Highway-Rail Grade Crossing Design

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Public Utilities Code

- California Public Utilities Commission (CPUC) derives authority from the state's Public Utilities Code
  - 1201-1205: Public Railroad Crossings
  - 7537, 7538: Private Railroad Crossings
  - 99152: Transit Rail Systems

Three E's

- Education
  - Operation Lifesaver
- Enforcement
  - Railroad police
  - Local law enforcement
- Engineering

General Orders

- CPUC establishes General Orders specifying rules and regulations
  - GO 26-D: Minimum Clearances
  - GO 72-B: Crossing Surface Maintenance
  - GO 75-D: Standard Warning Devices
  - GO 88-B: Modification of Rail Crossings
  - GO 135: Blocked Crossings
  - GO 145: Crossings Exempt from Stop Req's

When To Contact CPUC

- CPUC authorization required for:
  - Change in type of warning devices at public crossings
  - Modifications to roadway (widening, striping, sidewalks)
  - New crossings (at-grade and grade-separations)
- Authorization process
  - GO 88-B: Staff authorization of modifications
  - Formal Commission authorization

Guidance Documents

- FHWA Railroad-Highway Grade Crossing Handbook – Revised Second Edition, August 2007 (“**FHWA Handbook**”)
- FHWA Technical Working Group: Guidance on Traffic Control Devices at Highway-Rail Grade Crossings, 2002 (“**TWG Guidance**”)
- AASHTO Policy on Geometric Design of Highways and Streets (“**Green Book**”)
- **TCRP Report 17**: Integration of Light Rail Transit Into City Streets
- **TCRP Report 69**: Light Rail Service – Pedestrian and Vehicular Safety

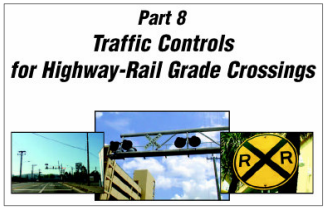
Diagnostic Review

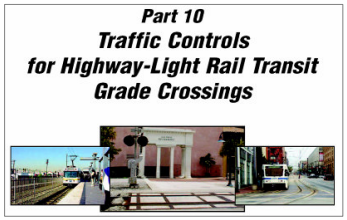
- Field review of crossing & proposed modifications
  - Diagnostic Team: CA MUTCD Section 8A.01
  - Representatives of parties of interest (CPUC, Roadway Agency, Rail/Transit)
- Evaluates conditions at crossing to make determinations or recommendations concerning safety needs at the crossing.

California MUTCD

- California Manual on Uniform Traffic Control Devices (CA MUTCD)
- The standard for traffic control devices in California
- FHWA MUTCD amended for use in California
- Published by Caltrans

California MUTCD





Part 4: Preemption

Part 6: Temporary Traffic Control

Crossing Closure

CA MUTCD Section 8A.04:

- If grade crossing cannot be justified **it should be removed**
- Requires traffic control device removal when crossing is eliminated

At-Grade Crossing Elimination

At-Grade Crossing Closure

Grade Separation

Grade Separation

- Eliminates conflicts between trains and vehicles and associated safety hazards
- Eliminates traffic delays
- Improves emergency response
- Eliminates maintenance of warning devices and surface

Grade Separation Planning

- Justification based on costs associated with above items
- Local planning should include:
  - Early right-of-way acquisition
  - Traffic impact fees for new development
- “Section 190”: State funding for grade separation of railroad crossings

Questions?

Planning and Development

- Grade separation planning
- Corridor approach to consolidate at-grade crossings
- Fencing and barriers to prevent access to railroad right-of-way
- Traffic impact fees for crossing safety improvements

Warning Device Elements

Standard Warning Devices

Minimum warning device is a Crossbuck facing each approach to the crossing.

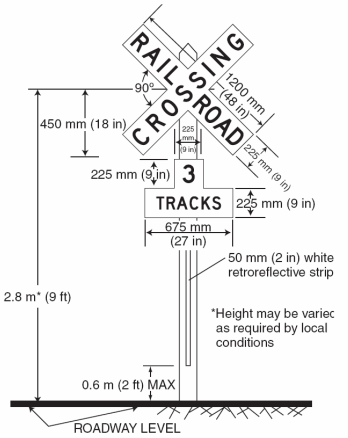
- Standard 1-R: Retroreflective Crossbuck
- Standard 8: Flashers
- Standard 9: Automatic Gate with Flashers
- "-A" suffix (e.g. 8-A or 9-A): Includes overhead flashers on cantilever

Crossbuck

Standard 1 (old)

Standard 1-R (retroreflective)

Crossbuck (Standard 1-R)



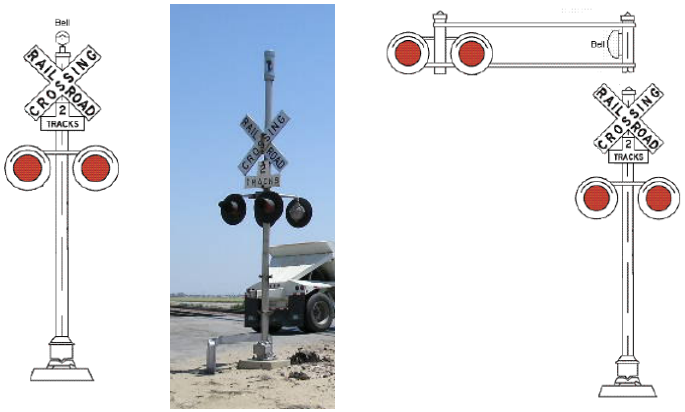
Placement of Crossbuck

- Minimum standard warning device on each crossing approach
- "Passive" device (not train activated)
- Motorists must "Yield" to trains
- Sight lines to approaching trains must be considered closely
- Retroreflective strips on post are required on new installations

Private Crossing Sign

Flashers (Standard 8)

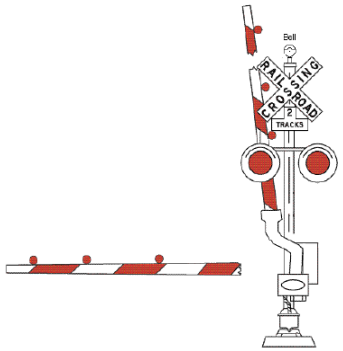
Flashers (Standard 8 / 8-A)



Placement of Flashers

- Equivalent to STOP sign when activated – driver may proceed if safe
- Sufficient sight distances necessary
- Not used at tracks with high speed trains
- May be considered where trailer trucks present gate maintenance problems
- Pedestrian specific applications

Gates (Standard 9)

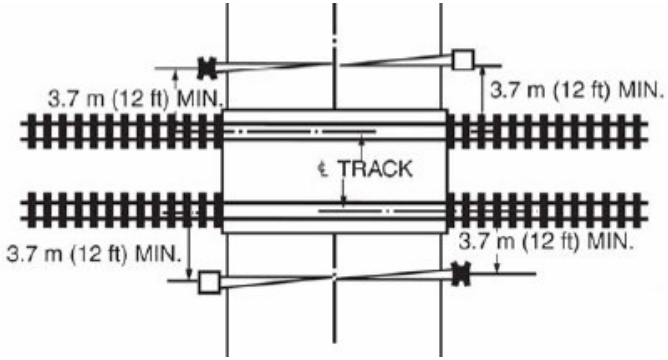


Placement of Gates

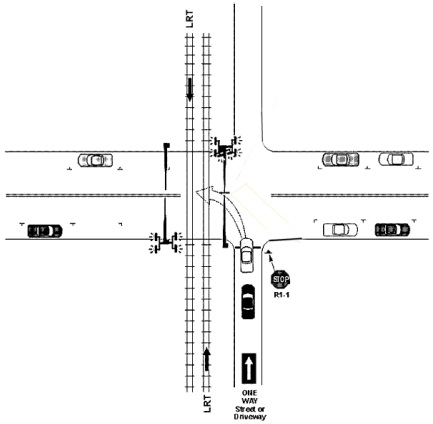
- Generally gates are placed at new or modified crossings where trains travel at greater speeds and/or frequency
- Gates have improved visibility over other warning devices
- Motorists are legally prohibited from driving past an activated gate arm
- Violation of activated gates is a problem

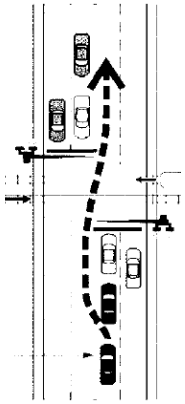
Gates (Standard 9-A)

Exit Gates (Standard 9-E)



Need for Exit Gate



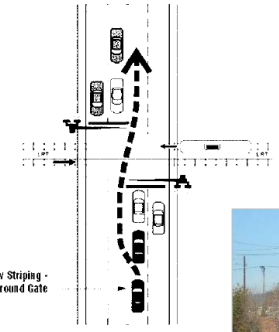


Medians

- Often placed with gates to provide “gated & channelized” design
- Discourages gate drive-around violations
- Inexpensive compared to additional warning devices (such as exit gates)
- Minimum 100-foot length
- May allow median placement of warning devices

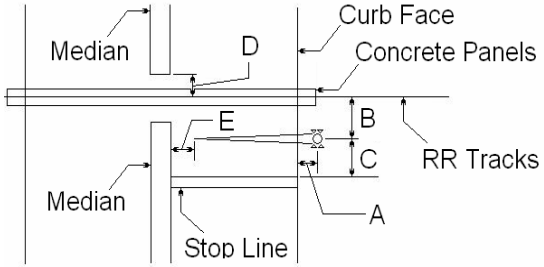
Exit Gates

Need For Medians



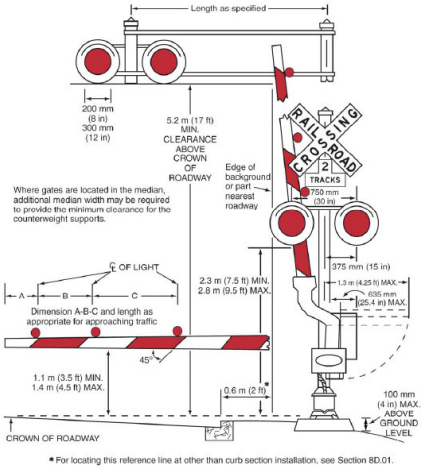
Medians

Clearances



- A: Warning Device CL to Curb Face – 4’ 3”
  B: Track CL to Warning Device CL – 12’
  C: Gate to Stop Line – 8’ (Stop Line must be min 15’ from CL Track)
  D: Track CL to Face of median – 10’
  E: Tip of lowered gate to edge of travel way – 1’
  Not shown: distance between tips of two complimentary gates – 2’

Clearances



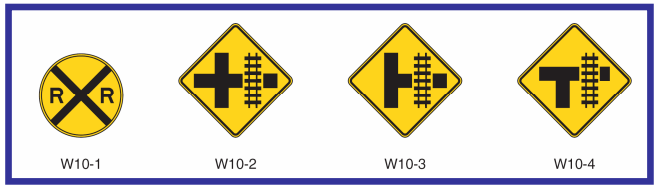
Questions?

Signs and Markings

- Railroad or transit agency maintains the CPUC Standard warning devices (e.g. Crossbuck, Flashers, Gates)
- Other signs and all markings must be placed and maintained by the roadway authority
- Each approach must have advance warning signs, “RXR” markings, and stop line

Advance Warning Signs

- Advance warning signs required on each approach to every crossing (CVC 21362)
- Parallel advance warning signs where <100 feet
- Ensure proper orientation of installed sign
- See CA MUTCD 8B.04 (different than FHWA)



Emergency Reporting Information

- Street name
- Crossing identification number (CPUC and/or DOT)
- Railroad milepost
- Toll-free emergency phone

- Generally posted by railroad on side of railroad equipment box if present, otherwise may be on Crossbuck post

Advance Warning Signs

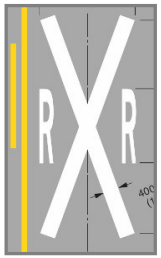
W48(CA)

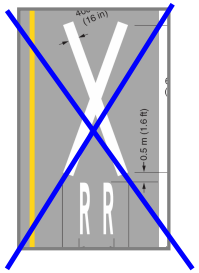
Number of Tracks Sign

•Required below W10-1
•Optional below W10-2, 3, 4

Low Ground Clearance

Advance Markings





Active Advance Warning

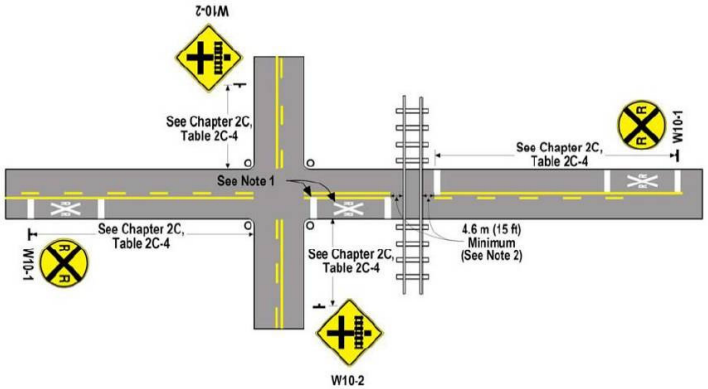
- Supplemental beacons on advance warning signs
- Provides enhanced visibility of advance warning
- May provide early notification of presence of train
- May be helpful with horizontal or vertical curves or fog

Stop Line

- CA stop line changed to FHWA standard
- Single stop line
- 2-foot wide
- Perpendicular to traveled way
- 8-feet in advance of gate
- Staggered if necessary
- Minimum 15-feet from track

Signs and Markings

Signs and Markings



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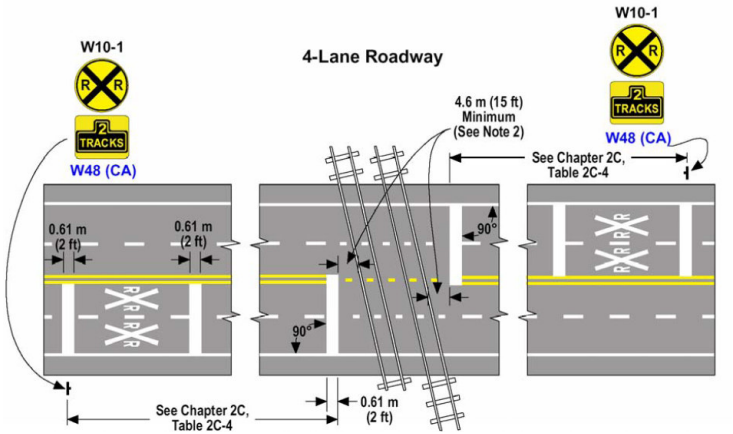


Dedicated Turn Lane

- Dedicated right turn lane onto track must have RXR marking if <50 feet between intersection and track
- W10-2 required if <100 feet between intersection and track

Questions

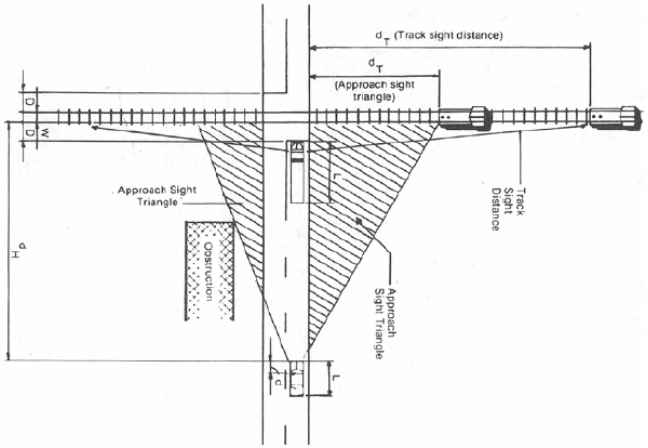
Comprehension of Warning Devices

- Equivalent interpretation
  - Crossbuck = YIELD sign
  - Activated Flashers = STOP sign
  - Activated Gates = Solid Red Traffic Signal
- Motorist comprehension and compliance dependent on education and enforcement

Motorist Perspective

- What information does the motorist need to cross safely?
- Is driver's response to traffic control device appropriate (safe) for the operating characteristics at crossing?
- See FHWA Handbook or AASHTO Green Book for details

Sight Distance Diagram



Stopping Sight Distance

- **Stopping Sight Distance**: Distance along roadway necessary to safely bring a design vehicle to stop prior to track
- Incorporates decision-reaction time
- See AASHTO Green Book

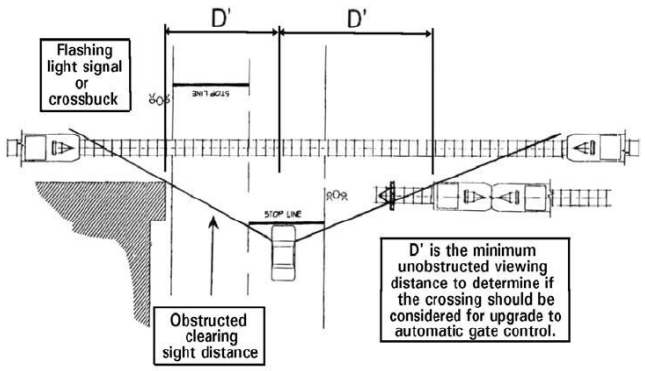
Clearing Sight Distance

- At non-gated crossings, distance along the track from motorist to approaching train necessary to safely clear crossing
- Some vehicles must stop at all railroad crossings. All vehicles must stop at activated flashing light signals.
- Unless gates are present, **motorist must decide** whether it is safe to proceed from a stop based on visibility along tracks.
- See distance tables in FHWA Handbook

Approach Sight Triangle

- **Approach (Corner) Sight Distance**: At passive crossings, this sight distance along the track is necessary to allow approaching motorists to identify an approaching train

Clearing Sight Distance



Warning Device Selection

- Minimum requirements
  - Crossbucks (passive), advance warning signs
  - Crossbucks may be insufficient if appropriate sight distances cannot be obtained
- Consider supplemental passive traffic control
  - STOP or YIELD signs
  - Advisory speed plaque
  - Traffic calming treatments
  - Provide sufficient sight distance through improved roadway geometry or removing obstructions

Warning Device Selection

- Selection of warning devices must consider additional factors other than sight distance
  - Visibility of warning devices
  - Major highways or arterials
  - Heavily used rail corridors
  - Passenger rail service
  - Multiple tracks (second train visibility)
  - Accident history as indicator of safety concern
  - Site specific conditions

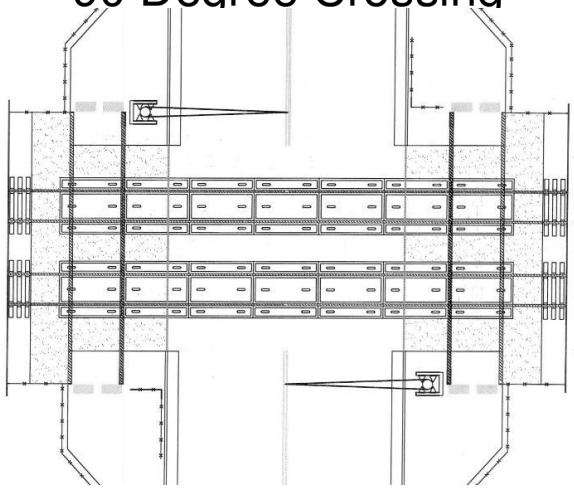
Warning Device Selection

- Active warning devices (train-activated)
  - Where appropriate Approach Sight Distance cannot be obtained
  - Includes Flashers or Gates
- Gates
  - Where appropriate Clearing Sight Distance cannot be obtained

Visibility of Flashers

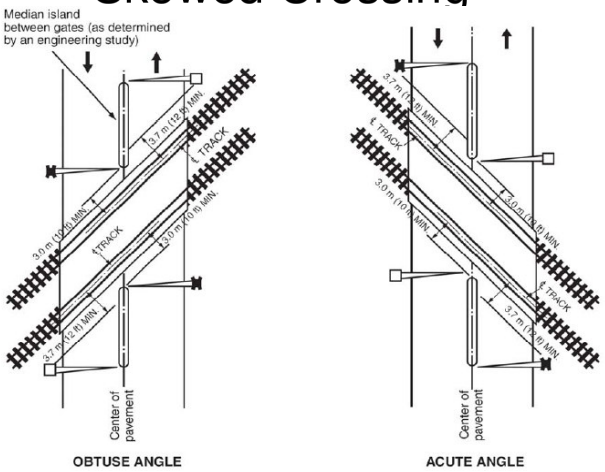
Visibility of Flashers

90 Degree Crossing



Questions

Skewed Crossing

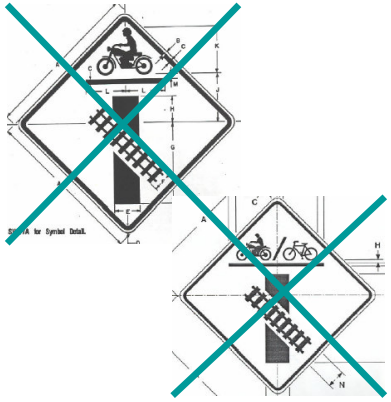


Skewed Crossing

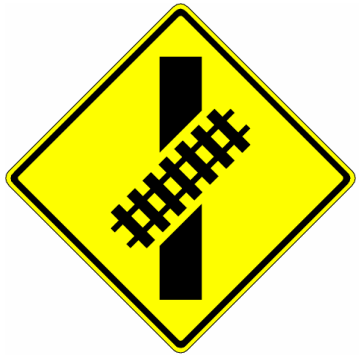
- Gates parallel to tracks can reduce space between gate and track
- Visibility of approaching trains may be more difficult than perpendicular crossing
- Queuing could be more problematic since clear storage distance varies by lane
- Medians may be necessary to fill gap between entrance and exit gates
- Median curb face should be parallel to track

Florence Avenue

Skewed Crossing



DELETE CA Code SW27 signs



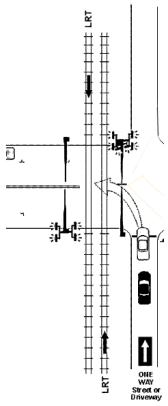
W10-12

USE MUTCD sign

Nearby Intersection

- Turns toward crossing
  - Exit gates are an alternative to address gate drive-around
  - Blank-out turn-prohibition signs
- Queuing problems
  - Limited Clear Storage Distance
  - Stop signs
  - Traffic signals (preemption, pre-signals, etc.)
- Medians may not be feasible

Turn Restrictions During Preemption

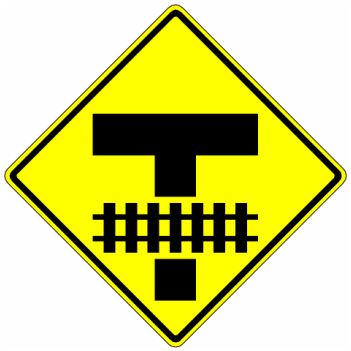


R3-1
Activated Blank Out

R3-2
Activated Blank Out

Limited Clear Storage Distance

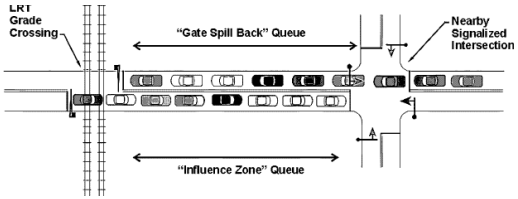
Limited Clear Storage Distance



W10-11

W10-11a

Queuing



Addressing Queuing

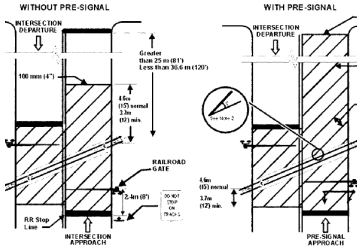
- Traffic signals, pre-signals
- STOP HERE ON RED sign
- DO NOT STOP ON TRACKS sign
- Hatch / KEEP CLEAR markings
- Bus Stop Relocation
- Temporary Traffic Control Zones

STOP HERE ON RED sign

Signalization of Intersections Near Crossings

- Roadway intersections near crossings present special condition where traffic signals should be considered
- Particular concern where STOP sign requires vehicles to queue or stop on track
- Installation of traffic signal may be the best solution to clear motorists from the rail crossing

KEEP CLEAR / Cross-Hatch Markings

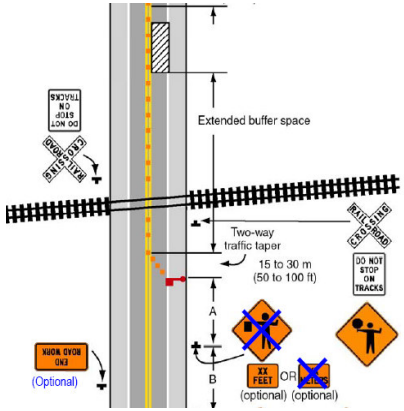


DO NOT STOP ON TRACKS Signs

- Should be placed when engineering judgment determines that potential for vehicle stopping on the tracks is high
- Can be placed on curb and median, near or far side of track

Temporary Traffic Control Zones

- Construction zones near crossing must avoid queuing on the track
- Flagger may be required



Relocating Bus Stops

Stop, Look and Listen Requirements

- Hazardous Materials Vehicles
- Passenger buses
- School buses

Exemption from Stop Requirements

	Before 1/1/78	After 1/1/78	MUTCD Option	
W10-1				R15-1
	W46A (CA)	W10-1a	R15-3	

Pedestrian Considerations

- Utilize “Gated and Channelized” design
- Requires automatic warning devices on all pedestrian approaches
- Audible warning is essential
- Compliance with ADA requirements

Questions?

Gated and Channelized Design

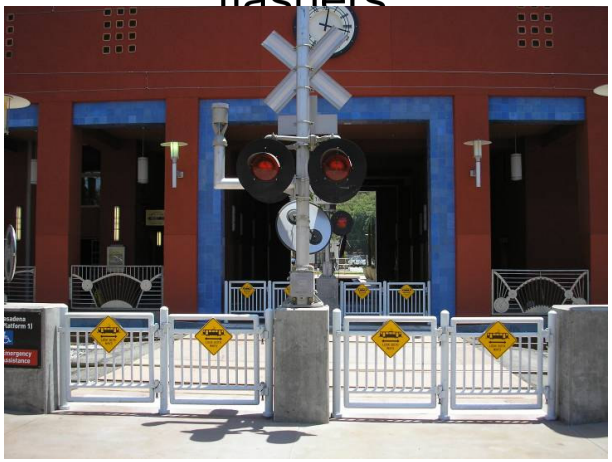
Gated and Channelized Design

- Pedestrian gates across pathway
- Swing gates for emergency exit
- Fencing for channelizing pedestrians to safe crossing location
- Alternative: Combination of swing gates and flashers

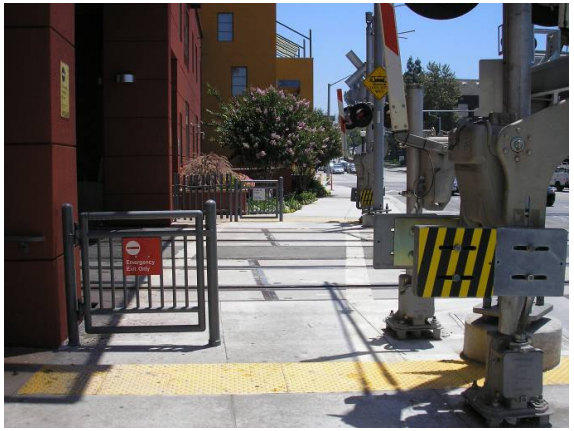
ADA Requirements

- Detectable warning consisting of raised truncated domes provides warning to visually impaired individuals of the presence of a crossing (street or rail).
- Kickplates are useful in assisting individuals in wheelchairs to open swing gates. Kick plates are recommended at all swing gate installations.

Combination of swing gates and flashers



ADA Requirements



ADA Requirements

Grade Crossing Improvement Program (Section 130)

- Funds safety improvements to hazardous grade crossings
- Funds all construction related costs
- Does not fund preliminary engineering

- See CPUC website for details

Questions?

Quiet Zones

- PUC Role
  - Approval required for modifications of crossings (“Supplementary Safety Measures” or SSM)
  - Need for Diagnostic Review at all crossings in corridor (SSM’s, Pedestrian treatments)

Contact Info

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http://www.cpuc.ca.gov/crossings