during a collision, turning collisions tend to be relatively severe. These facts indicate that traffic control devices that regulate turns are critical to LRT and general traffic safety.

Where turning traffic crosses a nongated, semiexclusive LRT alignment (an alignment where motor vehicles and pedestrians must cross at designated crossing locations only, for example, at an intersection) and is controlled by turn-arrow signal indications, an internally illuminated warning sign displaying the LRV front view symbol (W10-6a) or LRV side view symbol (W10-6b) should be installed, with a supplementary internally illuminated warning sign displaying the legend TRAIN, per the MUTCD, Part II, Section 2A-13 (see Figure 1). Both signs should flash when an LRV approaches. In this situation, the turn-arrow signal indication serves as the primary regulatory control device and the flashing, internally illuminated warning sign supplements it. The flashing, internally illuminated warning sign warns motorists of the increased risk associated with violating the turn-arrow signal indication. Because this warning sign is not a primary regulatory device and only supplements the primary device, only one flashing, internally illu-

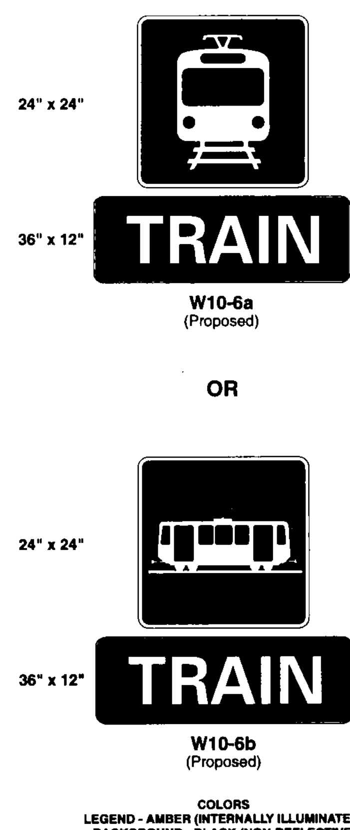


FIGURE 1 Flashing internally illuminated Train Approaching warning signs.

minated warning sign (W10-6a or W10-6b) should be provided for each turning movement. If this warning sign fails, motorists are to follow (*a*) the indication given by the primary regulator device, the left-turn arrow signal indications, and (*b*) the principles set forth in the *Uniform Vehicle Code*, Section 11-801 (Basic Rule):

> No person shall drive a vehicle at a speed greater than is reasonable and prudent under the conditions and having regard to the actual and potential hazards then existing. Consistent with the foregoing, every person shall drive at a safe and appropriate speed when approaching and crossing an intersection or railroad grade crossing.

Where turning traffic crosses a nongated, semiexclusive LRT alignment and is controlled by a stop sign or a signal without a turn arrow, an active, internally illuminated No Left/Right Turn symbol sign should be installed to restrict turns when an LRV is approaching. Because this sign serves as the primary regulatory control device for turning movements, at a minimum, two such symbol signs should be installed for each turning movement at a given crossing. The active, internally illuminated sign displaying the legend No Left/Right Turn may be used as an alternative to the symbol sign.

Instead of these symbol or legend turn signs, an all-red phase for motor vehicles and pedestrians may be used in combination with the No Turn on Red (R10-11a) signs when an LRV is approaching. If this strategy is used, a flashing, internally illuminated warning sign (W10-6a or W10-6b) may also be used to indicate to motorists and pedestrians the increased risk associated with violating the primary control device (the all-red signal indications).

Table 2 further summarizes the recommended practices for the active, internally illuminated No Left/Right Turn symbol sign (regulatory) and the flashing, internally illuminated Train Approaching sign (warning) for median or side-running LRT alignments where parallel traffic is allowed to proceed during LRV movements. As an alternative to the active, internally illuminated signs, as described in Table 2, passive No Left/Right Turn (R3-1,2) signs may be used to prohibit turning movements at all times (whether or not an LRV is approaching the crossing or intersection). However, alternative routes should exist and be clearly indicated by means of signing.

Pedestrian Crossing Treatments

Although collisions between LRVs and pedestrians occur less frequently than collisions between LRVs and motor vehicles (10 percent of the total collisions with

TABLE 2 Use of Active Internally Illuminated Signs for Parallel Traffic Turning Across LRT Tracks

Semi-Exclusive Gated	Stop[2]	Should	May
	Traffic Signal w/o Arrow[3]	Should	May
	Traffic Signal w/Arrow[4]	Not Recommended	May
Semi-Exclusive Non-Gated	Stop[2]	Should	May
	Traffic Signal w/o Arrow[3]	Should	May
	Traffic Signal w/Arrow[4]	Not Recommended	Should

1 Left turn signs are for median and side-running LRT alignments; right turn signs are for side-running LRT alignments only.

2 "Stop" refers to a stop-sign controlled intersection or driveway.

3 "Without Arrow" refers to a signalized intersection where the turning traffic does NOT have a red arrow displayed when a LRV is approaching, but has either a steady green ball, a red ball, or a flashing red ball displayed.

4 "With Arrow" refers to a signalized intersection at which the turning traffic has a red arrow displayed when a LRV is approaching. When a turn arrow traffic signal indication is used, an exclusive turn lane should be provided.

motor vehicles or pedestrians at the 10 LRT systems surveyed), LRV/pedestrian collisions are more severe than LRV/motor vehicle collisions. Furthermore, pedestrians are sometimes not completely alert to their surroundings, and LRVs when operating in a street environment are nearly silent. For these reasons, appropriate pedestrian crossing control systems are critical for LRT safety.

Warning Signs

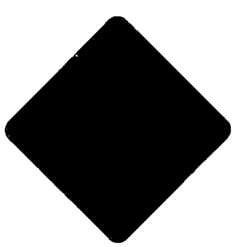
At signalized pedestrian crossings of LRT right-of-way (where pedestrian movements are controlled by pedestrian signals), the primary warning sign should be the Light Rail Transit Crossing (W10-5) sign (see Figure 2). The pedestrian signal is the primary regulatory device; the warning sign alerts the pedestrian of the increased risk associated with violating the pedestrian signal. At unsignalized pedestrian crossings of LRT street running right-of-way where LRT operates two-way, the W10-5a should be the primary warning sign (see Figure 2).

These warning signs should be mounted as close as possible to the minimum height above the ground set by the MUTCD (Part II, Section 2A-23). If these signs are mounted higher than the minimum height specified in the MUTCD [2.1 m (7 ft)], pedestrians often will not see or will simply ignore these signs. When these signs are mounted so that adequate clearance exists between the edge of the sign and the pedestrian travel path [minimum 0.9 m (3 ft) per the MUTCD, Part IX, Section 9B-2], they should be mounted with a minimum height of 1.2 m (4 ft) to better place the sign in the pedestrian's field of vision.

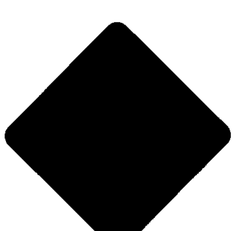
An LRV activated, internally illuminated, flashing sign with the legend Second Train—Look Left (or Look Right) may be used to supplement a W10-5 or W10-5a, to alert the pedestrian that a second (or third, fourth, etc.) LRV is approaching the crossing from a direction that the pedestrian might not be expecting when the crossing is located near an LRT station, track junction, or multiple track alignment (greater than two tracks). When this sign is activated, only one direction is illuminated at any time, Left or Right. Further, only one arrow (to the left of Look or the right of Right) is illuminated at any time: the arrow that points in the direction of the approaching, second LRV (see Figure 3).

Dynamic Envelope

The LRVs dynamic envelope should be delineated in semiexclusive street running, or nonexclusive corridors

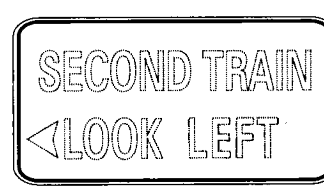


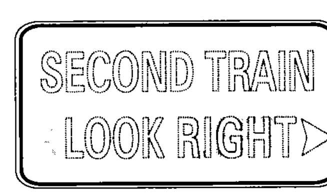
W10-5
(Proposed)
24" x 24"
COLORS
SYMBOL & BORDER - BLACK (NON-REFLECTIVE)
BACKGROUND - YELLOW (REFLECTIVE)



W10-5a
(Proposed)
24" x 24"
COLORS
SYMBOL & ARROW & LEGEND & BORDER - BLACK (NON-REFLECTIVE)
BACKGROUND - YELLOW (REFLECTIVE)

FIGURE 2 LRT crossing signs.





W10-7
(Proposed)
30" x 18"
COLORS
LEGEND - AMBER (FIBER OPTIC ILLUMINATION)
BACKGROUND - BLACK (NON-REFLECTIVE)

NOTE:
Only One Direction is Illuminated at any time.

FIGURE 3 Second Train internally illuminated signs.

at pedestrian crossings. Contrasting pavement texture should be used to identify an LRV's dynamic envelope through a pedestrian crossing. A solid 4-in.-wide line may be used as an alternative. The Americans with Disabilities Act–approved strips can be considered a contrasting pavement texture, and their requirement may supersede the use of painted striping or other contrasting pavement texture. In an LRT pedestrian mall, the dynamic envelope should be delineated in its entirety.

Pedestrian Crossing Configurations

At signalized intersections, pedestrian movements that cross the LRT tracks should be controlled by pedestrian signals displaying the symbols for Walk and Don't Walk. At nongated, unsignalized, pedestrian-only crossings of semiexclusive right-of-way, a flashing light signal assembly [without a crossbuck (R15-1) mounted above the flashing lights] with a W10-5a sign mounted below the flashing lights should be used to warn pedestrians of an approaching LRV. At motor vehicle, gated, LRT crossings without pedestrian automatic gates (described below), a flashing light signal assembly with a crossbuck (R15-1) mounted above the flashing lights and a W10-5a mounted below the flashing lights should be used in the two quadrants without motor vehicle automatic gates. Following the principle of consistent application of signs, the W10-5a sign should also be mounted on a separate post near the pedestrian path in the quadrants with vehicle automatic gates.

In addition to the pedestrian signals, warning signs, and dynamic envelope markings described above, several pedestrian crossing configurations have proven effective in reducing collisions between LRVs and pedestrians. These barriers, and some of the LRT systems where they have been successfully installed, include the following:

- Curbside pedestrian barriers (Calgary, San Diego): Between LRT crossings, curbside barriers (landscaping, bedstead barriers, fences, and/or bollards and chains) should be provided along side-running LRT alignments for contraflow operations or two-way operations along a one-way street. They may be provided for one-way side-running normal flow alignments.
- Pedestrian automatic gates (St. Louis): Pedestrian automatic gates are the same as standard automatic grade crossing gates except the gate arms are shorter. They are used to physically prevent pedestrians from crossing the LRT tracks when the automatic gates are

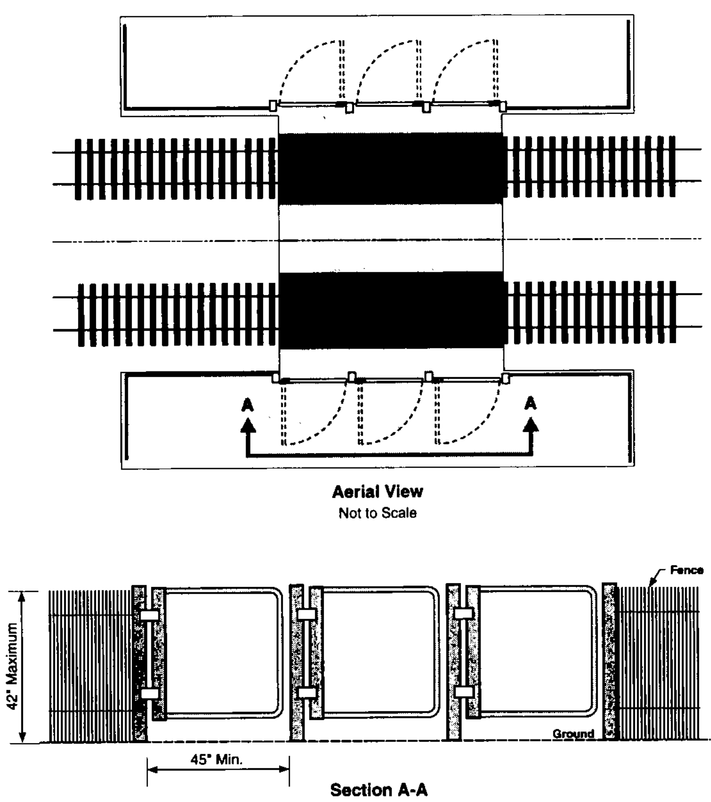


FIGURE 4 Swing gates.

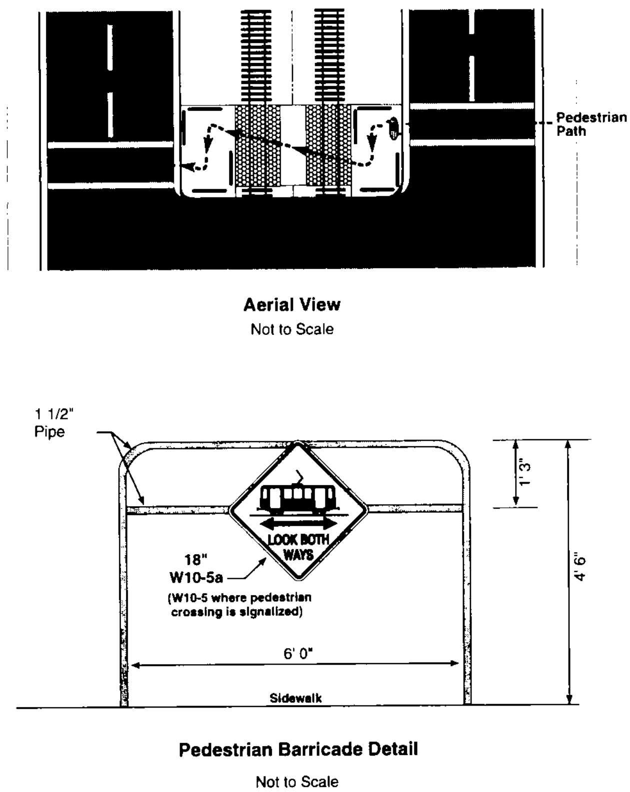


FIGURE 5 Bedstead barriers at LRT crossing.

activated by an approaching LRV. This type of barrier method should be used where the risk of a collision between a pedestrian and an LRV is medium to high. When stopping sight distance is inadequate, pedestrian automatic gates should be used.

The possibility of trapping pedestrians in the LRT right-of-way when four-quadrant pedestrian gates are installed should be minimized. Clearly marked pedestrian safety zones and escape paths within the crossing should be established.

- Swing gates (Calgary, San Jose): The swing gate alerts pedestrians to the LRT tracks and forces them to pause before crossing them, thus acting as a deterrent to running freely across the tracks without unduly restricting exit from the LRT right-of-way. The swing gate requires pedestrians to pull the gate in order to enter the crossing and to push the gate to exit the protected track area; therefore, a pedestrian cannot physically cross the track area without pulling and opening the gate (see Figure 4). The gates should be designed to return to the closed position after passage of the pedestrian. The Los Angeles LRT system plans to install them at various pedestrian crossing locations. Swing gates may be used when LRVs operate either on a single or double track.
- Bedstead barriers (Calgary): The "bedstead" concept may be used in tight urban spaces where the LRT

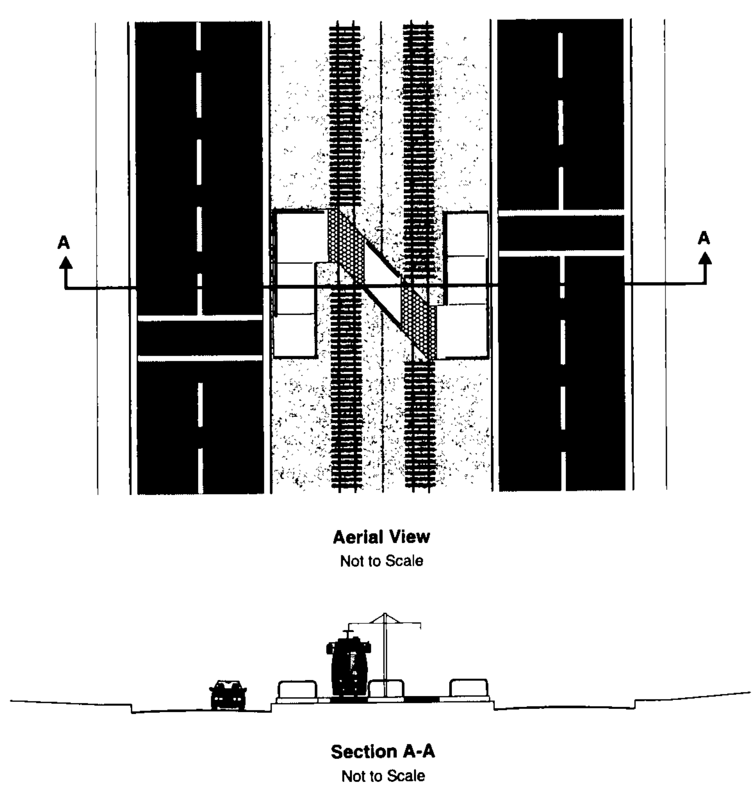


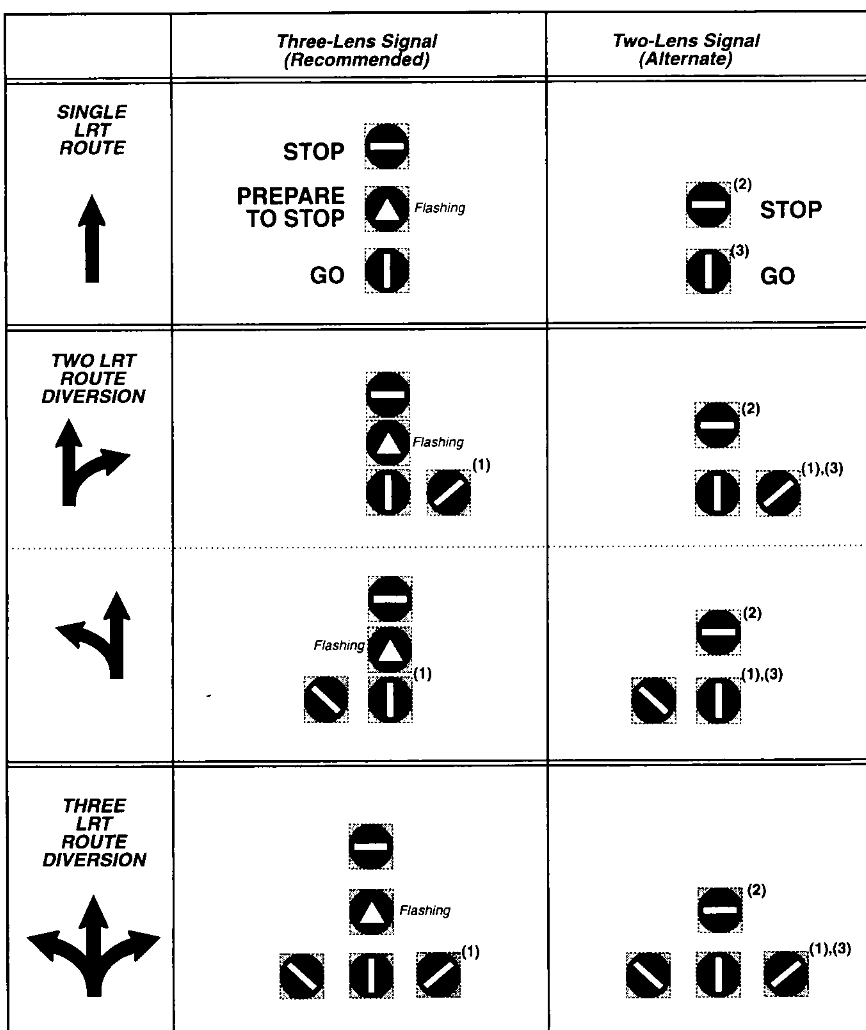
FIGURE 6 Z-crossing channelization.

right-of-way is not fenced in, such as a pedestrian grade crossing at a street intersection. The barricades are placed in an offset (i.e., maze-like) manner that requires pedestrians moving across the LRT tracks to navigate the passageway through the barriers (see Figure 5). They should be designed and installed to turn pedestrians toward the approaching LRV before they cross each track, forcing them to look in the direction of oncoming LRVs. The barriers also provide a safe pedestrian queuing area. Bollards and chains accomplish the same effect as bedstead barriers.

Bedstead barriers may be used in crossings where pedestrians are likely to run unimpeded across the tracks, such as stations or transfer points, particularly where pedestrian risk of a collision with an LRV is low to medium (i.e., excellent to moderate stopping sight distance, double tracking, low pedestrian volume, etc.). Bedstead barriers should not be used when LRVs operate on a single track with two-way operation since pedestrians may be looking the wrong way in some instances.

- Z-crossing channelization (Portland, San Diego, San Francisco): The Z-crossing controls movements of pedestrians approaching LRT tracks. Its design and installation turn pedestrians toward the approaching LRV before they cross each track, forcing them to look in the direction of oncoming LRVs (see Figure 6).

Z-crossing channelization may be used at crossings where pedestrians are likely to run unimpeded across the tracks, such as isolated midblock pedestrian-only



Notes:
All Aspects are White.
(1) Could be in Single Housing.
(2) "Stop" lens used in flashing mode to indicate "Prepare to Go".
(3) "Go" lens used in flashing mode to indicate "Prepare to Stop".

FIGURE 7 LRT signal aspects.

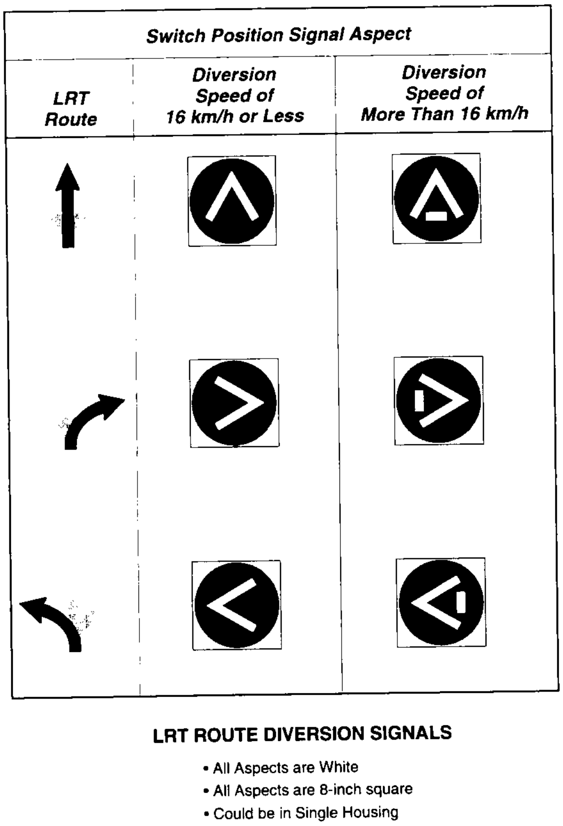


FIGURE 8 Separate signal indications for diversion switch positions.

crossings, particularly where pedestrian risk of a collision with an LRV is low to medium (i.e., excellent to moderate stopping sight distance, double tracking, low pedestrian volume, etc.). Z-crossings used with pedestrian signals create a safer environment for pedestrians than Z-crossings used alone. This type of channelization device may also be used in conjunction with automatic gates in high-risk areas. The Z-crossing should not be used when LRVs operate on a single track with two-way operation because pedestrians may be looking the wrong way in some instances.

LRT Signal Systems

Each of the 10 LRT properties surveyed for TCRP Project A-5 uses different LRT signal aspects and/or configurations (signal housing, color, etc.). For example, the LRT signal aspects range from the standard traffic signal aspect (i.e., the "ball" aspect, found in Boston, Buffalo, and Calgary), the "X" aspect (found in San Francisco), the "T" aspect (found in Los Angeles, Sacramento, San Diego, and San Jose), and the "Bar" aspect (found in Baltimore and Portland). The draft of the new part of the MUTCD addresses LRT signal indications that govern the movement of LRVs while operating on, adjacent to, or across city streets. Because motorists may be confused by the meaning of an LRT signal (e.g., motorists may interpret a green "T" signal that is visible from a left-turn pocket to mean "Turn"), they should have a format and color that are clearly different from conventional traffic signal displays. Where a light rail signal indication could cause motorists to be confused or misdirected, the signal indication should be positioned, shielded, optically programmed, or otherwise designed so that it is viewed exclusively by the LRV operators and not by motorists. The light rail signal indication should convey the intended message to the LRV operator without any supplementary signs (e.g., Trolley Signal sign). It should contrast with vehicular signals in size, shape, color, aspect, and placement.

The size of the LRT signal lenses should be a minimum of 30 cm (12 in.). In tight urban situations where LRVs operate at 40 km/hr (25 mph) or less, 20-cm (8-in.) lenses may be used. The shape of the signal housing should be rectangular (or square) and the color of the signal housing should be dark, preferably black, with a visor for each lens.

In addition to these general guidelines for LRT signal design and placement, the draft details the recommended LRT signal indications. The recommended LRT signal is the monochrome bar system where the Proceed indication is a vertical (or angled for diverging routes and switches) lunar white bar (placed near the bottom of the signal head), and the Stop indication is a horizontal lunar white bar (placed near the top of the signal head). Between the Proceed and Stop indications, a flashing lunar white triangle should be used to indicate Prepare To Stop (see Figure 7). Figure 7 also indicates the allowed alternative to the recommended LRV signal system.

LRT switch position indications (for diversion routes) should be a slanted bar Proceed indication in the standard LRT signal. Where separate signal indications are used for switch positions in street environments, the signal indication should be lunar white and display the arrow aspect [less than 16 km/hr (10 mph) route diverge] or the arrow aspect with a bar [more than 16 km/hr (10 mph) route diverge] (see Figure 8). The size of the signal lenses for LRT switch signals should be a minimum of 20 cm (8 in.) square. The color of the housing should be dark, preferably black, with a visor for each lens.