New Standards for Control of At-Grade Light Rail Transit Crossings

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Guidelines and standards for traffic control devices for at-grade light rail transit (LRT) crossings are needed. With the advent of several new LRT systems in the past decade (Calgary, San Diego, Buffalo, Portland, Edmonton, Sacramento, San Jose, Los Angeles, Baltimore) and more systems planned for the future, LRT systems are no longer isolated in a few areas in North America and need to be governed by a consistent set of standards. Up to this point, each system has been developing its own set of standards for traffic control devices with no uniformity from one city's system to the next or even within cities. This fact was discovered by ITE Committee 6Y-37 (Light Rail Transit Traffic Engineering), when researching the operation of at-grade crossings in various cities. Specifically the committee found that there were inconsistencies or no standards for at-grade crossing warning signs for roadway traffic; vehicle signal types and locations for operators; and midblock-crossing railroad gates, location and type. It was also recommended that a new committee be formed to research and develop guidelines for these traffic control devices. The new committee, ITE Committee 4D-2 (Guidelines for Traffic Control Devices for At-Grade Light Rail Crossings), will survey existing devices used in LRT systems throughout North America and Europe, and recommend a set of guidelines for these devices. It is also the intent of the new committee to have the guidelines adopted by the National Committee on Uniform Traffic Control Devices to create a national set of standards for LRT systems.

No standards exist for traffic control devices at light rail transit (LRT) at-grade crossings with surface streets. Systems from Baltimore to Portland and from San Francisco to Los Angeles have their own sets of standards for light rail vehicle (LRV) signal types, signal placement, the warrants for and placement of railroad gates, and other traffic control devices. ITE Committee 6Y-37, Light Rail Transit Traffic Engineering, has studied the problem and issued recommendations as a first step toward crafting a solution. Also, ITE has formed a new committee, 4D-2, Guidelines for Traffic Control Devices for At-Grade Light Rail Transit Crossings, which is studying a variety of different traffic control devices, to determine which are most appropriate and to develop a set of guidelines for the traffic control devices. The ultimate goal of the new committee is to have the guidelines adopted by the National Committee on Uniform Traffic Control Devices (NCUTCD) and published in the *Manual on Uniform Traffic Control Devices* (*1*).

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NEED FOR GUIDELINES

ITE Committee 6Y-37 researched at-grade operations and light rail systems throughout North America. One of its principal observations was that no standards exist for traffic control devices for light rail crossings. Each system examined, from Philadelphia to Los Angeles to Calgary, has developed its own set of guidelines for traffic control devices over the years. Inconsistencies were found not only within North America but within states (e.g., California), and within cities (e.g., San Francisco). Some examples are described in the following sections.

Why no current set of standards governs LRT crossings is not very apparent and needs to be researched further. In the earlier half of this century, when rail transit systems were more prevalent throughout North America, uniform national guidelines were never established. Thus systems evolved their own sets of guidelines based on their own experiences. After World War II, and throughout the 1950s and 1960s, the use and construction of rail systems declined, and the creation of national standards was probably thought to be unnecessary. In the mid1970s, however, UMTA, made an effort to develop guidelines for LRVs. Unfortunately, this attempt at standardization failed, and funding for the project and development of standards for other traffic control devices was dropped.

CURRENT WORK ON GUIDELINES

Since that experience, no concerted effort at standardization has been attempted—until now. In addition to the new ITE Committee 4D-2, the NCUTCD also has a Railroad Highway Grade Crossing Technical Subcommittee working toward establishing a new LRT section of the traffic control devices manual. This new section would contain standards for traffic control devices for both LRT and motorists for at-grade crossings.

Standards for LRT traffic control devices are clearly needed. Standards would help the public by conditioning expectations at crossings and by presenting a uniform set of clear messages, and would improve overall safety at crossings by making a safer design the standard. Standards would also help reduce costs by allowing economies of scale in design and manufacture of devices. Another highlight of this effort will be resolving the issue of whether to use existing traffic control devices (such as those for heavy rail) or develop an entirely new set of devices solely for LRT (e.g., devices currently being used for LRT systems).

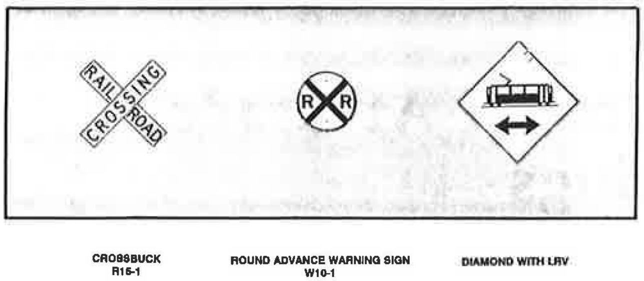


FIGURE 1 LRT grade crossing warning signs.

The ITE Committee 6Y-37's findings on the use of different traffic control devices throughout North America cover three categories of traffic control devices:

- LRT at-grade crossing warning signs for roadway traffic,
- LRV signal types and locations for LRV operators, and
- LRT midblock crossing railroad gates, location and type.

Light Rail Grade Crossing Warning Signs

Presently at least three different types of signs are being used to warn motorists and pedestrians of a light rail crossing (see Figure 1). One is the standard railroad crossbuck (R15-1), another is the round railroad sign (W10-1), and the third is the diamond-shaped yellow warning sign with a representation of an LRV on it. It is clear that there is a need for standardization. NCUTCD has already established a subcommittee to develop standards for other signs and traffic control devices at LRT crossings. This subcommittee is considering recommending that the diamond-shaped yellow warning sign become the standard sign. This is definitely a step in the right direction. The new ITE Committee 4D-2 has begun to work with the subcommittee to help define the problem and develop solutions for the advance LRT crossing warning sign and the many other nonstandard signs that exist.

Signal Types for Light Rail Vehicles

ITE Committee 6Y-37 found that LRT systems throughout North America and Europe used a wide variety of signal aspects, signal types, signal locations, and signal phasing for LRVs. Some systems even used different signals for LRVs along the same line (e.g., MUNI, San Francisco).

The signal type used for LRVs is very important because of the potential for motorists to confuse LRV signals with traffic signals. The signal type refers to the signal aspects, or lenses; the shape of the signal; the size of the signal; the color of the signal lenses; and the size and shape of the housing. Several LRV signals are being used that are very similar to standard traffic signals; other systems use LRV signals that are unlike traffic signals.

In addition to the signal type, the location of the LRV signal is very important. The location must be readily visible to the LRV operator to ensure safe operation of the LRV. However, the LRV signal should not be visible to motorists, especially if the LRV signal could be confused with a traffic signal. The LRV operator, a trained, professional driver, does not need to have LRV signals located with the same visibility criteria as traffic signals. The LRV signals can be located out of sight of the motorists, yet in a conspicuous and consistent location where LRT operators can be trained to expect them.

Signal Aspects

Initial research has shown that several different signal aspects are being used to control the movement of light rail vehicles across at-grade intersections. These range from standard traffic signals to Ts, Xs, bars, and dots. Figure 2 shows a sample of some of the different signal aspects. Colors range from the standard green, amber, red, to lunar white.

As part of the new ITE Committee 4D-2's work, a survey form is being sent to each LRT system throughout North America and Europe to gather more information on, not only the type of signal aspect, but also on the operation record and experience of the signal aspect. Figure 3 is a sample of the survey form. The purpose of the survey is to find out which signal aspect best meets the needs of the LRV operator without providing conflicting information to motorists.

The authors' initial research leads us to believe that the nonstandard traffic signal aspects, such as the lunar white bar, would be least likely to be perceived and misread by motorists. Other signal aspects, such as the T and the X, especially in the traditional green, amber, red colors, could be mistaken by motorists as an arrow or other indication. Because this problem has been experienced by LRT systems, these signals are typically accompanied by a sign, Trolley Signal, in an attempt to lessen the confusion (e.g., Blue Line, Los Angeles).

Signal Size and Shape

In addition to the variance in signal aspects, a similar variance was also found in the signal size and shape, which range from the standard 8-in. and 12-in. traffic signal heads to square and pedestrian signal heads. Some of the different signal shapes are also shown in Figure 2.

As with the signal aspects, the signal sizes and shapes are also being surveyed by ITE Committee 4D-2. Again, the purpose is to find the signal shape and signal aspect that meet the needs of the LRV operator without confusing motorists and that has a good safety record. At this time, the authors think that to lessen potential motorist confusion, the signal size and shape should also not resemble a typical traffic signal head, just as the signal aspect should not be similar. Thus the rectangular signal heads would seem more appropriate.

Signal Location

The last major issue concerning signals that control LRV movements across at-grade intersections is the actual location and mounting of the signal. ITE Committee 6Y-37 found that the location and mounting varies considerably from near-side/

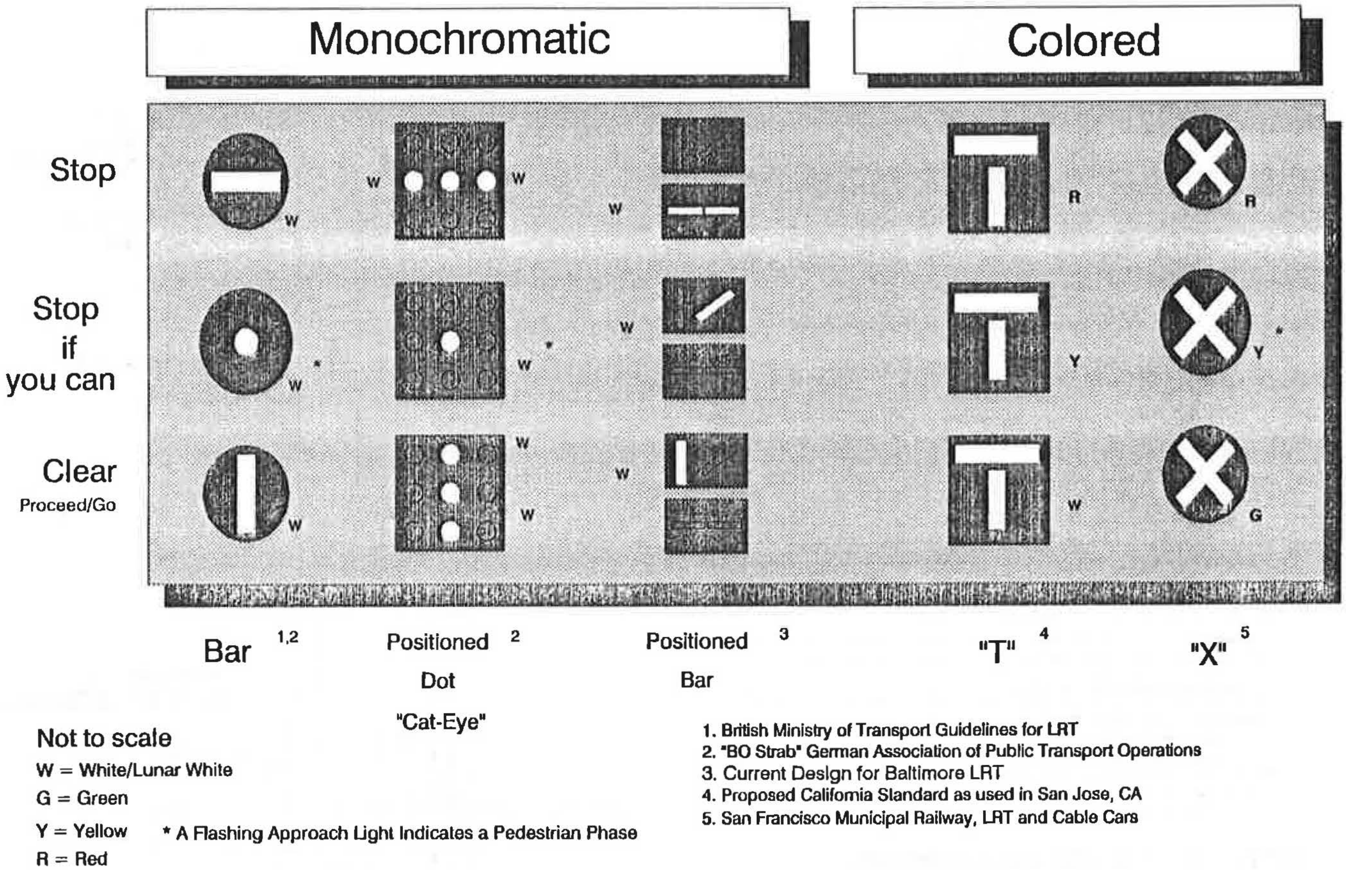


FIGURE 2 LRT signal aspects.

far-side combinations, to far-side only, near-side only, mounted on mast-arms with vehicle traffic signals, pole-mounted separately, mounted vertically, and mounted horizontally to name a few. Some systems locate the signals in a way that treat the LRV operator as an untrained motorist, putting LRV and traffic signals side by side. In fact the ITE Committee 6Y-37 has found inconsistency for different LRT systems to be *the* consistent pattern throughout North America.

The new ITE committee is also surveying LRT systems on signal locations and experiences related to signal locations. Initially the authors believe that the best location for the LRV signal is out of the main viewing area of a motorist. Installing additional signals, some of which may be similar to traditional traffic signals, in plain view of motorists can only cause additional confusion. For example, a typical location would be pole-mounted on the near-side of the at-grade crossing. Near-side LRV signals also help reduce the "creep factor"—LRVs slowly creep into an intersection. Of course, depending on the specifics of the actual crossing, other locations may be more appropriate.

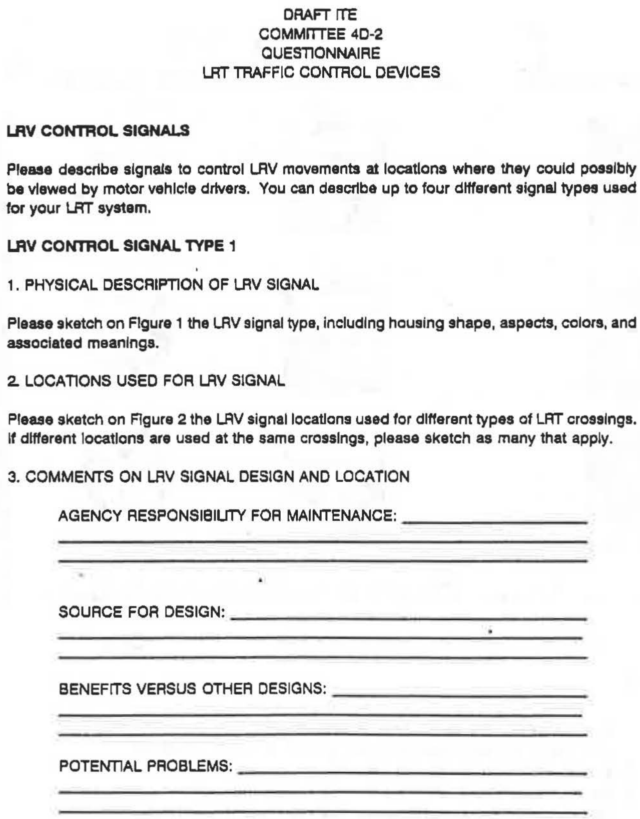
What's Being Used Now

Today, no clear consensus exists as to what is the most appropriate LRV control signal. Both San Jose and Los Angeles are using the T. Portland, following the lead of the European light rail systems, is using the positioned lunar white bar signal in a rectangular frame. Baltimore, which will open soon, is using a similar signal. The San Francisco Municipal Railway is still using the green, yellow, red X. The new Dallas system (DART) is considering using the lunar white bar signal (similar to Portland's). The DART system is in the design stages and will greatly benefit from a consistent set of national guidelines.

Midblock LRT Crossings

From the information gathered from the ITE Committee 6Y-37, several safety-related issues were uncovered related to at-grade midblock LRT crossings. The first issue deals with the protection of pedestrians. The second issue deals with the problem of vehicles driving around gates that are down. Both issues are critical at midblock crossings, because midblock crossings typically have only railroad gates with no traffic or pedestrian signals.

Current design practice for railroad gates calls for flashing lights and gates on the approaches to the crossings. Occasionally older installations may have traffic signals or other devices. The gates are typically located between the sidewalk and the street with the sidewalk areas protected by flashing


DRAFT ITE
COMMITTEE 4D-2
QUESTIONNAIRE
LRT TRAFFIC CONTROL DEVICES

LRV CONTROL SIGNALS

Please describe signals to control LRV movements at locations where they could possibly be viewed by motor vehicle drivers. You can describe up to four different signal types used for your LRT system.

LRV CONTROL SIGNAL TYPE 1

1. PHYSICAL DESCRIPTION OF LRV SIGNAL

Please sketch on Figure 1 the LRV signal type, including housing shape, aspects, colors, and associated meanings.

2. LOCATIONS USED FOR LRV SIGNAL

Please sketch on Figure 2 the LRV signal locations used for different types of LRT crossings. If different locations are used at the same crossings, please sketch as many that apply.

3. COMMENTS ON LRV SIGNAL DESIGN AND LOCATION

AGENCY RESPONSIBILITY FOR MAINTENANCE: ______

SOURCE FOR DESIGN: ______

BENEFITS VERSUS OTHER DESIGNS: ______

POTENTIAL PROBLEMS: ______

FIGURE 3 ITE Committee 4D-2 questionnaire.

lights. Some systems locate the railroad gates behind the sidewalk, in which case the railroad gates serve as a physical barrier for the automobile approach as well as the sidewalk in one direction. The Blue Line in Los Angeles does not have gates across the sidewalks but does use pedestrian signals. The RT light rail system in Sacramento has the gates located behind the sidewalks (see Figure 4).

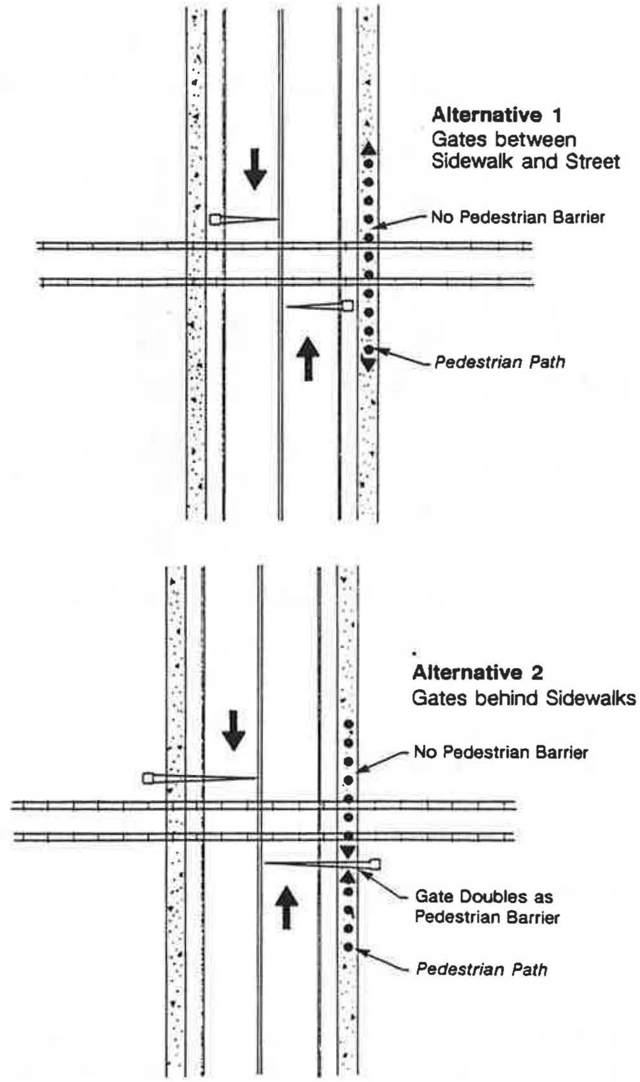


FIGURE 4 LRT gates at midblock crossings.

Pedestrians

As can be seen in the examples displayed in Figure 4, the railroad gates, depending on how they are located, do not provide a barrier to prohibit pedestrians from crossing the tracks while the gates are down. Alternative 1 provides no protection, whereas Alternative 2 provides protection in one direction but not both. Other than the flashing red lights intended to warn vehicles, pedestrians have no direct barrier or symbol warning them not to cross the tracks. Depending on the volume of pedestrians at the crossing special measures may be needed. In Palo Alto, California, a pedestrian accident with a commuter rail train prompted the California Public Utilities Commission to reverse an earlier position and recommend installation of pedestrian gates (*2*).

A possible solution to the problem would be to add a short railroad gate for the sidewalk only, as shown in Figure 5, Alternative 1. With the addition of fencing, and the other railroad gates located behind the sidewalk, pedestrians would be faced with a physical barrier to prohibit dangerous crossings. Other potential solutions include four-quadrant gates or special pedestrian signals that are activated along with the railroad gates. Some European systems even go so far as hanging "skirts" from the gate arms to discourage pedestrians from circumventing the gates.

One potential problem with four gates is trapping pedestrians or vehicles within the crossing. However, by sequentially lowering the upstream (near-side of the crossing) gate first and then the downstream gate, this entrapment problem can be lessened.

Note that the design of the fencing is also important. The diagram in Figure 5 indicates the fencing height at 3 ft. Fencing higher than 3 ft tends to block the view of both motorists and LRV operators, reducing sight distance (e.g., Blue Line, Los Angeles).

The goal for the new ITE committee will be to develop a recommended strategy for protecting pedestrians at midblock crossings, possibly including the establishment of guidelines to install gate arms or pedestrian signals. The guidelines could be based on the volume of pedestrians, the type of area, frequency of LRVs, and other factors. The use of pedestrian signals alone could be a first-step measure with gate arms being added to more critical crossings.

An underlying issue to all this is the actual design of the pedestrian signal—should it be a standard pedestrian signal or should it be a new design with a message referring to the coming LRV—Train Coming/Don't Walk? Another good example of this debate between existing devices and new designs is the advance warning crossing sign. Why create a new sign (the diamond-shaped sign with LRV on it) when all drivers are familiar with the existing round railroad crossing sign (W10-1)? This debate is an important one for the new committee to tackle to limit the already vast array of traffic control devices presented to motorists yet still properly inform and protect the motorists.

Driving Around Gates

A common problem with the exclusive use of a railroad gate to protect the approach to the LRT crossing is that it invites motorists to drive around the gates in the down position (see Figure 6). This is a problem with at-grade LRT and railroad crossings throughout North America. The problem is less serious when the crossing is frequented by slow-moving freight trains, especially trains involved in switching operations. However, with LRT come higher speeds and more frequent train operations. A typical railroad crossing may experience 5 to 10 trains a day, whereas a light rail crossing may experience that many trains in an hour. The problem gets worse when a train in one direction is followed very closely by a train in the other direction and the gates stay down. Motorists and pedestrians get lulled into thinking that after the first train has passed and the gate does not rise, the gate has malfunctioned and it is safe to drive around the gate. Such maneuvers can lead to serious accidents. The Blue Line in Los Angeles experienced two of these drive-around-the-gates accidents in late 1990. Both accidents involved drivers circumventing lowered gate arms only to be hit broadside by an LRV. The results of one of the accidents are shown in Figure

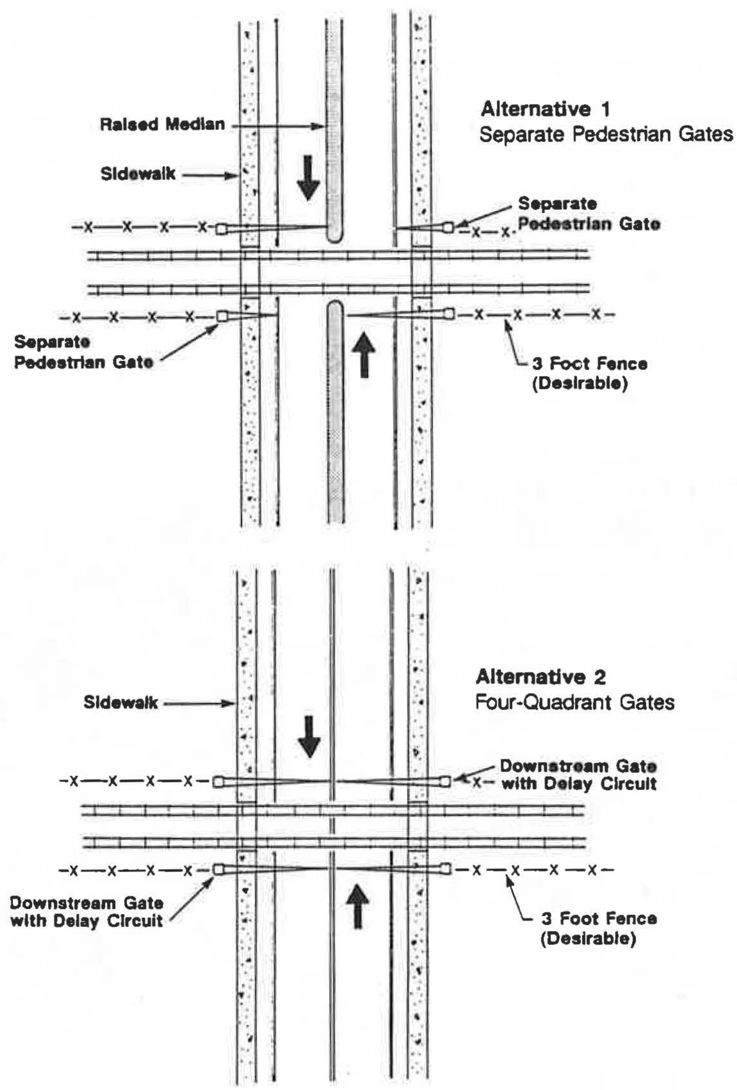


FIGURE 5 Proposed guidelines for LRT gates at midblock crossings.

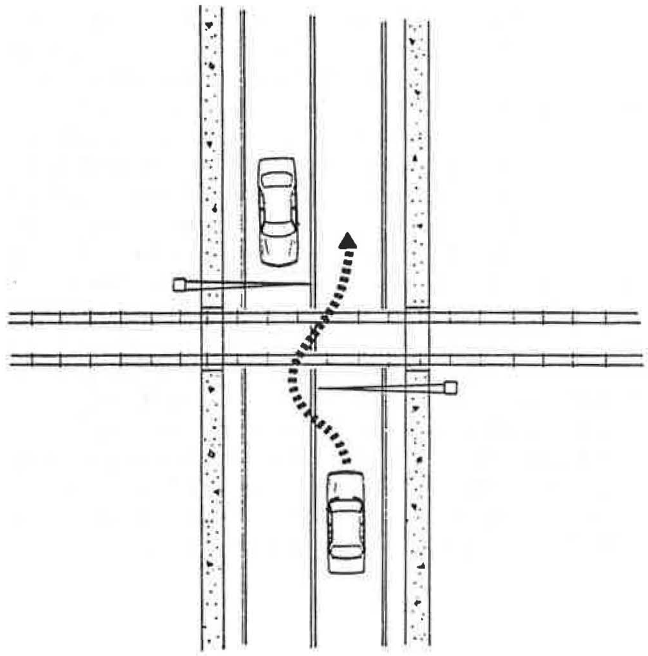


FIGURE 6 Automobile driving around lowered crossing gates.

7. In all, the Blue Line has experienced collisions with 37 vehicles in its first year and a half of operation.

Several solutions to this problem are possible. One is to install a median on the approach to the rail crossing as shown in Figure 5, Alternative 1. The median would physically prevent motorists from driving around the gates in the immediate vicinity of the approach. Circumventing the median would require either driving over the raised curb or driving around the median at an upstream opening. But constructing a median may require widening the street and it may require acquisition of some right-of-way.

Another way to solve the problem is to completely seal off the crossing. This typically requires a minimum of four gates, two for each side of the street on each side of the crossing, as illustrated by Figure 5, Alternative 2. This approach is commonly used in Europe with great success. A concern of the FRA is that vehicles or pedestrians may become trapped. This problem can be minimized by the sequential lowering of the railroad gates. The upstream railroad gate closes several seconds before the downstream railroad gate. With such an installation, the crossing, including the sidewalks, is completely closed during the train movements. Violation would require a driver to crash through the gates. A further refinement frequently used in Europe is to attach a skirt to the bottom of the gates and to fence off the rail right-of-way sealing off the crossing to anyone unless they climb over the fence or over the gate.

The use of the median to seal off the crossing completely is being used in Dallas by DART to make the at-grade crossings of the planned system as safe as possible. At one location where right-of-way is limited, the large Texas-style buttons (large raised pavement markers made of metal that act as a barrier to crossing over the double yellow line) will be used instead of a median. DART is monitoring the results of a safety study by the Los Angeles County Transportation Commission of the accident experience on the Blue Line to help make DART decisions. The ITE committee is planning

Caught on the Tracks

THOMAS KELSEY / Los Angeles Times

The driver of this car was critically injured when he apparently drove around lowered gates and was hit by a Long Beach-bound Blue Line commuter train at Willowbrook Avenue and Elm Street in Compton. The accident occurred at 5:35 a.m. Thursday.

FIGURE 7 Results of driving around lowered crossing gates.

to deal with this issue and develop recommendations by mid-1992.

ITE COMMITTEE 4D-2 GUIDELINES

As mentioned earlier, one of the principal recommendations of ITE Committee 6Y-37 was to establish a new committee to develop standards for traffic control devices at LRT crossings. ITE Committee 4D-2 has been formed to do just that. Its charge is to develop guidelines for traffic control devices controlling light rail crossings. Specifically, the committee is focusing on developing guidelines for LRT crossing warning signs for roadway traffic, guidelines for LRV signal types and location, and guidelines for the location of railroad crossing gates at midblock at-grade crossings.

The Committee is surveying the different LRT systems throughout North America to determine what is being used. The survey is also gathering the operational experience of each of the devices, including the effectiveness, safety, and potential problems. The second step for the committee will be to categorize the devices, and evaluate the experiences of each device type. The final step will be to develop recommended uniform guidelines for the devices and have the guidelines adopted as standards by NCUTCD.

CONCLUSION

With the advent LRT in the past decade—expansions of existing systems and more new systems being planned—the development of standards for LRT traffic control devices is an important task. ITE Committee 4D-2 will tackle this task with the goal of improving the safety and smooth operation of LRT systems throughout North America by providing a uniform set of guidelines.

REFERENCES

1. *Manual on Uniform Traffic Control Devices*. FHWA, U.S. Department of Transportation, 1988.
2. *General Order No. 143, Rules for the Design, Construction, and Operations of Light Rail Transit Systems Including Streetcar Operations*. Public Utilities Commission of the State of California.

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