



PUERTO RICO TRANSPORTATION TECHNOLOGY TRANSFER CENTER
University of Puerto Rico at Mayagüez

Practical Guidelines for Temporary Traffic Control (TTC) at Highway Construction Sites



Instructor

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CONTACT INFORMATION

Seminar Objectives



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1. To provide practical guidelines of the procedures to be followed at temporary highway utility construction sites using Part 6- Temporary Traffic Control (TTC) of the Manual of Uniform Traffic Control Devices (MUTCD).



2. Design and implementation of TTC plans for daytime and nighttime work activities

Topics to be covered: AM



- Overview of the Manual on Uniform Traffic Control Devices (MUTCD), December 2009 Edition, with Revisions 1 and 2 dated May 2012.
- Description of basic definitions (engineering judgment, engineering study, crash worthy, standards, guidance, option and support).
- Liability/tort claims of public work agencies, local municipalities and utility companies associated with negligent acts in highway work zones.
- Description of Part 6-Temporary Traffic Control
- Description of the fundamental components of a Traffic Control Plan (TCP) in a temporary work zone:
 - Advance Warning Area, Transition Area, Activity Area and Termination Area
- Description and typical uses of traffic control devices used in TTC zones (signs, panels, cones, drums, signals, barricades, portable barriers, Truck Mounted Attenuators (TMA), electronic devices, Variable Message Signs (VMS) and Automatic Flagger Assistance Devices (AFAD)).
- Examples of adequate and inadequate use of Temporary Traffic Control (TTC) in highway and utility work zones.

Topics to be covered: PM



- Description of representative Typical Applications (TA), applicable to the Virgin Islands Department of Public Works (VIDPW).
- The role and responsibilities of the flagger in a TTC.
- The requirements for Flagger safety vest.
- The STOP/ SLOW PADDLE: Do's and Don'ts.
- Brainstorming for establishing awareness for the implementation of a Temporary Traffic Control (TTC) in USVI.
- **Workshop:** Development of Traffic Control Plans (TCP) for Temporary Traffic Control (a) Rural; (b) Urban.



Table of Content

- **Module 1** - Importance of Work Zone Safety
- **Module 2** - Federal Regulations Related to Highway Work Zones
 - **Module 2a** - Work Zone Safety and Mobility Rule
 - **Module 2b** - Temporary Traffic Control Devices Rule
 - **Module 2c** - Worker Visibility Rule
- **Module 3** - An Overview to the MUTCD, December 2009 Edition
 - **Module 3a** - Evolution of the MUTCD
 - **Module 3b** - Revisions 1 & 2 (May 2012) to the MUTCD 2009 Edition
 - **Module 3c** – Known Errors in the Original MUTCD 2009 Edition
 - **Module 3d** - Description of Basic Definitions



Table of Content



- **Module 4** - Part 6: Temporary Traffic Control
- **Module 5** - Typical Applications of Activities Associated with TTC
- **Module 6** - Flagger Control
- **Module 7** - TTC Zone Devices
- **Module 8** - Brainstorming for creating awareness of TTC in USVI
- **Module 9** - Examples of adequate/inadequate use of TTC in highway and utility work zones
- **Module 10** - Workshop: Development of a TTC Plan

Module 1



Importance of Work Zone Safety



Temporary Traffic Control in Highway Work Zones

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□ Includes:

- ▣ Road construction
- ▣ Road maintenance
- ▣ Utility works

□ Risks to workers

- ▣ Traffic flow
- ▣ Work equipment and vehicles



Issues of TTC in Highway Work Zones

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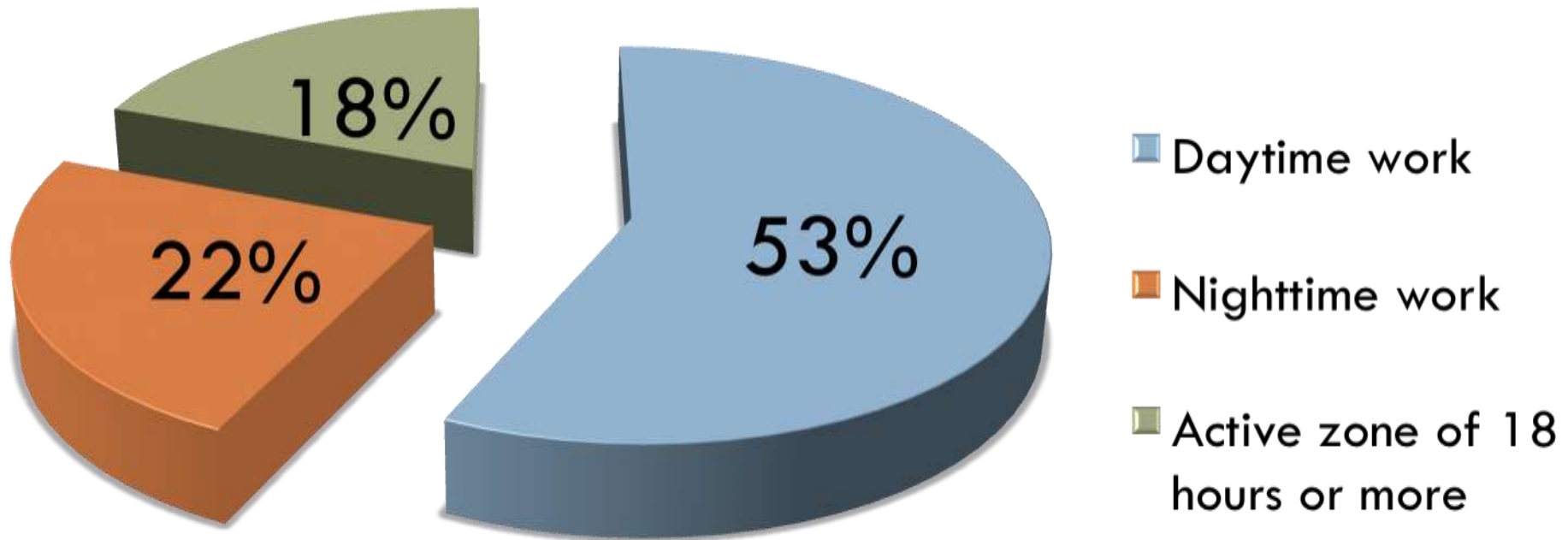
1. **Increase in traffic flow and congestion**
 - ▣ Increase in number of trips higher than increase in roadway miles
2. **Highway quality and level of service in decline**
 - ▣ More construction and repair is needed, resulting in more work zones
3. **More work zones activities under heavy traffic**
 - ▣ Limited work schedules
 - ▣ Increase in nighttime activities
4. **High priority in work zone safety**
 - ▣ 835 fatalities and over 41,000 injured in 2007 (15% pedestrians and cyclists)
5. **Travelers are not happy with work zones**
 - ▣ Unexpected and inconsistent conditions on the roadway cause anxiety and frustration to road users



TTC Activities in Work Zones in USA, 2007

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ON AVERAGE:

1 FATALITY EACH 10 HOURS

1 INJURY EACH 13 MINUTES



1
English

Workers, motorists face different hazards.

- **Struck by motorist**
- **Struck by construction vehicle**
- **Fall from vehicle**
- **Angry motorists**

- Entering buffer or work space as TTCDs are setup or removed
- Merging as lane closes
- Traffic congestion, delays and rear end collisions



What is TORT?



A wrongful act, not including breach of contract or trust, that results in injury to another person's property or the like and for which the injured party is entitled to compensation



Tort: Negligence



- **An act or omission within the scope of the duties of an individual, agency, or organization that leads to the harm of a person or of the public; the failure to use reasonable care in one's actions**
- Miss legal standard of protecting individuals against foreseeable risky, harmful acts of other members of society
- Negligent behavior towards others gives them rights to be compensated for the harm to their body or property
 - ▣ Duty of care
 - ▣ Breach of that duty
 - ▣ Breach causing harm in fact
 - ▣ Breach also causing harm in law
- Can be either criminal or civil in nature



Highway Tort Liability



- States are liable to lawsuits arising from death, injury, or property damage resulting from negligent design, construction, or maintenance of state highway facilities

- Compensation for damages caused by inaction, careless, or negligent actions by state transportation agency employees.







Aspects to Consider in Highway Work Zones



- Type of work activity
- Location and duration (short-term, intermediate-term, long-term)
- Roadway type / functional classification
- Traffic volume
- Speed differential
- Hazard potential
 - ▣ Prevention
 - ▣ Standard of care



Aspects to Consider in TTC in Highway Work Zones

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- Prioritize safety
 - ▣ Road users (pedestrians, disabled persons, drivers, trucks, older users, etc.)
 - ▣ Road crews; training is essential
 - MUTCD
 - Flagger procedures
- Planning and design of Temporary Traffic Control (TTC)
 - ▣ Follow MUTCD
 - ▣ Size, dimensions, colors, message and symbols
- Provide a clear and direct message
- Reduce conflicts with traffic
- Remove unnecessary / not applicable traffic control devices



Module 2



Federal Regulations Related to Highway Work Zones



Module 2a



WORK ZONE SAFETY AND MOBILITY RULE

Title 23 Highways, Chapter I Federal Highway Administration, Department of Transportation

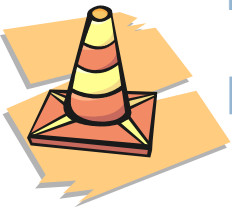
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□ PART 630 - PRECONSTRUCTION PROCEDURES

- ▣ Subpart A - Project Authorization and Agreements
- ▣ Subpart B - Plans, Specifications, and Estimates
- ▣ Subpart D - Geodetic Markers
- ▣ Subpart G - Advance Construction of Federal-Aid Projects
- ▣ Subpart H - Bridges on Federal Dams
- ▣ **Subpart J - Traffic Safety in Highway and Street Work Zones**
- ▣ Subpart K - Temporary Traffic Control Devices



Rule on Work Zone Safety and Mobility



54562 Federal Register / Vol. 69, No. 174 / Thursday, September 9, 2004 / Rules and Regulations

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

23 CFR Part 630

[FHWA Docket No. FHWA-2001-11130]

RIN 2125-AE29

Work Zone Safety and Mobility

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Final rule.

SUMMARY: The FHWA amends its regulation that governs traffic safety and mobility in highway and street work zones. The changes to the regulation will facilitate comprehensive consideration of the broader safety and mobility impacts of work zones across project development stages, and the

Government Printing Office's Web site at: <http://www.access.gpo.gov/nara>.

Background

History

Pursuant to the requirements of Section 1051 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), (Pub. L. 102-240, 105 Stat. 1914; Dec. 18, 1991), the FHWA developed a work zone safety program to improve work zone safety at highway construction sites. The FHWA implemented this program through non-regulatory action by publishing a notice in the **Federal Register** on October 24, 1995 (60 FR 54562). This notice established the National Highway Work Zone Safety Program (NHWZSP) to enhance safety at highway construction, maintenance, and utility sites. In this

FHWA issued a supplemental notice of proposed rulemaking (SNPRM) on May 13, 2004, at 69 FR 26513. The SNPRM addressed the comments related to flexibility and scalability of provisions, eliminated ambiguous terms from the language, and reduced the documentation requirements. We received several supportive comments in response to the SNPRM. Most respondents noted that the SNPRM addressed the majority of their concerns regarding the originally proposed rule. However, they did offer additional comments regarding specific areas of concern. In the final rule issued today, the FHWA has addressed all the comments received in response to the SNPRM that are within the scope of this rulemaking.

The regulation addresses the changing



Overview of Rule



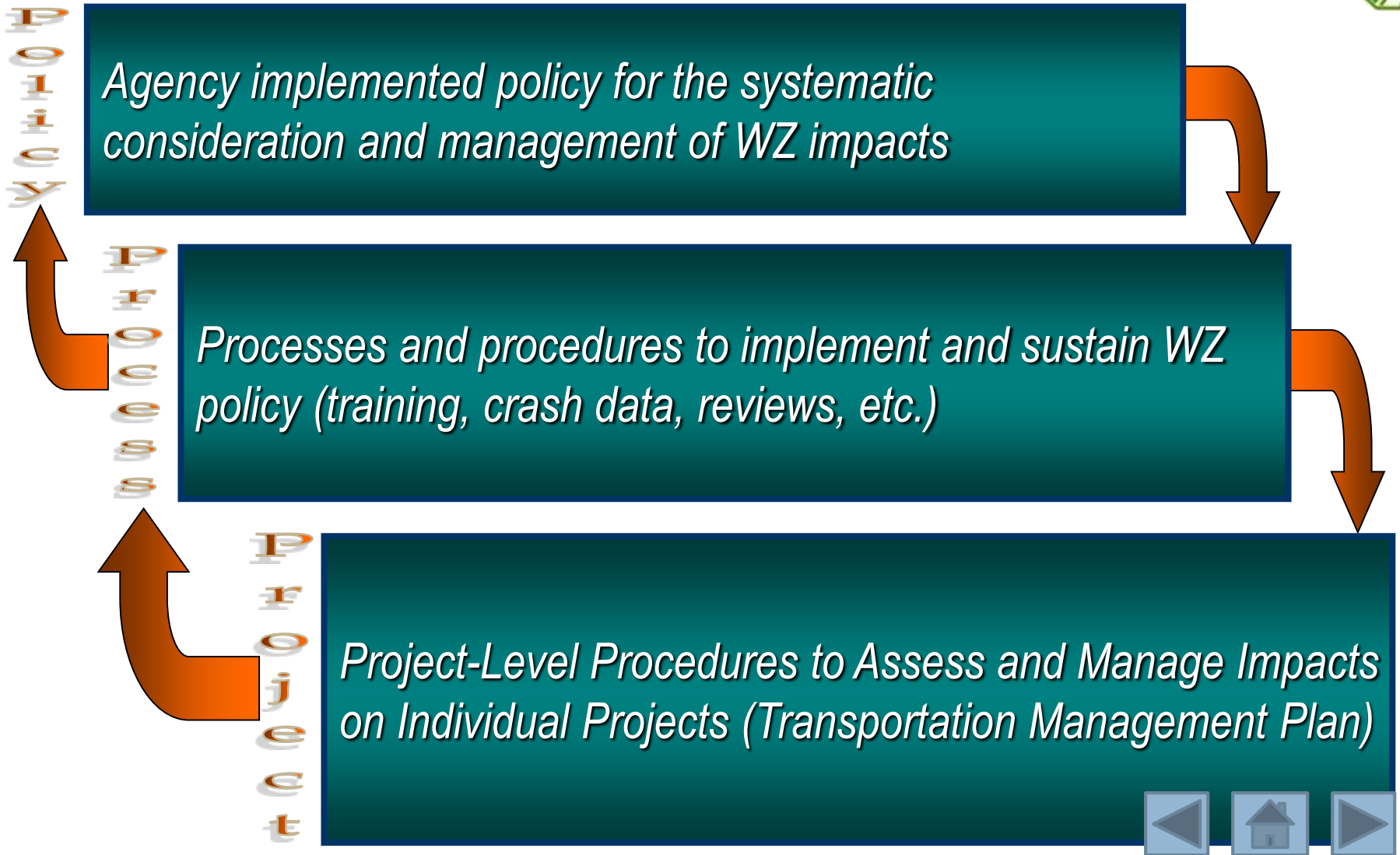
- Establishes requirements and provides guidance for:
 - ▣ Systematically addressing work zone safety and mobility impacts
 - ▣ Developing strategies to help manage these impacts on all Federal-aid highway projects

“Better reflect current needs for improved safety and to minimize disruptions to traffic during the construction of highway projects”

- Timeframe
 - ▣ Published Final Rule on September 2004
 - ▣ Must implement rule provisions by October 2007



Rule Components



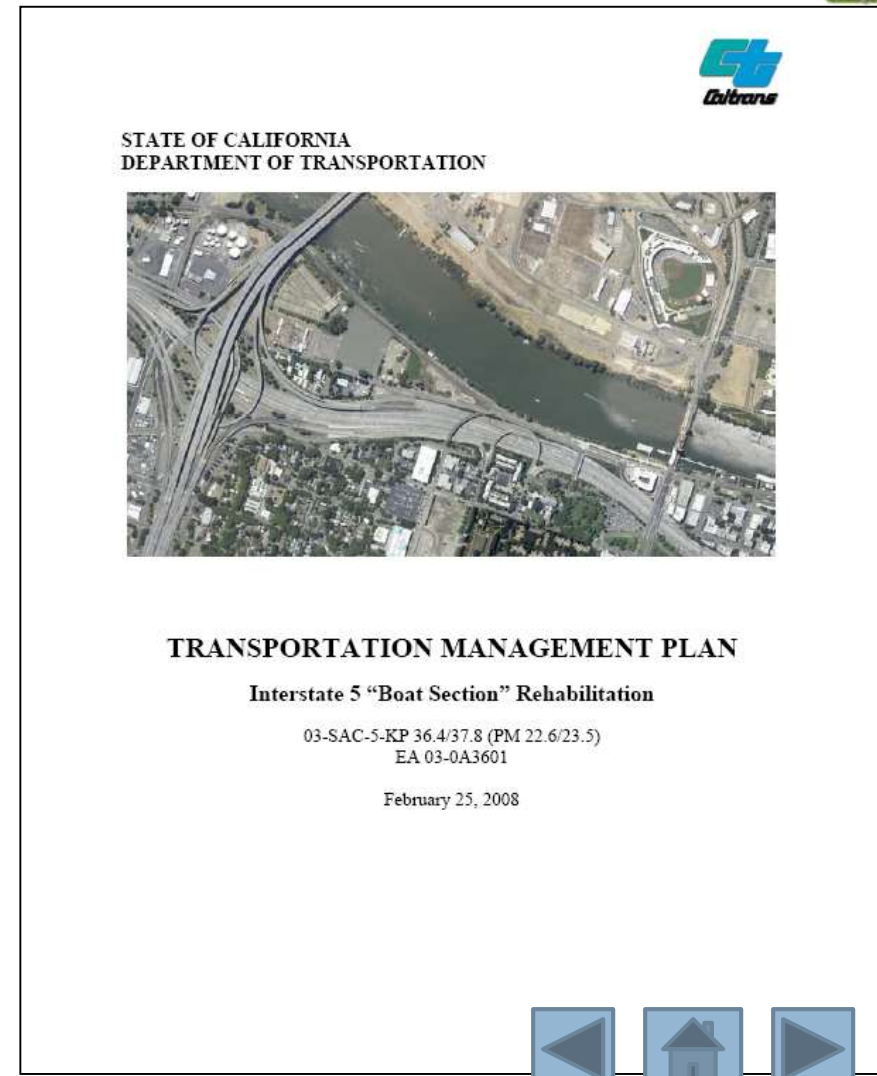
Transportation Management Plan (TMP)

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- Document that includes a series of coordinated transportation management strategies and describes how can be applied to manage the highway work zone impacts.



TMP Components



- A TMP can be a single document or several compiled and coordinated documents & plans
- Must always include a **Temporary Traffic Control** (TTC)
- For significant projects, the TMP should include a **Traffic Operations** component (TO) and a **Public Information** component

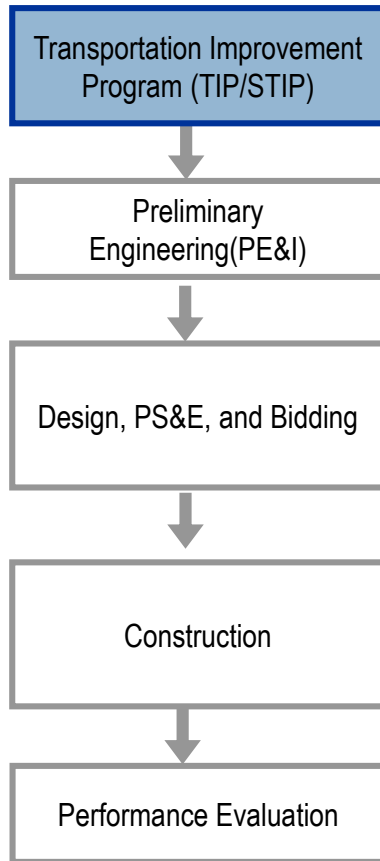
A significant project is one that the agency expects to have a high level of disruption



Transportation Improvement Program (TIP/STIP)

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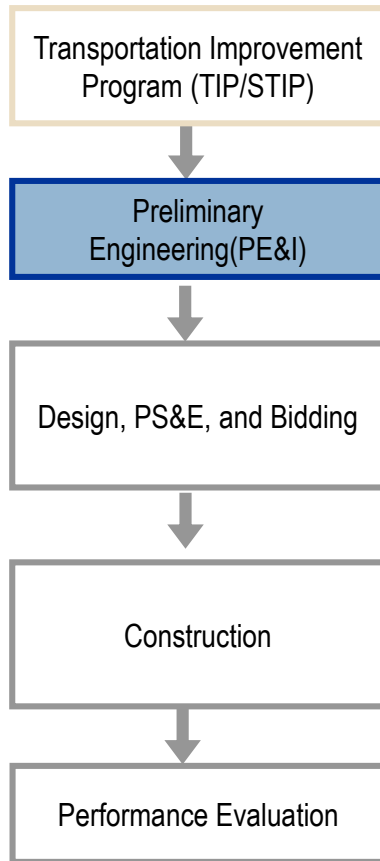


- Early identification of projects that are expected to have significant impacts
- Project development phase

Preliminary Engineering

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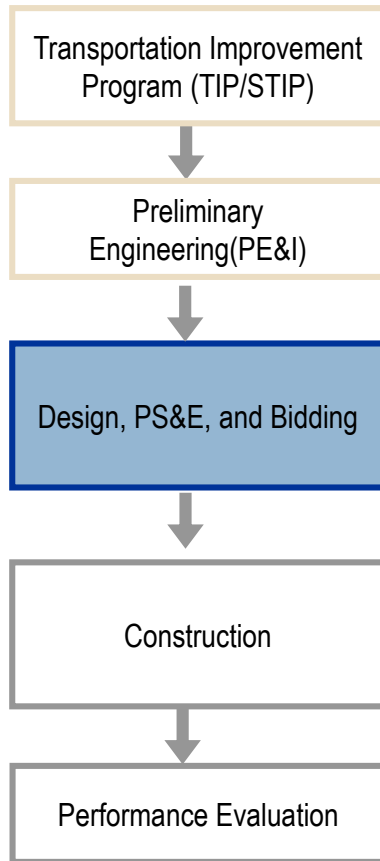


- Identify potential work zone impacts
- Identify potential transportation management strategies
- Identify other coordination issues (utilities, community impacts, etc.)

Design, PS&E, and Bidding

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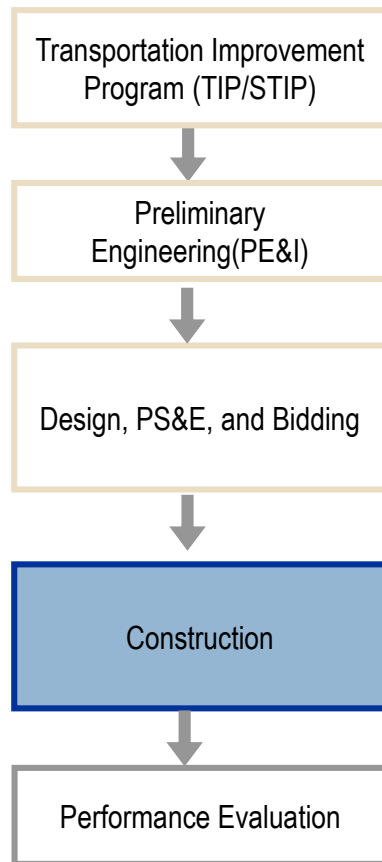


- **Evaluate all impacts**
Consider alternatives for design, construction, contracting, management strategies
- **Develop proper TMP**
Select proper transportation management strategies that help mitigate work zone impacts
- **Include TMP elements in plans, specifications and estimates (PS&E)**

Construction

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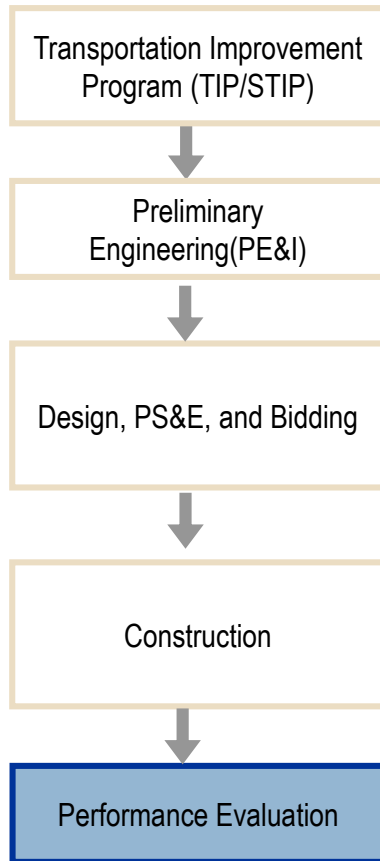


- Implement TMP requirements
- Monitor safety and mobility
 - *Use field observations, crash data and traffic operations information to manage impacts*
- Consult with stakeholders to keep them inform and get their input and knowledge of regional aspects
- Review projects as necessary
- Review TMP if necessary

Performance Evaluation

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- Analyze crash and traffic operation data from multiple projects
- Save data and information that helps to identify improvements in procedures and practices
- Perform a biannual review process
 - Analysis of work zone data and/or project reviews
 - *Improve procedures, data and information resources and training programs*

Module 2b



TEMPORARY TRAFFIC CONTROL DEVICES RULE



Title 23 Highways, Chapter I Federal Highway Administration, Department of Transportation

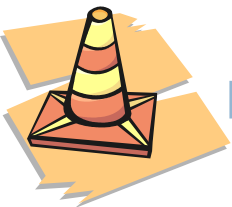
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□ PART 630 - PRECONSTRUCTION PROCEDURES

- ▣ Subpart A - Project Authorization and Agreements
- ▣ Subpart B - Plans, Specifications, and Estimates
- ▣ Subpart D - Geodetic Markers
- ▣ Subpart G - Advance Construction of Federal-Aid Projects
- ▣ Subpart H - Bridges on Federal Dams
- ▣ Subpart J - Traffic Safety in Highway and Street Work Zones
- ▣ **Subpart K - Temporary Traffic Control Devices**



Rule on Temporary Traffic Control Devices - 23 CFR Part 630 Subpart K

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DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

23 CFR Part 630

[FHWA Docket No. FHWA-2006-25203]

RIN 2125-AF10

Temporary Traffic Control Devices

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Final rule.

SUMMARY: The FHWA is adding a new Subpart K to 23 CFR part 630 to supplement existing regulations that govern work zone safety and mobility in highway and street work zones to include conditions for the appropriate use of, and expenditure of funds for, uniformed law enforcement officers, positive protective measures between workers and motorized traffic, and installation and maintenance of temporary traffic control devices during construction, utility, and maintenance operations. These regulations are intended to decrease the likelihood of fatalities and injuries to road users, and to workers who are exposed to motorized traffic (vehicles using the highway for purposes of travel) while working on Federal-aid highway projects. The regulations are issued in accordance with section 1110 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Public Law 109-59, 119 Stat. 1227, codified at 23 U.S.C. 109(e) and 112(g).

DATES: *Effective Date:* December 4, 2008.



Rule Major Aspects



- Supplement to Work Zone Safety and Mobility Policy (Title 23 CFR 630 Subpart J)
- **Purpose:** Reduce worker (and road users) exposure and risk from motorized traffic.
- Applies to Federal-aid projects only; encourages states to use for other projects.

- Publication date: November 1, 2006
- Effective date: December 4, 2008

Rule Components



- A. Positive Protection Devices
- B. Exposure Control Measures
- C. Other Traffic Control Measures
- D. Uniformed Law Enforcement Officers
- E. Work Vehicles and Equipment
- F. Payment for Traffic Control
- G. Maintenance of Traffic Control



Work Zone Policy



- Policy and related processes, procedures, and/or guidance established under Subpart J shall include consideration of road user and worker safety
 - ▣ Use of positive protection devices to prevent intrusions;
 - ▣ Exposure control measures to minimize exposure;
 - ▣ Other traffic control measures to minimize crashes;
 - ▣ Safe entry/exit of work vehicles and equipment onto/from the travel lanes
- Should be based on consideration of standards and/or guidance in the MUTCD and the AASHTO Roadside Design Guide, as well as agency guidelines and project characteristics and factors



A. Positive Protection Devices



- Use shall be based on an engineering study
- Use of positive protection shall be considered where
 - ▣ workers are at increased risk from traffic, and
 - ▣ positive protection devices offer the highest potential for increased safety for workers and road users



Example of Factors and Characteristics to Consider for TCDs

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- Project scope and duration
- Anticipated traffic speeds through the work zone
- Anticipated traffic volume
- Vehicle mix
- Type of work (related to worker exposure and crash risks)
- Distance between traffic and workers, and extent of worker exposure
- Escape paths available for workers to avoid a vehicle intrusion into the work space
- Time of day (e.g., night work)
- Work area restrictions (including impact on worker exposure)
- Consequences from/to road users resulting from roadway departure
- Potential hazard to workers and road users presented by device itself and during device placement and removal
- Geometrics that may increase crash risks (e.g., poor sight distance, sharp curves)
- Access to/from work space
- Roadway classification
- Impacts on project cost and duration



Examples of Conditions that may Warrant Use of Positive Protection

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- ❑ WZs that provide workers no means of escape from motorized traffic;
- ❑ Long duration WZs that result in substantial worker exposure to traffic
- ❑ Projects with high anticipated operation speeds
- ❑ Work operations that place workers close to travel lanes open to traffic
- ❑ Roadside hazards that will remain in place overnight or longer



B. Exposure Control Measures



- Should be considered to avoid or minimize exposure for workers and road users
 - ▣ Full road closures
 - ▣ Ramp closures
 - ▣ Median crossovers
 - ▣ Full or partial detours or diversions
 - ▣ Protection of WZ setup and removal using rolling road blocks
 - ▣ Performing work at night or during off-peak periods
 - ▣ Accelerated construction techniques



C. Other Traffic Control Measures



- Effective, credible signing
- Changeable message signs
- Arrow panels
- Warning flags and lights on signs
- Longitudinal and lateral buffer space
- Trained flaggers and spotters
- Enhanced flagger station setups
- Intrusion alarms
- Rumble strips
- Pace or pilot vehicle
- High quality work zone pavement markings and removal of misleading markings
- Channelizing device spacing reduction
- Longitudinal channelizing barricades
- Work zone speed management (including changes to the regulatory speed and/or variable speed limits)
- Law enforcement
- Automated speed enforcement (where permitted by law)
- Drone radar
- Worker and work vehicle/equipment visibility
- Worker training
- Public information and traveler information
- Temporary traffic signals



D. Uniformed Law Enforcement



- Each agency, in partnership with the FHWA, **shall** develop a policy addressing the use of uniformed law enforcement on Federal-aid highway projects
- The policy may consist of processes, procedures, and/or guidance
 - ▣ Criteria, training requirements, reimbursement procedure, etc.
- Need for law enforcement is greatest on projects with high traffic speeds and volumes, and where the work zone is expected to result in substantial disruption to or changes in normal traffic flow patterns

Sample of Project Conditions for Uniformed Law Enforcement

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1. Frequent worker presence adjacent to high-speed traffic without positive protection devices
2. Traffic control setup or removal that presents significant risks to workers and road users
3. Complex or very short term changes in traffic patterns with significant potential for road user confusion or worker risk from traffic exposure
4. Night work operations that create substantial traffic safety risks for workers and road users



Sample of Project Conditions for Uniformed Law Enforcement

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5. Existing traffic conditions and crash histories indicate a potential for substantial safety and congestion impacts related to the work zone activity, and may be mitigated by improved driver behavior and awareness of work zone
6. Work zone operations that require brief stoppage of all traffic in one or both directions
7. High-speed roadways where unexpected or sudden traffic queuing is anticipated, especially if the queue forms a considerable distance in advance of the work zone or immediately adjacent to the work space



E. Work Vehicles and Equipment

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- Agencies should address safe means for work vehicles and equipment to enter and exit traffic lanes and for delivery of construction materials to the work space, based on individual project characteristics and factors



F. Payment



- Payment for traffic control features and operations **shall** not be incidental to the contract, or included in payment for other items of work not related to traffic control and safety
- Separate pay items **shall** be provided for major categories of traffic control devices, safety features, and WZ safety activities
- For method-based specs, unit price pay items, lump sum pay items, or a combination thereof may be used
- Specs should include provisions to require and enforce compliance with implementation and maintenance of the project TMP and related traffic control items

Module 2c



WORKER VISIBILITY RULE

Worker Visibility Final Rule

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67792 Federal Register / Vol. 71, No. 226 / Friday, November 24, 2006 / Rules and Regulations

g.4. Glass or glass lined (including vitrified or enameled coatings);
g.5. Tantalum or tantalum alloys;
g.6. Titanium or titanium alloys;
g.7. Zirconium or zirconium alloys; or
g.8. Niobium (columbium) or niobium alloys.

h. Multi-walled piping incorporating a leak detection port, in which all surfaces that come in direct contact with the chemical(s) being processed or contained are made from any of the following materials:

h.1. Alloys with more than 25% nickel and 20% chromium by weight;
h.2. Fluoropolymers;
h.3. Glass (including vitrified or enameled coatings or glass lining);
h.4. Graphite or carbon-graphite;
h.5. Nickel or alloys with more than 40% nickel by weight;
h.6. Tantalum or tantalum alloys;
h.7. Titanium or titanium alloys;
h.8. Zirconium or zirconium alloys; or
h.9. Niobium (columbium) or niobium alloys.

i. Multiple-seal and seal-less pumps with manufacturer's specified maximum flow-rate greater than 0.6 m³/hour, or vacuum pumps with manufacturer's specified maximum flow-rate greater than 5 m³/hour (under standard temperature (273 K (0 °C)) and pressure (101.3 kPa) conditions), and casings (pump bodies), preformed casing liners, impellers, rotors or jet pump nozzles designed for such pumps, in which all surfaces that come into direct contact with the chemical(s) being processed are made from any of the of the following materials:

i.1. Alloys with more than 25% nickel and

Dated: November 16, 2006.

Christopher A. Padilla,

Assistant Secretary for Export Administration.

[FR Doc. E6-19825 Filed 11-22-06; 8:45 am]

BILLING CODE 3510-33-P

DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

23 CFR Part 634

[FHWA Docket No. FHWA-2005-23200]

RIN 2125-AF11

Worker Visibility

AGENCY: Federal Highway Administration (FHWA), DOT.

ACTION: Final rule.

SUMMARY: Pursuant to Section 1402 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), this final rule establishes a policy for the use of high-visibility safety apparel. The FHWA establishes a new Part in title 23, Code of Federal Regulations (CFR) that requires the use of high-visibility safety apparel and provides guidance on its application. This rulemaking applies only to workers who are working within the rights-of-way of Federal-aid

comments received may be viewed online through the Document Management System (DMS) at <http://dms.dot.gov>. The DMS is available 24 hours each day, 365 days each year. Electronic submission and retrieval help and guidelines are available under the help section of the Web site.

An electronic copy of this document may also be downloaded from the Office of the Federal Register's home page at: <http://www.archives.gov> and the Government Printing Office's Web page at: <http://www.access.gpo.gov/nara>.

Background

On April 24, 2006, at 71 FR 20925, the FHWA published a NPRM proposing to establish a policy for the use of high-visibility safety apparel for workers who are working within the Federal-aid highway rights-of-way. This NPRM proposed regulations implementing the requirements of Section 1402 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (Pub. L. 109-59; August 10, 2005), which directed the Secretary of Transportation to, within one year, issue regulations to decrease the likelihood of worker injury and maintain the free flow of vehicular traffic by requiring workers whose duties place them on or in close proximity to a Federal-aid highway to wear high-visibility safety apparel.



Worker Visibility Rule

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- *All workers within the right-of-way of a Federal-aid highway who are exposed either to traffic (vehicles using the highway for purposes of travel) or to construction equipment within the work area **shall** wear high-visibility safety apparel*

- Publication date:
November 24, 2006
- Effective date:
November 24, 2008



Representative crash scene



Shortcoming of wearing NO vest!



Pertinent Definitions associated with TTC in Highway Work Zones

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1. Worker: people on foot whose duties place them within the right-of-way of a Federal-aid highway

- ▣ highway construction and maintenance forces
- ▣ survey crews
- ▣ utility crews
- ▣ responders to incidents within the highway right-of-way, including volunteers
- ▣ law enforcement personnel when directing traffic, investigating crashes, and handling lane closures, obstructed roadways, and disasters



Pertinent Definitions associated with TTC in Highway Work Zones (continue)

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2. High-visibility safety apparel: personal protective safety clothing intended to provide conspicuity during both daytime and nighttime usage

- ▣ Meets Performance Class 2 or 3 requirements of the ANSI/ISEA 107-2004 “American National Standard for High-Visibility Safety Apparel and Headwear”

3. Close proximity: within the highway right-of-way of a Federal-aid highway

American National Standards Institute (ANSI)

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- ANSI-107-2004 High visibility garment
(updated 1999 standards)
- International Safety Equipment Association
(ISEA)
 - www.ansi107.org
 - www.safetyequipment.org
 - Phone (703) 525-1695



ANSI/ISEA 107-2004 Requirements

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- Color and minimum areas for retroreflective and background materials
- Minimum washing cycles
- Describe test methods for materials
- Garment Performance Class (PC) 1, 2 and 3
 - ▣ Garment selection shall be based on an assessment of the work environment



Overview of Garment Performance Classes



- **Performance Class 3: PC3**
 - ▣ For use in most severe environments
 - ▣ Offers the greatest amount of fluorescent and reflective coverage
- **Performance Class 2: PC2**
 - ▣ For moderately severe environments
 - ▣ Balance of fluorescent and reflective materials
- **Performance Class 1: PC1**
 - ▣ For low-risk environments
 - ▣ Lowest levels of fluorescent and reflective materials

Variables to Consider in Assessing Risk

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- Speed of traffic through the work zone
- Amount of traffic through the work zone
- Time of day / day or night
- “Background clutter” in the work zone
- Amount of activity in the work zone
 - ▣ Other construction vehicles, etc.
- Type of activity the worker is performing
 - ▣ Where is the worker’s attention?
 - ▣ Towards on-coming traffic or the task at hand?
- Location of work and proximity to traffic and other construction vehicles



Use of Performance Class 3 Garments



- Anyone who has a high task load and is in close proximity to moving equipment or traffic at high speeds
- Highest speed (>50 mph)
- Work occurs at night
- Worker's attention is diverted from on-coming traffic and surrounding environment
- "Cluttered" work zone with high levels of activity
- Worker must be visible from all angles and identifiable as a person
- Worker has no separation between them and traffic



PC 3 Garments

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- Class 3 ensemble
 - ▣ Class 2 vest, Class E bottom

- Class 3 one piece
 - ▣ Jacket
 - ▣ Coat
 - ▣ Torso covering garment with full or partial sleeve



Performance Class 3

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Performance Class 3

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Performance Class 3 - Typical Examples

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- **Roadway construction personnel and flaggers**
- **utility workers**
- **survey crews**
- **emergency response personnel**
- **vehicle assistance personnel**



Use of Performance Class 2 Garments



- Greater visibility needed due to inclement weather conditions
- Complex and cluttered backgrounds
- Most work is performed during daytime hours
- Worker's attention is diverted from on-coming traffic and surrounding environment

Performance Class 2

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Performance Class 2 - Typical Examples



- **Roadway construction workers**
- **Utility workers**
- **Survey crews**
- **School crossing guards in traffic**
- **Delivery vehicle drivers**
- **High-volume parking and/or toll gate personnel**
- **Airport baggage handlers/ground crew**
- **Emergency response personnel,**
- **Law enforcement personnel**
- **Trash collection and recycling**
- **Crash site investigators**



Use of Performance Class 1 Garments



- Worker's attention is fully on oncoming traffic and surrounding environment
- Separation between the worker and traffic
- Not much competition for worker attention
- Controlled environment where driver expects to move very slowly

Performance CLASS 1 - Typical Examples



- Parking lot attendants
- People retrieving shopping carts from parking areas
- Workers exposed to the hazards of warehouse equipment traffic and roadside “right-of-way” or sidewalk maintenance workers
- Applicable to certain delivery vehicle drivers



ANSI 207-2006 Public Safety Vest Standard

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ANSI 207-2006 Standard

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- Understanding that competing hazards exists for public safety employees that also need high visibility garments
 - ▣ Pockets – cannot create gaps in material 1.97 in
 - ▣ Panels-limited to 72 in²
 - ▣ Identification
 - **Fire: red**
 - **Police: blue**
 - **EMS: green**
 - ▣ Tear-away: should be incorporated when applicable



Vest Design Examples

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Assessment of Garment Quality and Wear

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Acceptable



New high-visibility safety apparel is characterized by having vivid color contrast and high reflectivity.

Marginal



Characteristics: Good reflectivity although the vest has some soiling and light fading.

Unacceptable



Characteristics: little or no reflectivity, and soiled and faded material.

Acceptable



Apparel that is used but is in like-new condition is characterized as having excellent color contrast, excellent reflectivity, and is not faded or soiled.

Marginal *



Characteristics: Good reflectivity but has some soiling and light fading of material. *Note: This picture was taken with a flash and simulates nighttime conditions.

Unacceptable



Characteristics: Poor color contrast, low or no reflectivity, significant fading or soiling, and deteriorated reflective strips.



Module 3



An Overview to the Manual on Uniform Traffic Control Devices (MUTCD), December 2009 Edition



With Revisions 1 & 2 of May 2012



Module 3a



Evolution of the Manual on Uniform Traffic Control Devices (MUTCD)



Evolution of the Manual on Uniform Traffic Control Devices (MUTCD)

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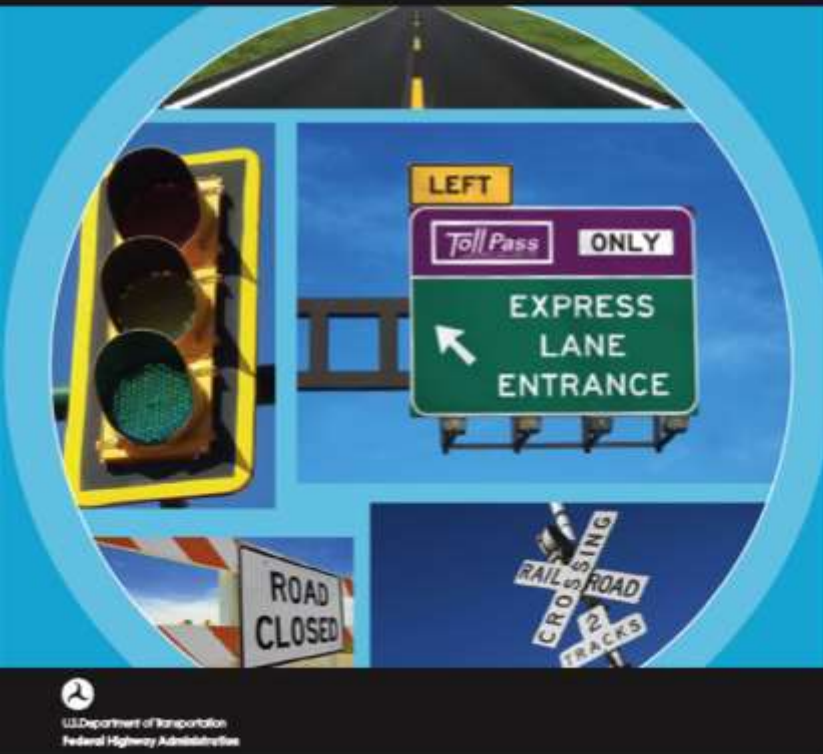
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Including Revision 1 dated May 2012
and Revision 2 dated May 2012



- 1988, 1993, 2000, 2003, November 2004, December 2007 and December 2009
- Two revisions: May 2012
- 23 CFR, Part 655, Subpart F
- ...*national standard for all traffic control devices installed on any street, highway, or bicycle trail open to public travel...*



Parts of the MUTCD, December 2009 Edition

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Introduction

1. General
 - Includes definitions
2. Signs
3. Markings
4. Highway traffic signals
5. Low-volume roads
6. Temporary traffic control (TTC)
7. School areas
8. Railroad and light rail transit grade crossings
9. Bicycle facilities



Application of MUTCD



“... in 1966, the Secretary of Transportation has decreed that traffic control devices on all streets and highways in each State (US territories) **shall** be in substantial conformance with standards issued or endorsed by the Federal Highway Administration.”



Traffic Control Device Defined (MUTCD)



- "...all signs, signals, markings, and other devices used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by authority of a public agency having jurisdiction."



Module 3b



Revisions 1 and 2 of May 2012, to the
*Manual on Uniform Traffic Control
Devices (MUTCD) 2009 Edition*



Last Revisions to the MUTCD 2009 Edition



- The FHWA published the *2009 MUTCD with Revision Numbers 1 and 2 incorporated*, dated May 2012
- Available **ONLY** on Portable Document Format (PDF) in the FHWA's webpage: http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm
 - ▣ See it now!
 - Click here for Revised [PDF version with HOTLINKS](#)
 - Click here for Revised [PDF version without HOTLINKS](#)
 - Click here for the **ORIGINAL** [MUTCD 2009 Ed. PDF version](#)
- The Revision's List is available online ([Click here to see it now](#)).
 - Note: The revisions were made to a few sections of Part 1 and Part 2 of the MUTCD.

How can I identify the revised content in the MUTCD?



- “Note that, in the PDF version of the 2009 Edition of the MUTCD with Revision Numbers 1 and 2 incorporated, a black vertical line and the notation “Rev. 1” or “Rev. 2” in the margin alongside a particular paragraph or table denotes the location of the changes that have been made with Revisions Numbers 1 and 2, respectively.”
 - ▣ As illustrated next!
 - Click here to see the [Revision's List](#).

Manual on Uniform Traffic Control Devices

for Streets and Highways

Changes to
front page



2009 Edition

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and Revision 2 dated May 2012



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Table I-2. Target Compliance Dates Established by the FHWA

2009 MUTCD Section Number(s)	2009 MUTCD Section Title	Specific Provision	Compliance Date
2A.08	Maintaining Minimum Retroreflectivity	Implementation and continued use of an assessment or management method that is designed to maintain regulatory and warning sign retroreflectivity at or above the established minimum levels (see Paragraph 2)	2 years from the effective date of this revision of the 2009 MUTCD*
2A.19	Lateral Offset	Crashworthiness of sign supports on roads with posted speed limit of 50 mph or higher (see Paragraph 2)	January 17, 2013 (date established in the 2000 MUTCD)
2B.40	ONE WAY Signs (R6-1, R6-2)	New requirements in the 2009 MUTCD for the number and locations of ONE WAY signs (see Paragraphs 4, 9, and 10)	December 31, 2019
2C.06 through 2C.14	Horizontal Alignment Warning Signs	Revised requirements in the 2009 MUTCD regarding the use of various horizontal alignment signs (see Table 2C-5)	December 31, 2019
2E.31, 2E.33, and 2E.36	Plaques for Left-Hand Exits	New requirement in the 2009 MUTCD to use E1-5aP and E1-5bP plaques for left-hand exits	December 31, 2014
4D.26	Yellow Change and Red Clearance Intervals	New requirement in the 2009 MUTCD that durations of yellow change and red clearance intervals shall be determined using engineering practices (see Paragraphs 3 and 6)	5 years from the effective date of this revision of the 2009 MUTCD, or when timing adjustments are made to the individual intersection and/or corridor, whichever occurs first
4E.06	Pedestrian Intervals and Signal Phases	New requirement in the 2009 MUTCD that the pedestrian change interval shall not extend into the red clearance interval and shall be followed by a buffer interval of at least 3 seconds (see Paragraph 4)	5 years from the effective date of this revision of the 2009 MUTCD, or when timing adjustments are made to the individual intersection and/or corridor, whichever occurs first
6D.03**	Worker Safety Considerations	New requirement in the 2009 MUTCD that all workers within the right-of-way shall wear high-visibility apparel (see Paragraphs 4, 6, and 7)	December 31, 2011
6E.02**	High-Visibility Safety Apparel	New requirement in the 2009 MUTCD that all flaggers within the right-of-way shall wear high-visibility apparel	December 31, 2011
7D.04**	Uniform of Adult Crossing Guards	New requirement in the 2009 MUTCD for high-visibility apparel for adult crossing guards	December 31, 2011
8B.03, 8B.04	Grade Crossing (Crossbuck) Signs and Supports	Retroreflective strip on Crossbuck sign and support (see Paragraph 7 in Section 8B.03 and Paragraphs 15 and 18 in Section 8B.04)	December 31, 2019
8B.04	Crossbuck Assemblies with YIELD or STOP Signs at Passive Grade Crossings	New requirement in the 2009 MUTCD for the use of STOP or YIELD signs with Crossbuck signs at passive grade crossings	December 31, 2019

Rev. 2



Section 1A.09 Engineering Study and Engineering Judgment

Support:

- 01 Definitions of an engineering study and engineering judgment are contained in Section 1A.13.

Standard:

- 02 **This Manual describes the application of traffic control devices, but shall not be a legal requirement for their installation.**

Guidance:

- 03 *The decision to use a particular device at a particular location should be made on the basis of either an engineering study or the application of engineering judgment. Thus, while this Manual provides Standards, Guidance, and Options for design and applications of traffic control devices, this Manual should not be considered a substitute for engineering judgment. Engineering judgment should be exercised in the selection and application of traffic control devices, as well as in the location and design of roads and streets that the devices complement.*

- 04 *Early in the processes of location and design of roads and streets, engineers should coordinate such location and design with the design and placement of the traffic control devices to be used with such roads and streets.*

Rev. 1

Module 3c



Known Errors in the **Original** *Manual on Uniform Traffic Control Devices (MUTCD) 2009 Edition*



Known Errors of the MUTCD 2009 Edition



- “ The FHWA intends to correct these errors via a future rulemaking action. This list of known errors is provided solely for the information of MUTCD users and does not constitute official changes to the MUTCD at this time.”
- Approximately 80 errors were identified: most of them *sentences* or *table columns* out of order or incorrect use of *words*.
 - Click here to see the [List of Known Errors](#).

Module 3d



DESCRIPTION OF BASIC DEFINITIONS, MUTCD DECEMBER 2009 REVISED EDITION



Section 1A.13: Definitions of Headings, Words, and Phrases in this Manual - **Standard**



- A. **Standard** — a statement of required, mandatory, or specifically prohibitive practice regarding a traffic control device. All Standard statements are labeled, and the text appears in bold type. The verb “shall” is typically used. The verbs “should” and “may” are not used in Standard statements. Standard statements are sometimes modified by Options.

NOTE: Revision 1 of May 2012 modified this definition by eliminating the following text which was the last sentence of the original text of MUTCD 2009 Ed.:

Standard statements shall not be modified or compromised based on engineering judgment or engineering study.

Standard:

- 02 The Manual on Uniform Traffic Control Devices (MUTCD) is incorporated by reference in 23 Code of Federal Regulations (CFR), Part 655, Subpart F and shall be recognized as the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel (see definition in Section 1A.13) in accordance with 23 U.S.C. 109(d) and 402(a). The policies and procedures of the Federal Highway Administration (FHWA) to obtain basic uniformity of traffic control devices shall be as described in 23 CFR 655, Subpart F.



Section 1A.13: Definitions of Headings, Words, and Phrases in this Manual - Guidance



B. Guidance—a statement of recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate. All Guidance statements are labeled, and the text appears in unbold type. The verb “should” is typically used. The verbs “shall” and “may” are not used in Guidance statements. Guidance statements are sometimes modified by Options.

Section 1A.02 Principles of Traffic Control Devices

Guidance:

02 To be effective, a traffic control device should meet five basic requirements:

- A. Fulfill a need;*
- B. Command attention;*
- C. Convey a clear, simple meaning;*
- D. Command respect from road users; and*
- E. Give adequate time for proper response.*



Section 1 A.1 3: Definitions of Headings, Words, and Phrases in this Manual - Option



C. Option—a statement of practice that is a permissive condition and carries no requirement or recommendation. Option statements sometime contain allowable modifications to a Standard or Guidance statement. All Option statements are labeled, and the text appears in unbold type. The verb “may” is typically used. The verbs “shall” and “should” are not used in Option statements.

Option:

04 With the exception of symbols and colors, minor modifications in the specific design elements of a device may be made provided the essential appearance characteristics are preserved.



Section 1A.13: Definitions of Headings, Words, and Phrases in this Manual - Support



D. Support—an informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. Support statements are labeled, and the text appears in unbold type. The verbs “shall,” “should,” and “may” are not used in Support statements.

Support:

04 The definition of the word “speed” varies depending on its use. The definitions of specific speed terms are contained in Section 1A.13.



Crashworthy



43. Crashworthy—a characteristic of a roadside appurtenance that has been successfully crash tested in accordance with a national standard such as the National Cooperative Highway Research Program Report 350, “Recommended Procedures for the Safety Performance Evaluation of Highway Features.”

Engineering judgment



64. Engineering Judgment—the evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. Engineering judgment shall be exercised by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. Documentation of engineering judgment is not required.



Engineering study



65. Engineering Study—the comprehensive analysis and evaluation of available pertinent information, and the application of appropriate principles, provisions, and practices as contained in this Manual and other sources, for the purpose of deciding upon the applicability, design, operation, or installation of a traffic control device. An engineering study shall be performed by an engineer, or by an individual working under the supervision of an engineer, through the application of procedures and criteria established by the engineer. An engineering study shall be documented.



Temporary Traffic Control (TTC) Zone



229. Temporary Traffic Control Zone—an area of a highway where road user conditions are changed because of a work zone or incident by the use of temporary traffic control devices, flaggers, uniformed law enforcement officers, or other authorized personnel.

Traffic Control Device (TCD)



238. Traffic Control Device—a sign, signal, marking, or other device used to regulate, warn, or guide traffic, placed on, over, or adjacent to a street, highway, private road open to public travel, pedestrian facility, or shared-use path by authority of a public agency or official having jurisdiction, or, in the case of a private road open to public travel, by authority of the private owner or private official having jurisdiction.

Worker



256. Worker—a person on foot whose duties place him or her within the right-of-way of a street, highway, or pathway, such as street, highway, or pathway construction and maintenance forces, survey crews, utility crews, responders to incidents within the street, highway, or pathway right-of-way, and law enforcement personnel when directing traffic, investigating crashes, and handling lane closures, obstructed roadways, and disasters within the right-of-way of a street, highway, or pathway.



What represents a Temporary Traffic Control (TTC) Plan?

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- Describes TTC measures to be used for facilitating road users through a work zone or an incident area.
- Plays a vital role in providing continuity of reasonably safe and efficient road user flow when a work zone, incident, or other event temporarily disrupts normal road user flow.
- TTC plans range in scope from being very detailed to simply referencing typical drawings.
- The degree of detail in the TTC plan depends entirely on the nature and complexity of the situation.



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for Streets and Highways

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PART 1. GENERAL



Section 1A.02

Principles of Traffic Control Devices

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Guidance:

02 To be effective, a traffic control device should meet five basic requirements:

- A. Fulfill a need;*
- B. Command attention;*
- C. Convey a clear, simple meaning;*
- D. Command respect from road users; and*
- E. Give adequate time for proper response.*



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PLEASE REFER TO THE
MUTCD, DECEMBER 2009
EDITION, PART I: GENERAL
(PDF VERSION)

[PRESS HERE](#)

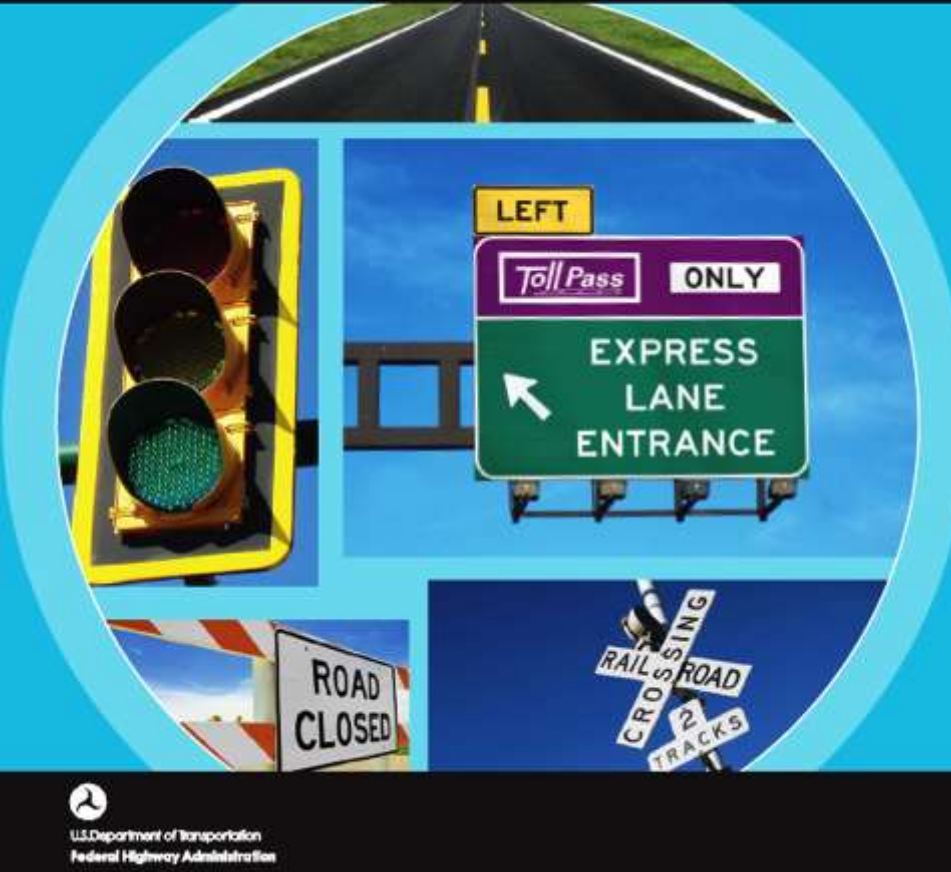


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Federal Highway Administration

PART 5. TRAFFIC CONTROL DEVICES FOR LOW-VOLUME ROADS

- A. General
- B. Regulatory Signs
- C. Warning Signs
- D. Guide Signs
- E. Markings
- F. Traffic Control for Highway-Rail
Grade Crossings
- G. Temporary Traffic Control Zones
- H. Traffic Control for School Areas



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PLEASE REFER TO THE
MUTCD, DECEMBER 2009
EDITION, PART 5: TRAFFIC
CONTROL DEVICES FOR
LOW-VOLUME ROADS
(PDF VERSION)

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Section 5A.01: Function



Standard:

01 A low-volume road shall be defined for this Part of the Manual as follows:

A. A low-volume road shall be a facility lying outside of built-up areas of cities, towns, and communities, and it shall have a traffic volume of less than 400 AADT.

B. A low-volume road shall not be a freeway, an expressway, an interchange ramp, a freeway service road, a road on a designated State highway system, or a residential street in a neighborhood. In

terms of highway classification, it shall be the equivalent of a conventional road or defined in Section 1A.13.

C. A low-volume road shall be paved or unpaved.



Chapter 5G: Temporary Traffic Control Zones

Section 5G.01: Introduction



Guidance:

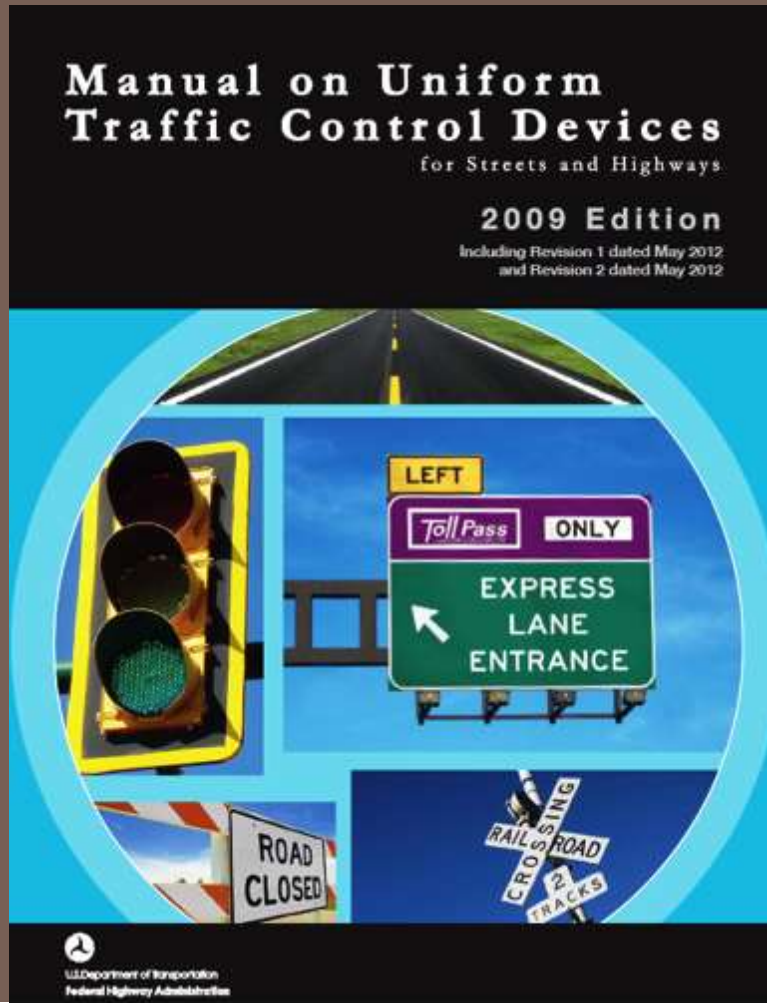
01 The safety of road users, including pedestrians and bicyclists, as well as personnel in work zones, should be an integral and high priority element of every project in the planning, design, maintenance, and construction phases. Part 6 should be reviewed for additional criteria, specific details, and more complex temporary traffic control zone requirements. The following principles should be applied to temporary traffic control zones:

- A. Traffic movement should be disrupted as little as possible.*
- B. Road users should be guided in a clear and positive manner while approaching and within construction, maintenance, and utility work areas.*
- C. Routine inspection and maintenance of traffic control elements should be performed both day and night.*
- D. Both the contracting agency and the contractor should assign at least one person on each project to have day-to-day responsibility for assuring that the traffic control elements are operating effectively and any needed operational changes are brought to the attention of their supervisors.*



Module 4

PART 6. TEMPORARY TRAFFIC CONTROL (TTC)



6A. General

6B. Fundamental Principles

6C. TTC Elements

6D. Pedestrian & Worker Safety

6E. Flagger Control

6F. TTC Zone Devices

6G. Type of TTC Zone Activities

6H. Typical Applications

6I. Control of Traffic through Traffic Incident Management Areas

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PLEASE REFER TO THE
MUTCD, DECEMBER 2009
EDITION, PART 6:
TEMPORARY TRAFFIC
CONTROL (PDF VERSION)

[PRESS HERE](#)



Chapter 6A: General

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Standard:

02 The needs and control of all road users (motorists, bicyclists, and pedestrians within the highway, or on private roads open to public travel (see definition in Section 1A.13), including persons with disabilities in accordance with the Americans with Disabilities Act of 1990 (ADA), Title II, Paragraph 35.130) through a TTC zone shall be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.

E=Engineering

E=Education

E=Enforcement

E=Emergency Management



Temporary Traffic Control Zones

Activities: Work Duration

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1. **Long-term** → stationary, work that occupies a location more than 3 days
2. **Intermediate** → term stationary, work that occupies a location more than one daylight period up to 3 days, or nighttime work lasting more than 1 hour
3. **Short-term stationary** → daytime work that occupies a location for more than 1 hour within a single daylight period
4. **Short duration** → work that occupies a location up to 1 hour
5. **Mobile** → work that moves intermittently or continuously



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CHAPTER 6B FUNDAMENTAL PRINCIPLES

CHAPTER 6C TEMPORARY TRAFFIC CONTROL ELEMENTS



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Standard**

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- The needs and control of all road users through a TTC zone **shall** be an essential part of highway construction, utility work, maintenance operations, and the management of traffic incidents.
- Roads users include:



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Standard**

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- Before any new detour or temporary route is opened to traffic, all necessary signs **shall** be in place
- All TTC devices **shall** be removed as soon as practical (ASAP) when they are no longer needed
- When work is suspended for short periods of time, TTC devices that are no longer appropriate **shall** be removed or covered



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- General plans or guidelines **should** be developed to provide safety for all users...:
 - a. The basic safety principles governing the design of permanent roadways and roadsides should also govern the design of TTC zones
 - b. The goal should be to route road users through such zones using roadway geometrics, roadside features, and TTC devices as nearly as possible comparable to those for normal highway situations
 - c. A TTC plan, in detail appropriate to the complexity of the work project or incident, should be prepared and understood by all responsible parties before the site is occupied



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- Road user movement **should** be inhibited as little as practical, based on the following considerations:
 - a. TTC at work and incident sites should be designed on the assumption that drivers will only reduce their speeds if they clearly perceive a need to do so.
 - b. Frequent and abrupt changes in geometrics such as lane narrowing, dropped lanes, or main roadway transitions that require rapid maneuvers, should be avoided.



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- c. Provisions should be made for the reasonably safe operation of work, particularly on high-speed, high volume roadways.
- d. Road users should be encouraged to use alternative routes that do not include TTC zones.
- e. Bicyclists and pedestrians, including those with disabilities, should be provided with access and reasonably safe passage through the TTC zone.



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- f. Roadway occupancy should be scheduled during off-peak hours and, if necessary, night work should be considered.
- g. Early coordination with officials having jurisdiction over the affected cross streets and providing emergency services should occur before roadway or ramp closings.

Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- To provide acceptable levels of operations, routine day and night inspections of TTC elements **should** be performed...:
 - a. Individuals who are knowledgeable (i.e., trained and/or certified) in the principles of proper TTC should be assigned responsibility for safety in TTC zones.
 - All TTC devices of the project are reasonably consistent with the TTC plan, and
 - are effective in providing reasonably safe conditions for motorists, bicyclists, pedestrians, and workers.



Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- b. As the work progresses, TTC and/or working conditions should be modified in order to provide reasonably safe and efficient road user movement and to provide worker safety.
 - The individual responsible for TTC should have the authority to halt work until applicable or remedial safety measures are taken.

Chapter 6B - Fundamental Principles of Temporary Traffic Control (TTC): **Guidance**

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- c. TTC zones should be carefully monitored under varying conditions of road user volumes, light, and weather to check that applicable TTC devices are effective, clearly visible, clean, and in compliance with the TTC plan.
- d. When warranted, an engineering study should be made (in cooperation with law enforcement officials) of reported crashes occurring within the TTC zone. Crash records in TTC zones should be monitored to identify the need for changes in the TTC zone.



Chapter 6C - Temporary Traffic Control

(TTC) Elements: **Guidance**

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- ❑ Reduced speed limits should be used only in the specific portion of the TTC zone where conditions or restrictive features are present.
- ❑ Frequent changes in the speed limit should be avoided.
- ❑ A TTC plan should be designed so that vehicles can reasonably safely travel through the TTC zone with a speed limit reduction of no more than 16 km/h (10 mph).
 - ❑ A higher reduction in the speed limit should be used only when required by restrictive features in the TTC zone.



Chapter 6C - Temporary Traffic Control

(TTC) Elements: **Guidance**

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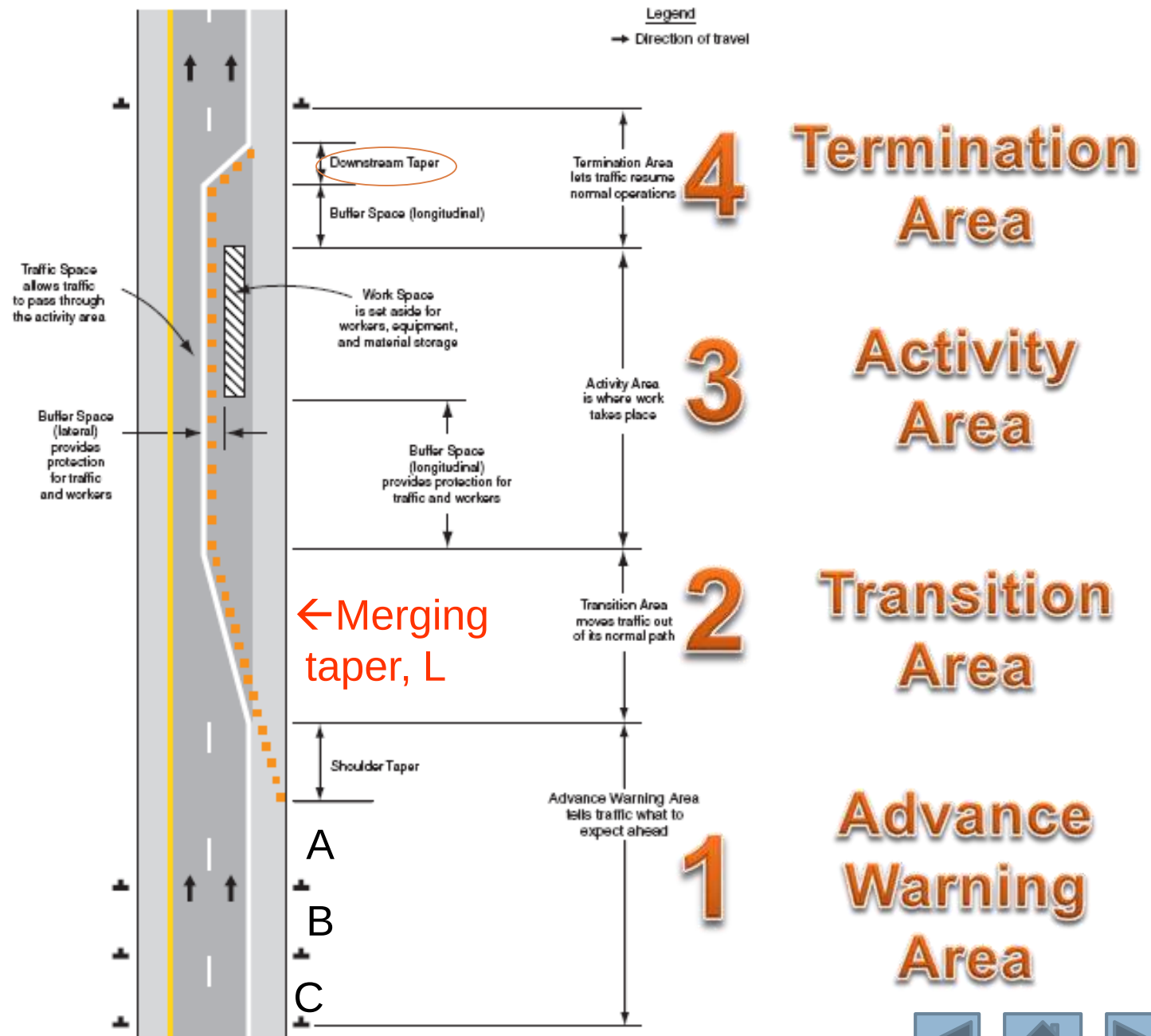
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- Where restrictive features justify a speed reduction of more than 16 km/h (10 mph), additional driver notification should be provided.
- The speed limit should be stepped down in advance of the location requiring the lowest speed, and additional TTC warning devices should be used.
- Reduced speed zoning (lowering the regulatory speed limit) should be avoided as much as practical because drivers will reduce their speeds only if they clearly perceive a need to do so.



Figure 6C-1. Component Parts of a Temporary Traffic Control Zone



Components of Temporary Traffic Control (TTC) Zones

1. Advance Warning Area

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□ Support

- ▣ Section of highway where road users are informed about the upcoming work zone or incident area.

□ Option

- ▣ May vary from a single sign or high-intensity rotating, flashing, oscillating, or strobe lights on a vehicle to a series of signs in advance of the TTC zone activity area.

Table 6C-1. Suggested Advance Warning Sign Spacing, MUTCD 2003 Edition (metric units and formulas were eliminated)



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	A	B	C
Urban (low speed)*	30 (100)	30 (100)	30 (100)
Urban (high speed)*	100 (350)	100 (350)	100 (350)
Rural	150 (500)	150 (500)	150 (500)
Expressway / Freeway	300 (1,000)	450 (1,500)	800 (2,640)

* Speed category to be determined by highway agency

Distance in meters (feet)

** Distances are shown in meters (feet). The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The third sign is the first one in a three-sign series encountered by a driver approaching a TTC zone.)

$V \leq 40$ mph = Low Speed

$V \geq 45$ mph = High Speed



Table 6C-1. Recommended Advance Warning Sign Minimum Spacing, MUTCD, December 2009 Edition



Table 6C-1. Recommended Advance Warning Sign Minimum Spacing

Road Type	Distance Between Signs**		
	A	B	C
Urban (low speed)*	100 feet	100 feet	100 feet
Urban (high speed)*	350 feet	350 feet	350 feet
Rural	500 feet	500 feet	500 feet
Expressway / Freeway	1,000 feet	1,500 feet	2,640 feet

* Speed category to be determined by the highway agency

** The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The "first sign" is the sign in a three-sign series that is closest to the TTC zone. The "third sign" is the sign that is furthest upstream from the TTC zone.)



Guidance on Typical Distances for Advance Warning Signs

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- Freeways and expressways
 - ▣ Typical distances for placement of advance warning signs on should be longer because drivers are conditioned to uninterrupted flow.
 - ▣ Advance warning sign placement should extend on these facilities as far as 800 m (0.5 mi) or more.

- Rural highways (normally characterized by higher speeds)
 - ▣ Effective placement of the first warning sign in meters (feet) should be from 1.5 to 2.25 times the speed limit in km/h (8 to 12 times the speed limit in mph).
 - ▣ Since two or more advance warning signs are normally used for these conditions, the advance warning area should extend 450 m (1,500 ft) or more for open highway conditions (see Table 6C-1).



Guidance on Typical Distances for Advance Warning Signs



- On urban streets
 - Effective placement of the first warning sign in meters (feet) should range from 0.75 to 1.5 times the speed limit in km/h (4 to 8 times the speed limit in mph).
 - When a single advance warning sign is used (such as in low-speed residential streets), the advance warning area can be as short as 30 m (100 ft).
 - When two or more advance warning signs are used on higher-speed streets (such as major arterials) see Table 6C-1.



Components of Temporary Traffic Control (TTC) Zones

2. Transition Area

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□ Support

- ▣ The section of highway where road users are redirected out of their normal path. Usually involve strategic use of tapers.
- ▣ In mobile operations, the transition area moves with the work space.

□ Standard

- ▣ When redirection of the road users' normal path is required, they **shall** be channelized from the normal path to a new path

Components of Temporary Traffic Control (TTC) Zones

3. Activity Area

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□ Support

- ▣ The section of the highway where the work activity takes place.
- ▣ It is comprised of the work space, the traffic space, and the buffer space.
 - **Traffic space** = portion of the highway in which road users are routed through the activity area.
 - **Buffer space** = lateral and/or longitudinal area that separates road user flow from the work space or an unsafe area, and might provide some recovery space for an errant vehicle. (For recommended longitudinal lengths, see Table 6C-2)



Table 6C-2. Stopping Sight Distance as a Function of Speed, MUTCD 2003 Edition



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Speed* (km/h)	Distance (m)
30	35
40	50
50	65
60	85
70	105
80	130
90	160
100	185
110	220
120	250

Speed* (mph)	Distance (ft)
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
75	820

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed



Table 6C-2: Stopping Sight Distance as a Function of Speed, MUTCD December 2009 Edition



**Table 6C-2. Stopping Sight Distance
as a Function of Speed**

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed



Components of Temporary Traffic Control (TTC) Zones

4. Termination Area

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□ Standard

- **Shall** be used to return road users to their normal path.
- **Shall** extend from the downstream end of the work area to the last TTC device, such as **END ROAD WORK** signs, if posted.

Components of Temporary Traffic Control (TTC) Zones

6C.08 - Tapers

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□ Option

- ▣ May be used in both the transition and termination areas.
- ▣ Whenever tapers are to be used in close proximity to an interchange ramp, crossroads, curves, or other influencing factors, the length of the tapers may be adjusted.

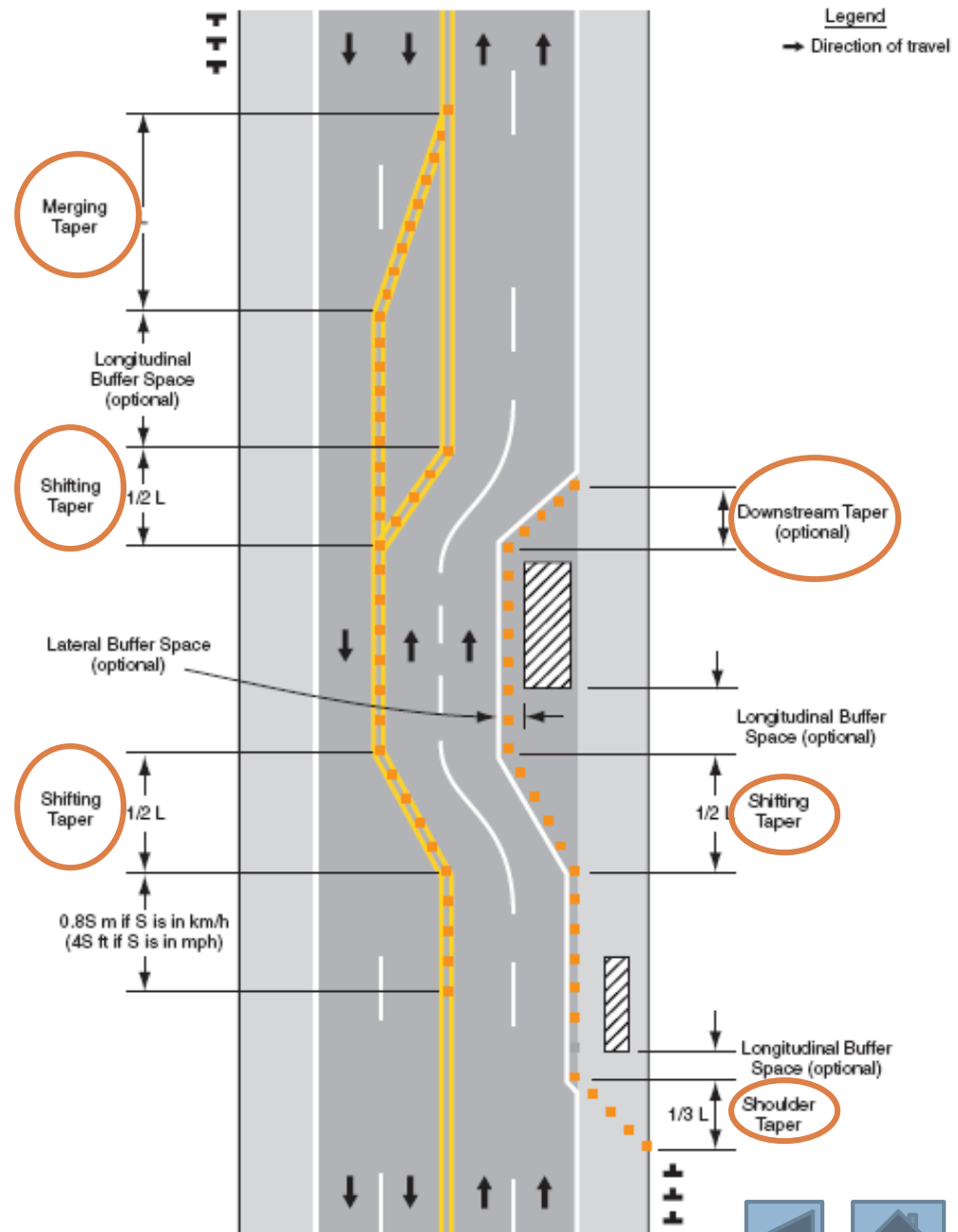
□ Support

- ▣ Tapers are created by using a series of channelizing devices and/or pavement markings to move traffic out of or into the normal path.



Taper Types

- Merging
- Shifting
- Shoulder
- Downstream



Taper Length Criteria, MUTCD 2003 Edition



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Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones

Type of Taper	Taper Length (L)*
Merging Taper	at least L
Shifting Taper	at least 0.5L
Shoulder Taper	at least 0.33L
One-Lane, Two-Way Traffic Taper	30 m (100 ft) maximum
Downstream Taper	30 m (100 ft) per lane

The maximum distance in meters (feet) between devices in a taper should not exceed 0.2 times the speed limit in km/h (1.0 times the speed limit in mph).



Taper Length Criteria, MUTCD 2009 Edition



Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones

Type of Taper	Taper Length
Merging Taper	at least L
Shifting Taper	at least 0.5 L
Shoulder Taper	at least 0.33 L
One-Lane, Two-Way Traffic Taper	50 feet minimum, 100 feet maximum
Downstream Taper	50 feet minimum, 100 feet maximum

Note: Use Table 6C-4 to calculate L



Formulas to Determine Taper Lengths, MUTCD 2003 Edition

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Table 6C-4. Formulas for Determining Taper Lengths

Speed Limit (S)	Taper Length (L) Meters
60 km/h or less	$L = \frac{WS^2}{155}$
70 km/h or more	$L = \frac{WS}{1.6}$

Speed Limit (S)	Taper Length (L) Feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$

Where: L = taper length in meters (feet)

W = width of offset in meters (feet)

S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in km/h (mph)



Formulas to Determine Taper Lengths, MUTCD 2009 Edition

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**Table 6C-4. Formulas for Determining
Taper Length**

Speed (S)	Taper Length (L) in feet
40 mph or less	$L = \frac{WS^2}{60}$
45 mph or more	$L = WS$

Where: L = taper length in feet
W = width of offset in feet
S = posted speed limit, or off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph



Section 6C.10

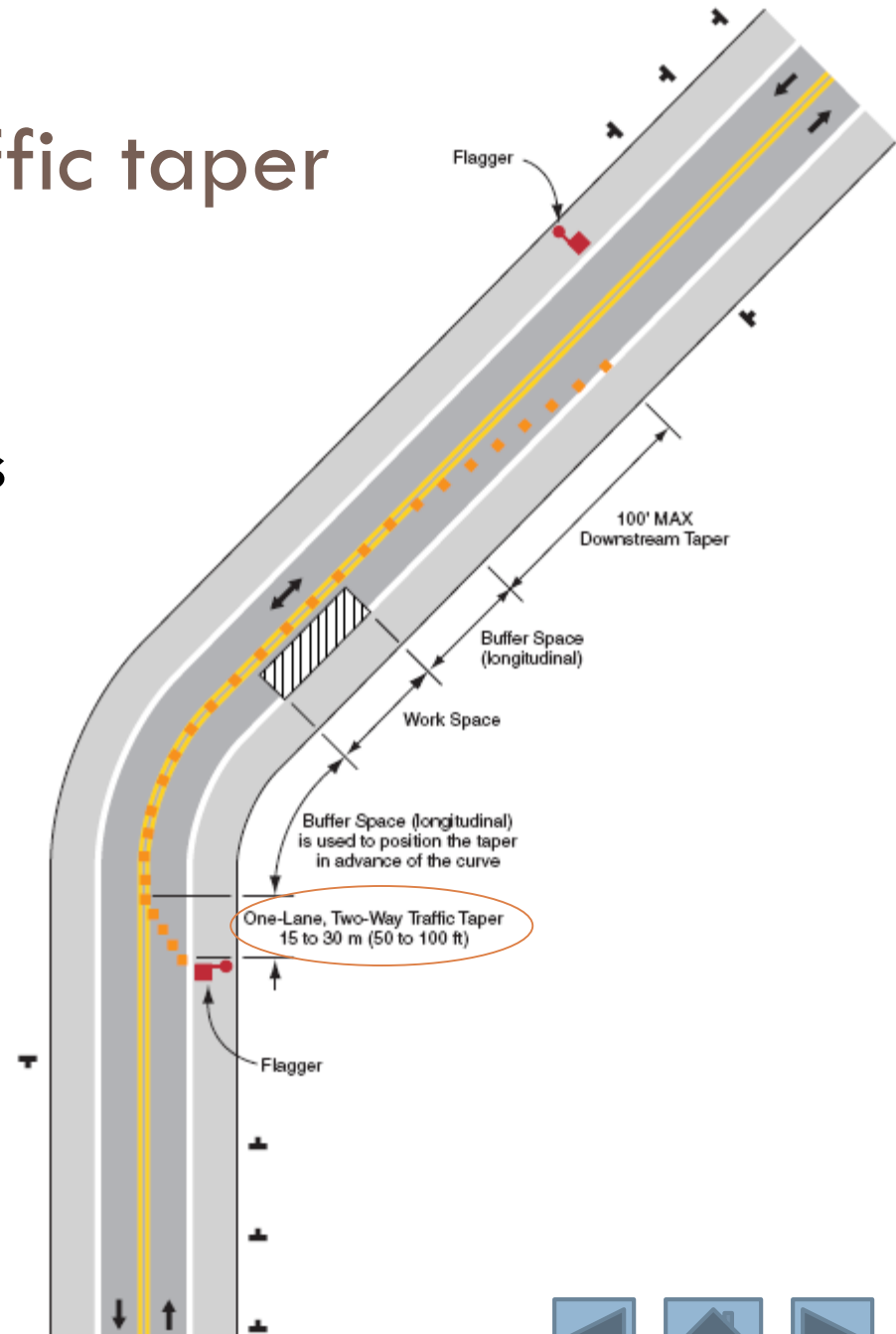
One-lane, two-way traffic taper

Standard

When traffic in both directions must use a single lane for a limited distance, movements from each end **shall** be coordinated.

Minimum $L = 50$ ft

Maximum $L = 100$ ft



Module 5



Typical Applications of Activities Associated with TTC (Please refer to PDF version)

[Press Here](#)



Example # 1: TTC Four (4) Lane Divided Highway

TA-33 - Stationary Lane Closure on a Divided Highway

PUERTO RICO TRANSPORTATION TECHNOLOGY TRANSFER CENTER



Given:

- 4 lane rural highway (2 lanes per direction)
- Posted speed limit or 85th percentile off-peak speed, $S = 55$ mph
- Lane width, $W = 12$ ft / lane (3.65 m/lane)
- Outside shoulder width, $w = 10$ ft (3 m)
- Work space = 0.5 mile (0.8 km)
- Duration of work = 2 months
- Traffic = 40,000 vpd





12'

12'

10'



Example # 1: TTC 4 Lane Divided Highway

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Required:

1. Length of advance warning area
2. Length of shoulder taper
3. Length of transition area
4. Length of activity area
5. Length of longitudinal buffer
6. Length of termination area
7. Minimum number of channelizing devices in transition area

Calculate using MUTCD
Part 6 Standards and
Guidelines





Aspects to Consider in Highway Work Zones

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- Type of work activity
- Location and duration (short-term, intermediate-term, long-term)
- Daytime / Nighttime / Both periods
- Roadway type / functional classification
- Traffic volume
- Speed differential
- Hazard potential
 - ▣ Prevention
 - ▣ Standard of care



Check for MUTCD Typical Application



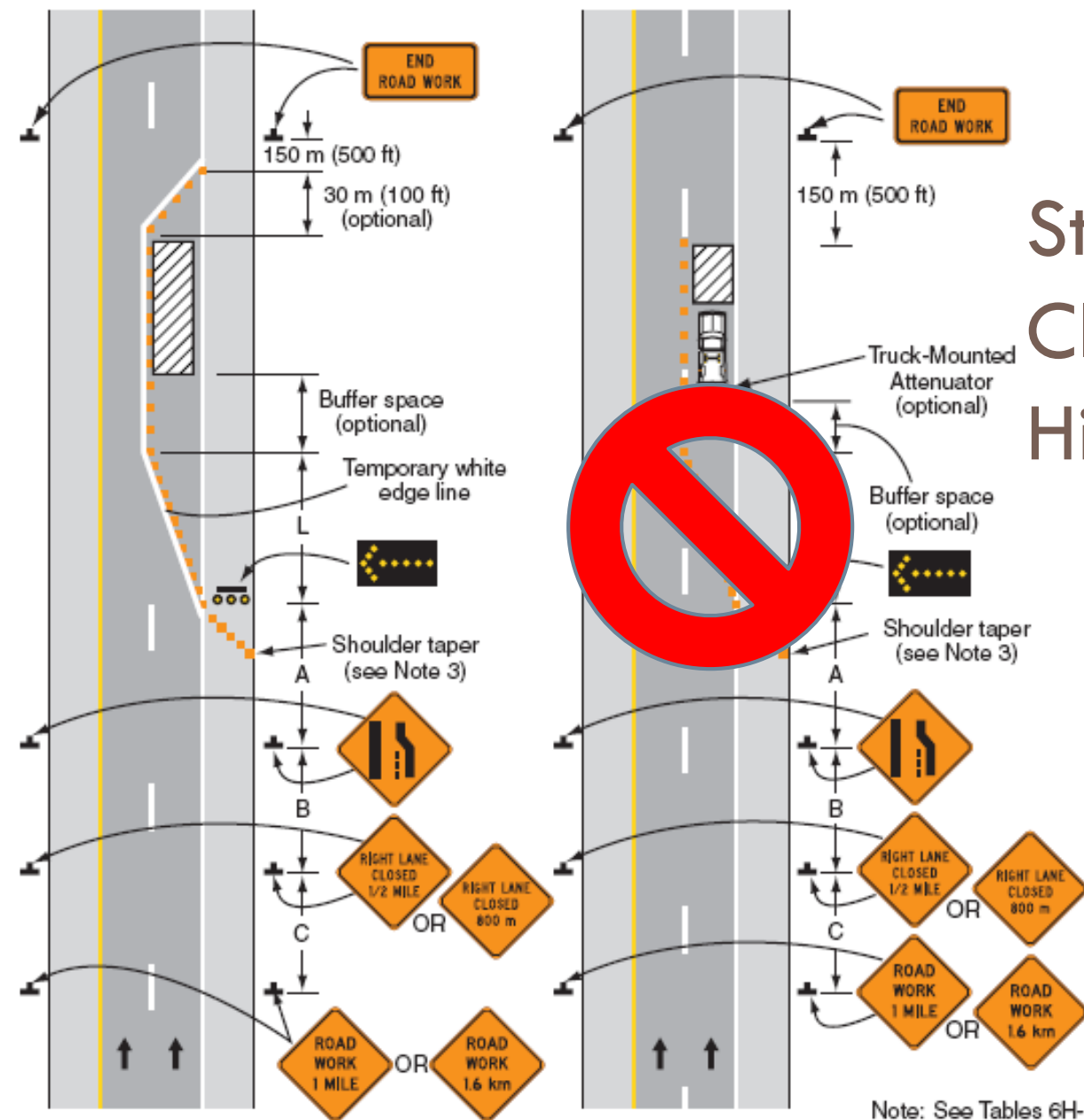
148

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Typical Application Description	Typical Application Number
Work Within the Traveled Way of Multi-lane, Nonaccess Controlled Highways (see Section 6G.12)	
Interior Lane Closure on Multi-lane Street	TA-30
Lane Closure on Street with Uneven Directional Volumes	TA-31
Half Road Closure on Multi-lane, High-Speed Highway	TA-32
Lane Closure on Divided Highway	TA-33
Lane Closure with Temporary Traffic Barrier	TA-34
Mobile Operation on Multi-lane Road	TA-35



Stationary Lane Closure on Divided Highway (TA-33)



Note: See Tables 6H-2 and 6H-3 for the meaning of the symbols and/or letter codes used in this figure.

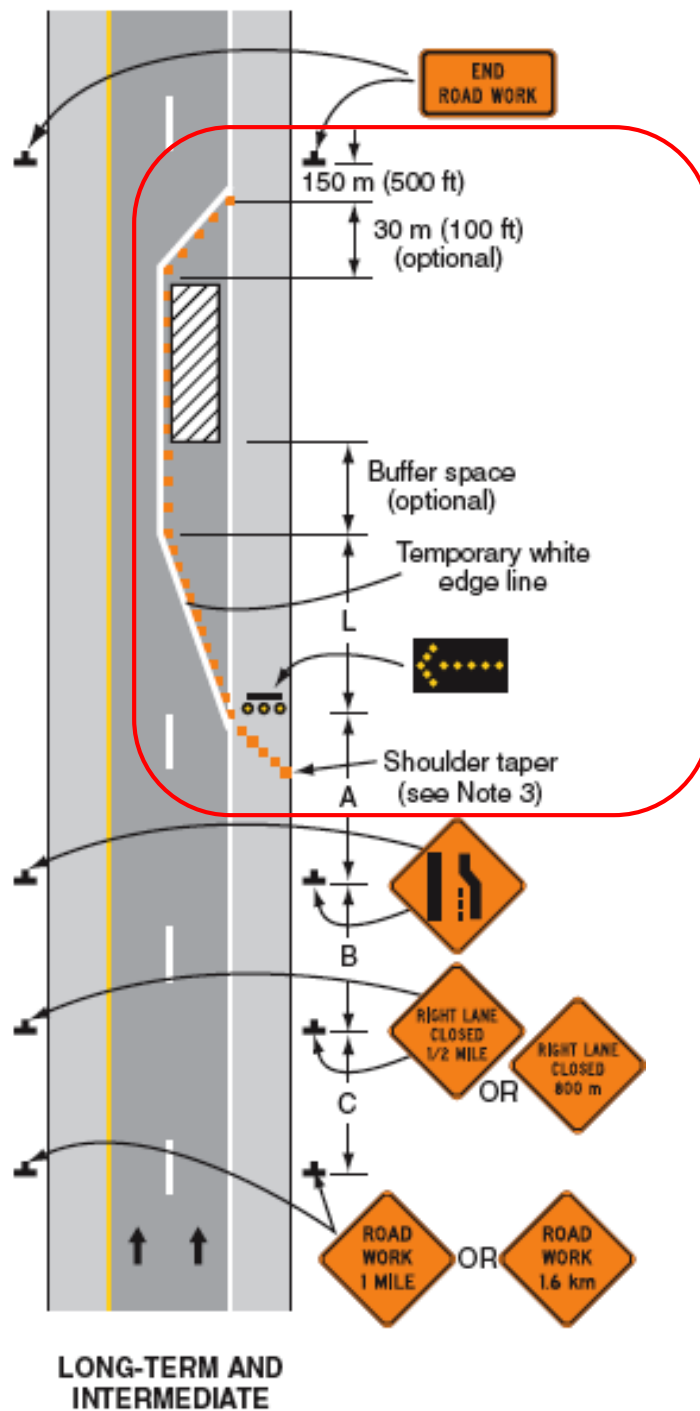
LONG-TERM AND
INTERMEDIATE

SHORT-TERM

Table Application 33



TA-33



Termination
Area

Activity
Area

Transition
Area

Transition Area – Shoulder taper & Merging Taper

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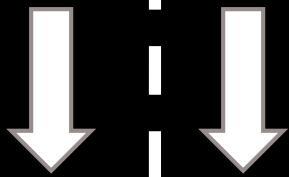


Table 6C-3. Taper Length Criteria for Temporary Traffic Control Zones

Type of Taper	Taper Length (L)*
Merging Taper	at least L
Shifting Taper	at least 0.5L
Shoulder Taper	at least 0.33L
One-Lane, Two-Way Traffic Taper	30 m (100 ft) maximum
Downstream Taper	30 m (100 ft) per lane

Maximum distance in meters (feet) between devices in a taper should not exceed 0.2 times the speed limit in km/h (1.0 times the speed limit in mph).





Speed Limit (S)

Taper Length (L)
Feet

40 mph or less

$$L = \frac{WS^2}{60}$$

45 mph or more

$$L = WS$$

L = taper length (feet)

W = width of offset (feet)

S = posted speed limit (mph)

85th perc. speed
anticipated op. speed

Downstream taper



Merging taper = L

Shoulder taper = 0.33L



Minimum Taper Lengths



Merging _taper

$$L = W \cdot S = 12 \times 55 = 660 \text{ feet}$$

Shoulder _taper

$$L = W \cdot S = 10 \times 55 = 550 \text{ feet}$$

$$0.33 \cdot L = 0.33 \times 550 = 181.5 \text{ feet}$$



100 feet

660 feet

181.5 feet



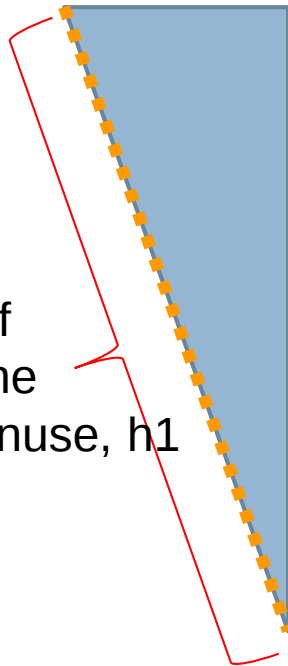
Amount of Channelizing Devices in Transition Area

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Shoulder width,
 $W_l = 12$ feet

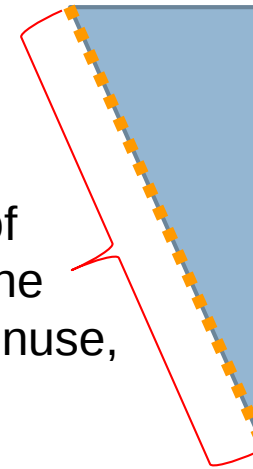


Length of
device line
= hypotenuse, h_1

Length of
merging taper,
 $L_m = 660$ feet

$$h_1 = \sqrt{W_l^2 + L_m^2} = \sqrt{12^2 + 660^2} = 660.11 \text{ ft}$$

Shoulder width,
 $W_s = 10$ pies



Length of
merging taper,
 $L_s = 181.5$ feet

Length of
device line
= hypotenuse,
 h_2

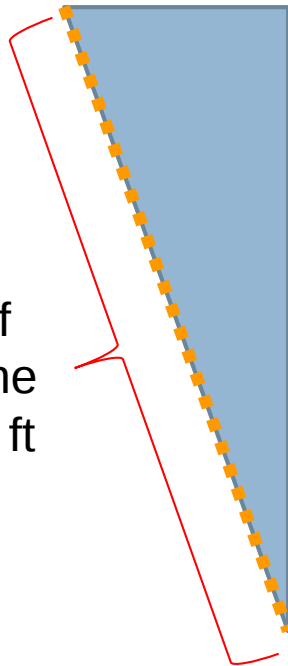
$$h_2 = \sqrt{W_s^2 + L_s^2} = \sqrt{10^2 + 181.5^2} = 181.78 \text{ ft}$$



Amount of Channelizing Devices in Transition Area

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Length of
device line
= 660.11 ft

Length of
device line
= 181.78 ft



Maximum distance between pairs
of devices = 55 feet

Minimum amount of devices =

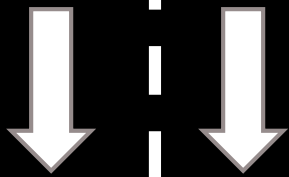
Merging taper

$$(660.11 / 55) + 1 = 13 \text{ devices}$$

Shoulder taper

$$(181.78 / 55) + 1 = 4 \text{ devices}$$





Traffic
space



Work
space

Long.
buffer
space

100 feet

Activity
Area =

Work space
+
Buffer space

660 feet

181.5 feet



Length of Activity Area

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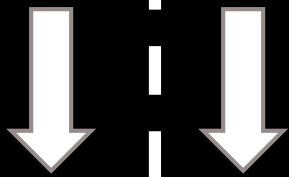


- Work space = 2640 feet
- Longitudinal buffer = 495 feet
- Length of Activity Area
 $= 2640 + 495 = 3,135$ feet

Speed* (mph)	Distance (ft)
20	115
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
75	820

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed





Traffic
space



Work
space

Long.
buffer
space

495 feet

100 feet

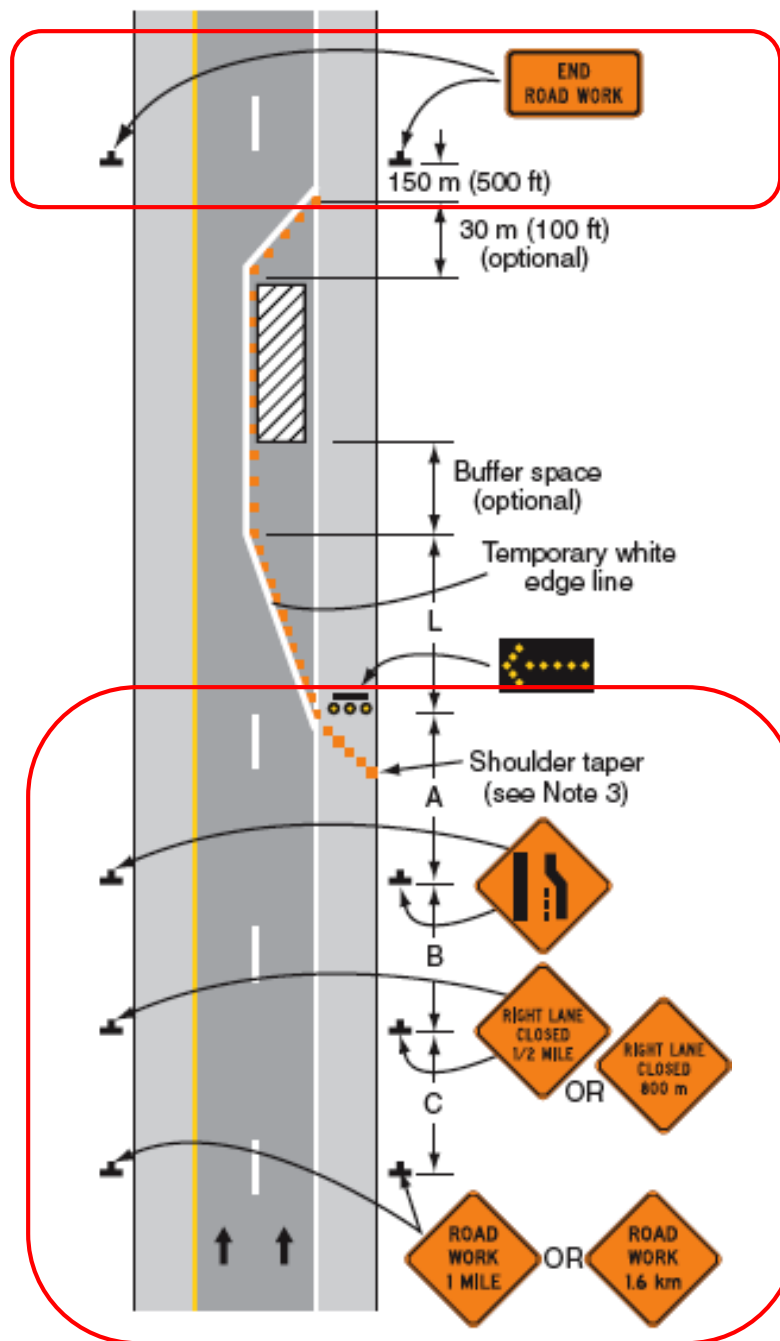
Activity
Area =

3,135 feet

660 feet

181.5 feet





LONG-TERM AND
INTERMEDIATE

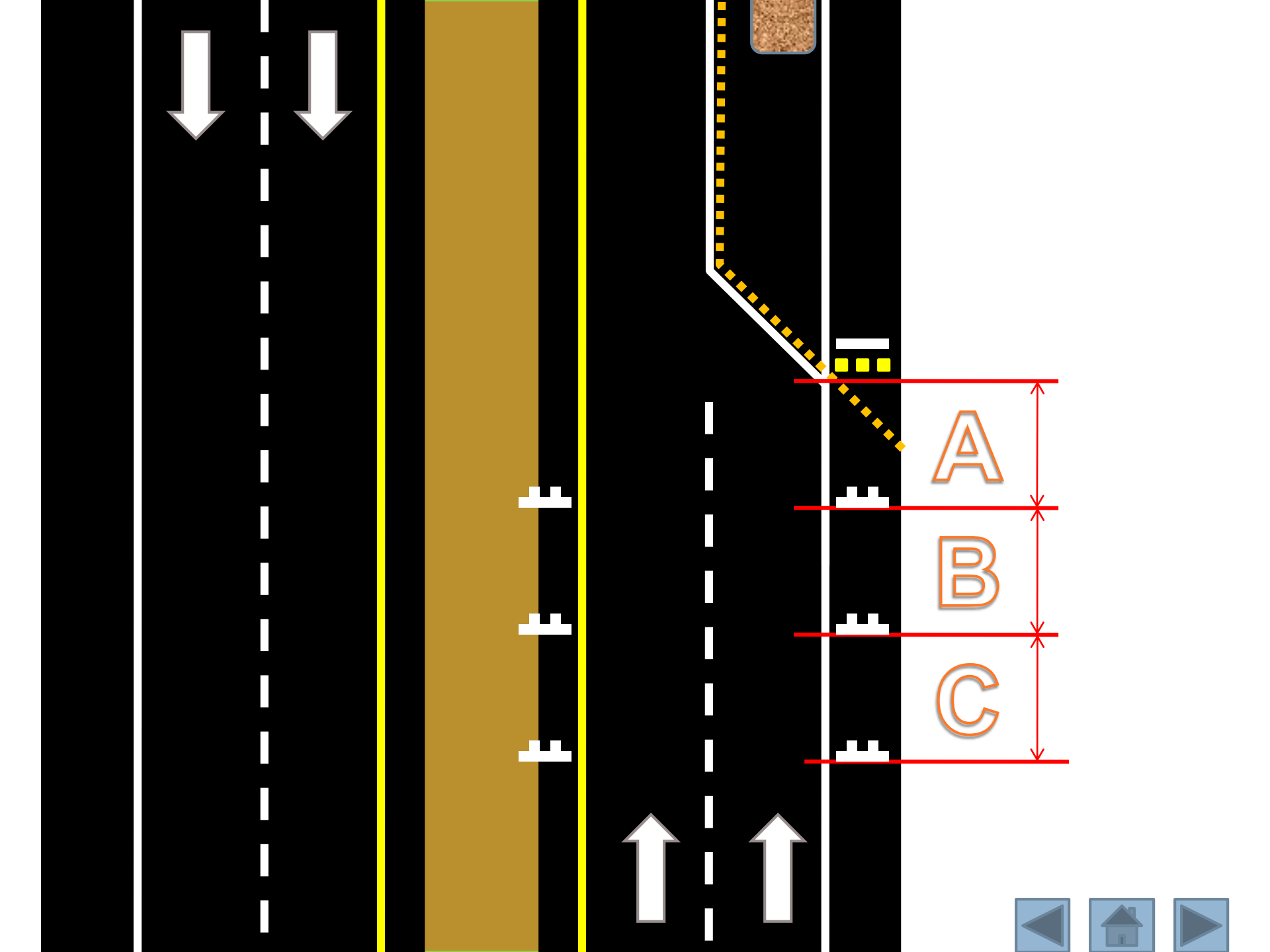


Table 6C-1. Suggested Advance Warning Sign Spacing

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	A	B	C
Urban (low speed)*	30 (100)	30 (100)	30 (100)
Urban (high speed)*	100 (350)	100 (350)	100 (350)
Rural	150 (500)	150 (500)	150 (500)
Expressway / Freeway	300 (1,000)	450 (1,500)	800 (2,640)

* Speed category to be determined by highway agency

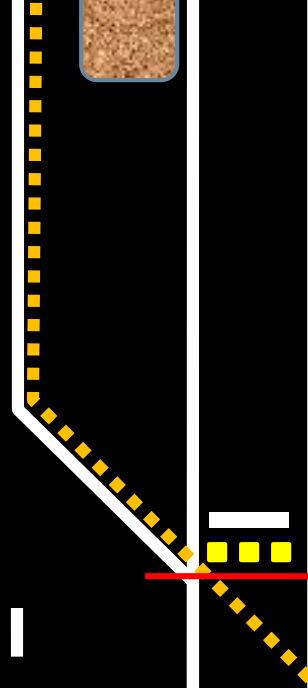
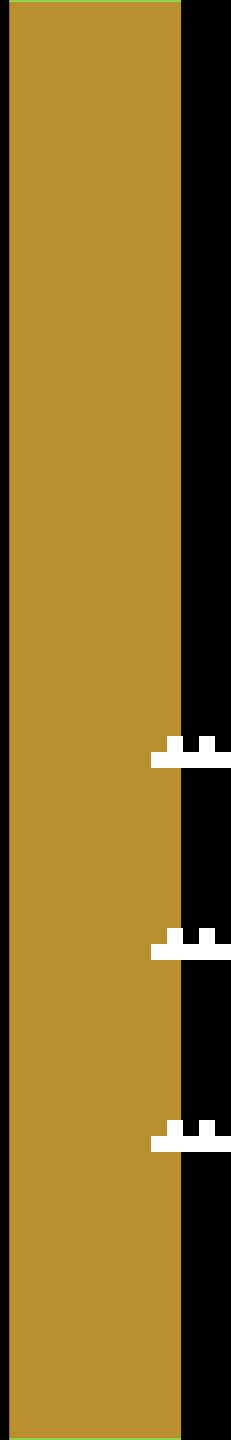
Distancias en metros (pies)

** Distances are shown in meters (feet). The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-46. The A dimension is the distance from the transition or point of restriction to the first sign. The B dimension is the distance between the first and second signs. The C dimension is the distance between the second and third signs. (The third sign is the first one in a three-sign series encountered by a driver approaching a TTC zone.)

$V \leq 40$ mph = Low Speed

$V \geq 45$ mph = High Speed



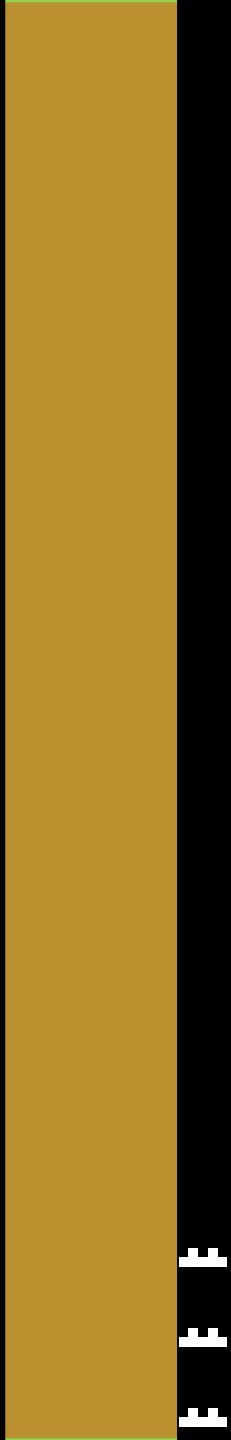


A=1,000ft

B=1,500ft

C=2,640ft





Traffic space



Work space

Long. buffer space

495 feet

100 feet

Activity Area =

3,135 feet

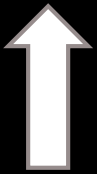
660 feet

181.5 feet

1,000 feet

1,500 feet

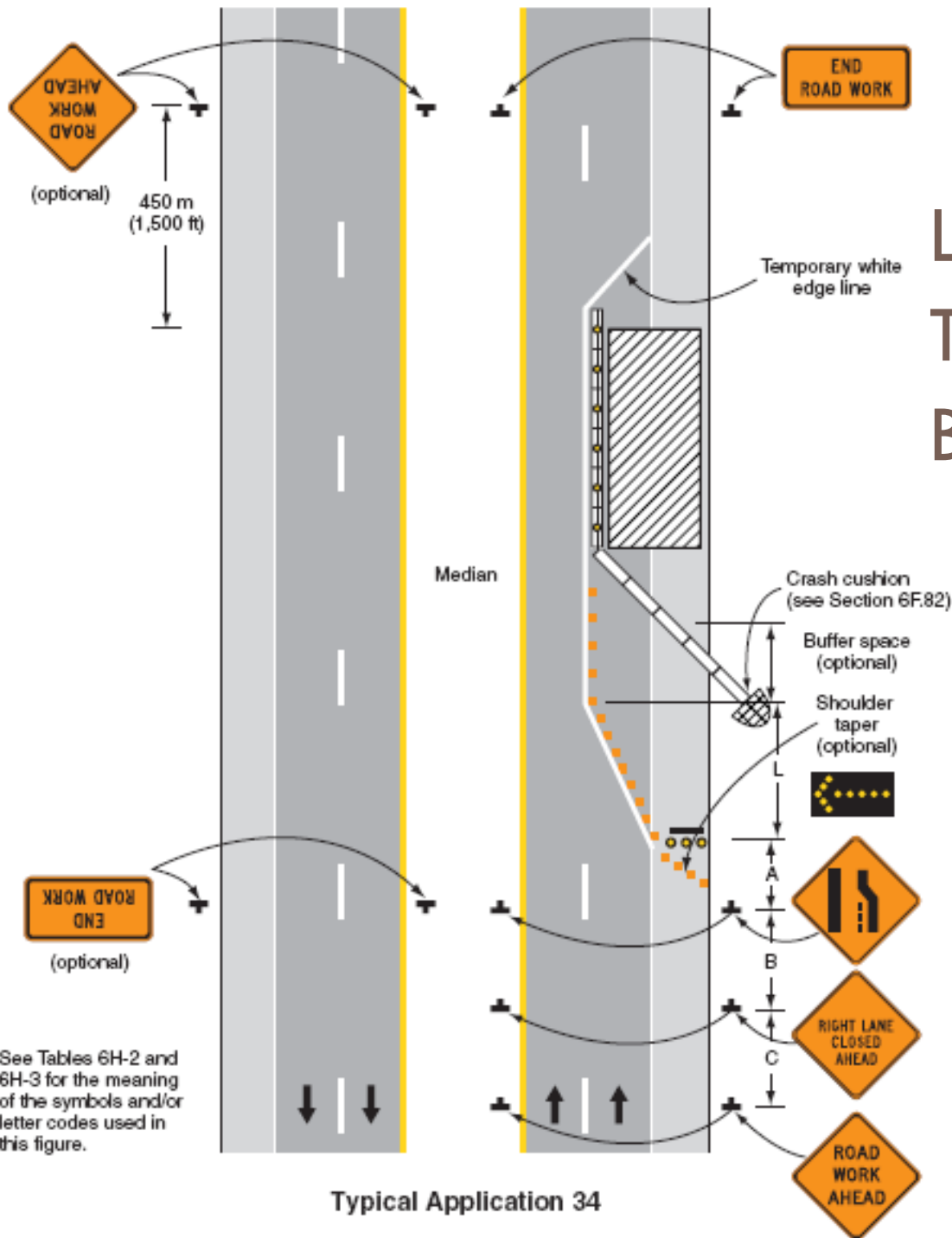
2,000 feet



What if we want to include a temporary barrier?

Jerome Atwood, Hatch Mott MacDonald





Lane Closure with Temporary Traffic Barrier (TA-34)

Typical Application 34



Traffic
space



Work
space

100 feet

Activity
Area =

3,135 feet

Long.
buffer
space
495 feet

660 feet

181.5 feet

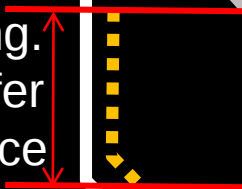




Lat.
buffer
space



Long.
buffer
space





CHAPTER 6D. PEDESTRIAN AND WORKER SAFETY



Pedestrian Considerations

Standards

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- TTC provisions for pedestrian and worker safety... **shall** be applied by knowledgeable persons after appropriate evaluation and engineering judgment.
- TTC devices used to delineate a TTC zone pedestrian walkway **shall** be crashworthy and, when struck by vehicles, present a minimum threat to pedestrians, workers, and occupants of impacting vehicles.

Pedestrian Considerations



- Pedestrians should be provided with a reasonably safe, convenient, and accessible path that replicates as nearly as practical the most desirable characteristics of the existing sidewalk(s) or footpath(s).
- Pedestrians should not be led into conflicts with
 - ▣ work site vehicles, equipment, and operations
 - ▣ vehicles moving through or around the work site.

Pedestrian Considerations

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- Special consideration to special groups
 - ▣ Children
 - ▣ Older persons
 - ▣ People with disabilities

**These pedestrians need
a clearly delineated and
usable travel path**



Accessibility Considerations

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- When existing pedestrian facilities are disrupted, closed, or relocated in a TTC zone, the temporary facilities **shall** be detectable and include accessibility features consistent with the features present in the existing pedestrian facility



Pedestrian Considerations

Standard

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- Advance notification of sidewalk closures **shall** be provided to the maintaining agency.
 - ▣ Alternative access clearly indicated (TA -28)
- Where pedestrians with visual disabilities normally use the closed sidewalk, a barrier that is detectable by a person with a visual disability traveling with the aid of a long cane **shall** be placed across the full width of the closed sidewalk.



Issues for Pedestrians with Mobility Disabilities

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Issues for Pedestrians with Visual Disabilities

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Is there a barrier preventing pedestrians from entering work zone?



3/11/2009

Accessible Design for the Blind



Issues for Pedestrians with Visual Disabilities

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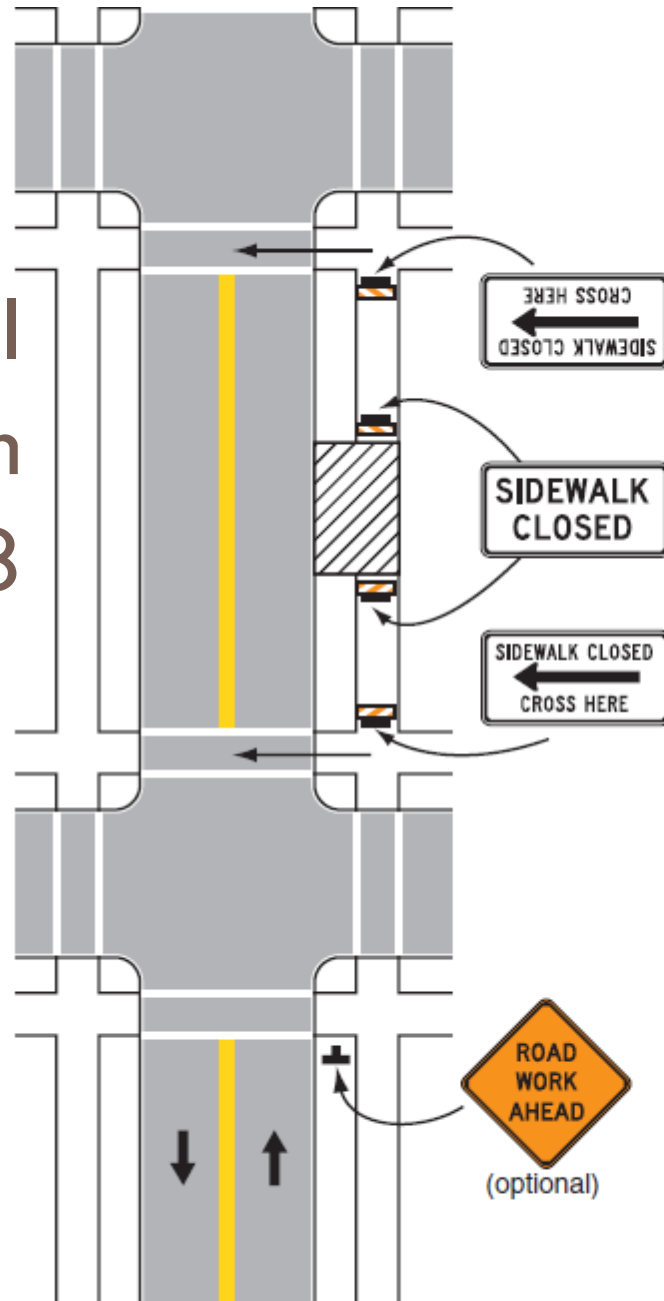
PUERTO RICO TRANSPORTATION TECHNOLOGY TRANSFER CENTER



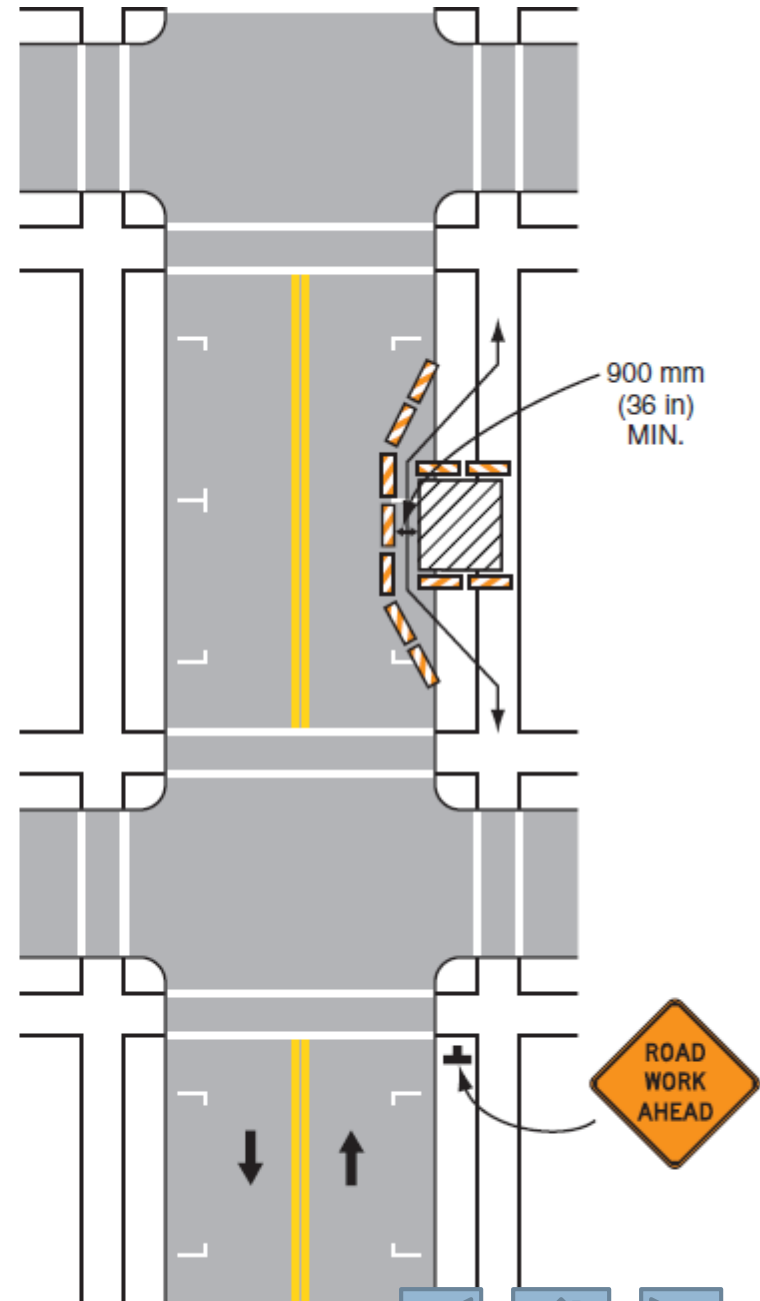
Same-side route...or cross?



Typical Application TA-28



SIDEWALK DETOUR



SIDEWALK DIVERSION



Typical Application 28 - Sidewalk Closures and Bypass Sidewalks

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- Where high speeds are anticipated, a temporary traffic barrier and, if necessary, a crash cushion should be used to separate the temporary sidewalks from vehicular traffic.
- For nighttime closures, Type A Flashing warning lights may be used on barricades that support signs and close sidewalks.
- Type C Steady-Burn or Type D 360-degree Steady-Burn warning lights may be used on channelizing devices separating the temporary sidewalks from vehicular traffic flow.



Note: For welfare, replace S for S^c .



Pedestrian Considerations



- Where pedestrians who have visual disabilities encounter work sites that require them to cross the roadway to find an accessible route, instructions should be provided using an audible information device
 - ▣ Passive pedestrian actuation
 - ▣ Continuous message
 - ▣ Button activated message
- Spoken message artifacts not needed if the alternative route is evident to visually-disabled pedestrians



Pedestrian Considerations



- A pedestrian route should not be severed and/or moved for non-construction activities such as parking for vehicles and equipment
- When crossing the road is necessary, direct pedestrians with advance signing placed at intersections (rather than midblock locations)
- Tape, rope, or plastic chain strung between TTC devices are not detectable and should not be used as a control for pedestrian movements
- Regularly inspect the activity area so that effective pedestrian TTC is maintained



M4-9a



M4-9b



M4-9c



Issues for Pedestrians with Visual Disabilities

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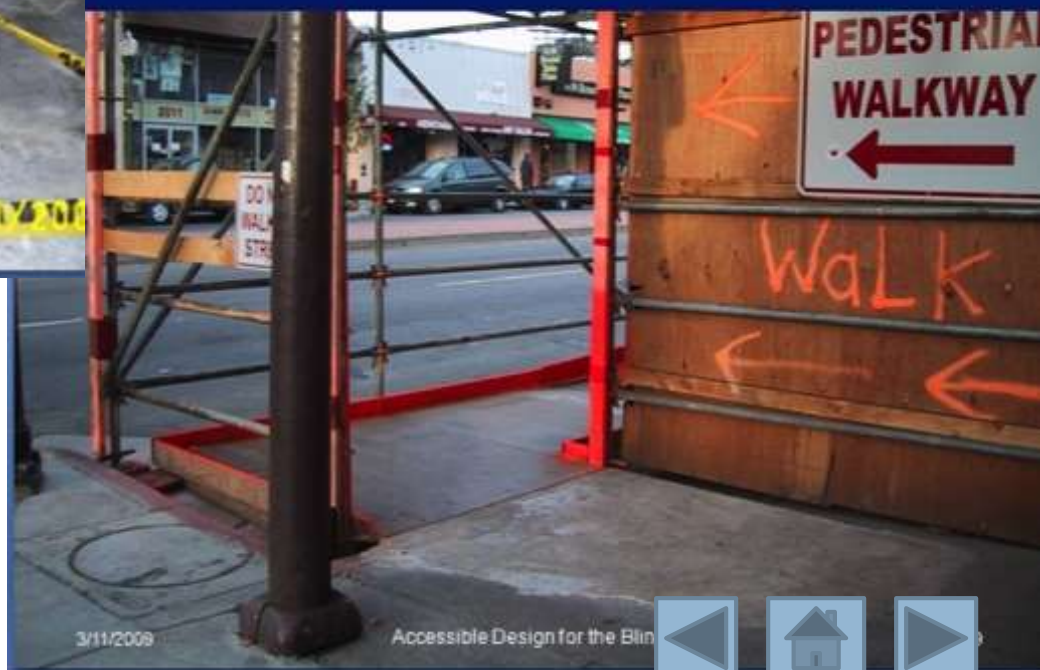
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Is an alternate route defined?
...detectable?



Defined and detectable



Accessible Design for the Blind



Route information may be provided by clearly delineated path



Information in usable formats



Barrier + audible information device to provide alternate route information



Extent of the detour...where does it start...and end?



Free of hazardous protruding objects?



Wide enough for passage?



- Need to provide room for people traveling in opposite directions to pass each other
 - Should be at least five feet wide
 - Six feet more comfortable



Not a good start...



Worker Safety Tips

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Operator Safety ROADWAY SAFETY+

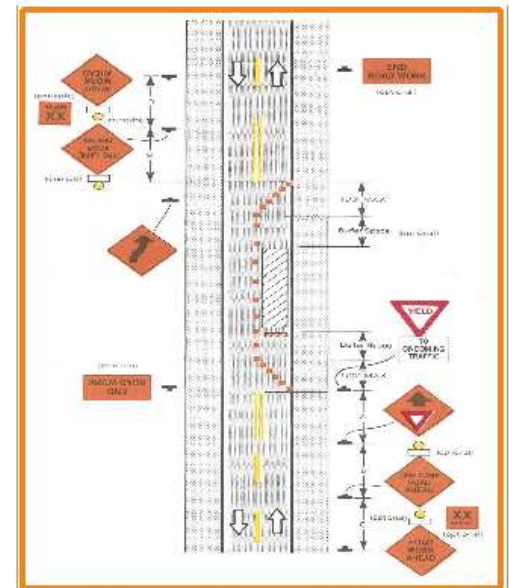


How Can We Be Safe in the Work Zone?

The operator has special responsibilities.

Know the job

- Know the work zone and your position in it
- Know the internal traffic control plan
- Use designated equipment routes and areas
- Identify rollover hazards such as unlevelled areas, embankments, unstable soil
- If you must move cones or barricades, return them to the original positions as soon as possible



Safety Considerations for Workers

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1. **Training**

- ▣ How to work next to motor vehicle traffic in a way that minimizes their vulnerability
- ▣ TTC techniques, device usage, and placement

2. **Safety Apparel**

- ▣ Wear high-visibility safety apparel meeting the requirements of ANSI 107-1999 standard performance for Class 1, 2, or 3 risk exposure
- ▣ Assign a competent person as responsible for the worker safety plan who should make the selection of the appropriate class of garment



Safety Considerations for Workers



3. **Temporary Traffic Barriers:** should be placed along the work space depending on factors such as lateral clearance of workers from adjacent traffic, speed of traffic, duration and type of operations, time of day, and volume of traffic
4. **Speed Reduction:** mainly through regulatory speed zoning, funneling, lane reduction, or the use of uniformed law enforcement officers or flaggers, should be considered

Safety Considerations for Workers

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5. **Activity Area:** minimize backing-up maneuvers of construction vehicles should be considered
6. **Worker Safety Planning**
 - ▣ Designate competent person to conduct a basic hazard assessment for the work site and job classifications required in the activity area
 - ▣ This safety professional should determine whether engineering, administrative, or personal protection measures should be implemented.
 - ▣ Plan should be in accordance with the Occupational Safety and Health Act of 1970

Additional Safety Elements for Workers



1. **Shadow Vehicle**

- ▣ Equipped with appropriate lights and warning signs
- ▣ May be used to protect the workers from impacts by errant vehicles
- ▣ May be equipped with a rear-mounted impact attenuator

2. **Road Closure:** when alternative routes are available

3. **Law Enforcement Use**

- ▣ For relatively short activities, units may be stationed to heighten the awareness of passing vehicular traffic and to improve safety through the TTC zone

Additional Safety Elements for Workers

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4. **Lighting:** for nighttime activities

- Iluminar área de trabajo para operaciones nocturnas

5. **Special Devices**

- Rumble strips
- Changeable message signs
- Hazard identification beacons
- Flags
- Warning lights
- Intrusion warning devices



Worker Safety Tips

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INSTRUCTION
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Operator Safety ROADWAY SAFETY+

4

English

How Can We Protect Other Workers?

Always keep other workers in mind.

On the worksite

- Know the locations of other workers around you at all times
- Set up a means of communication with workers around you such as flaggers, grade checkers
- Never allow other workers to ride on equipment
- Where possible, provide barriers between workers and equipment
- Avoid excessive speeds and dangers caused by hills, obstacles, curves



Worker Safety Tips

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Runovers/Backovers ROADWAY SAFETY+



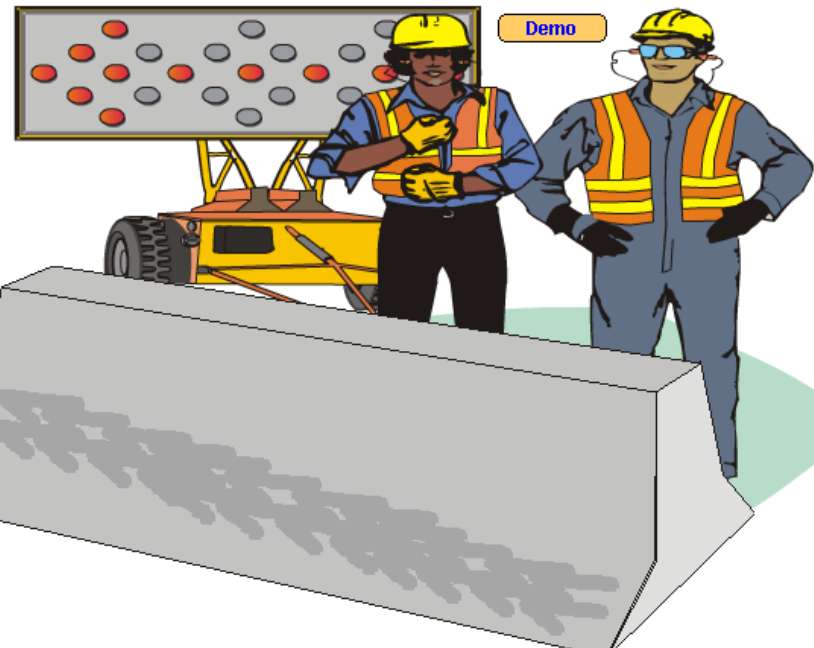
Can We Be Safe Near Equipment/Traffic?

Being struck is the biggest danger in road work.



Workers on foot must

- Remain alert at all times
- Check surroundings often, listen for warnings
- Keep a safe distance from traffic
- Stay behind protective barriers where possible
- Look out for each other, warn coworkers

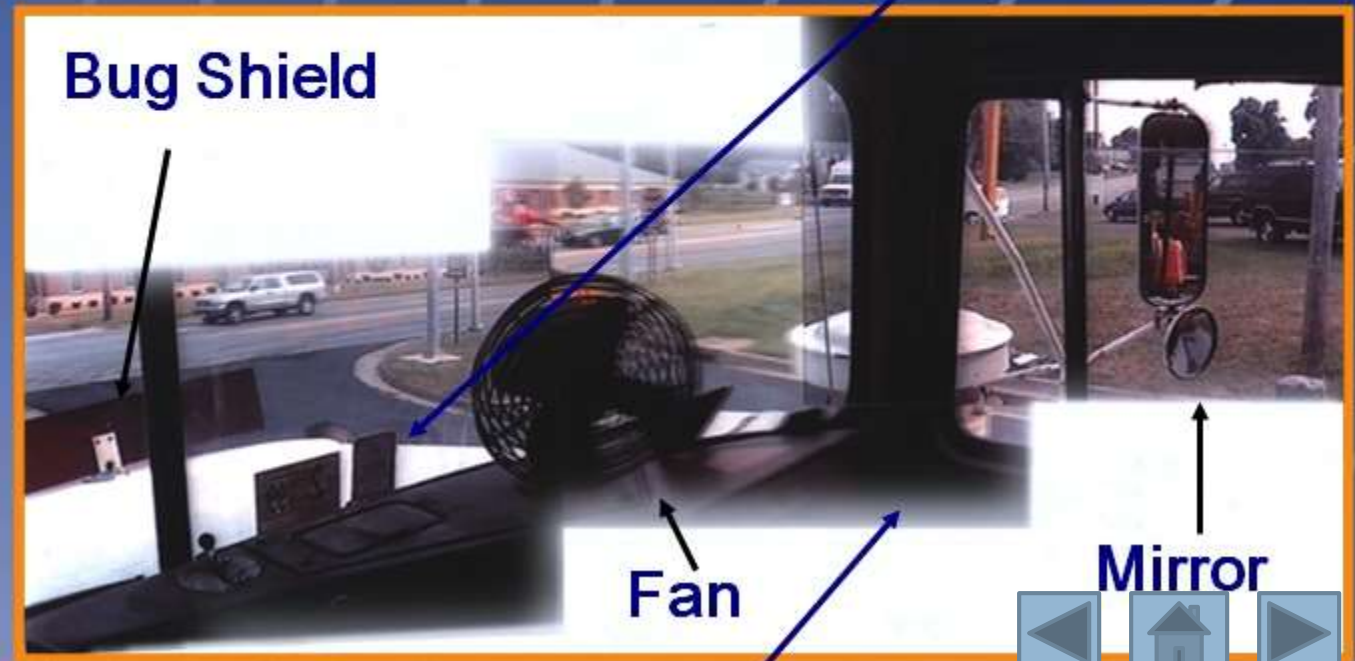


View from the Street

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View from Inside the Cab



Blind Area Mapping

www.cdc.gov/niosh/topics/highwayworkzones



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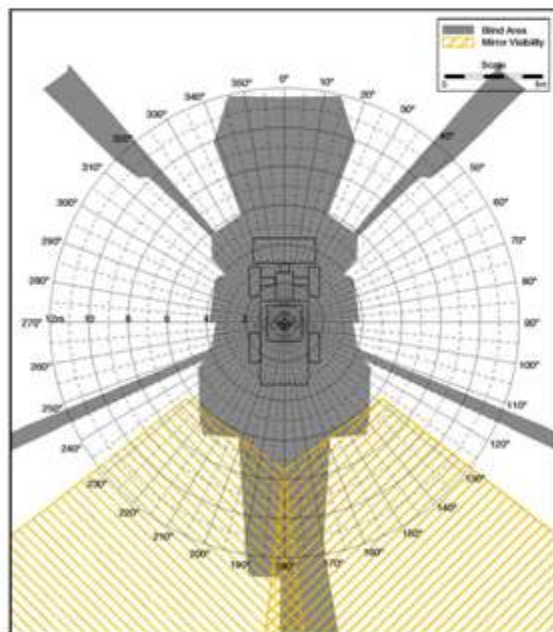
PUERTO RICO TRANSPORTATION TECHNOLOGY TRANSFER CENTER

Caterpillar Inc.
PO Box 1875
Peoria, Illinois 61656-1875

Contract # 200-2002-00563

Blind Area Diagram for Construction Vehicle – Ground Plane

Loader (Manufacturer and Model)	Komatsu WA 480
GVW	54,000 lb
Serial #	WA480 H50074
Machine Dimensions	10' 5" wide 30' 0" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



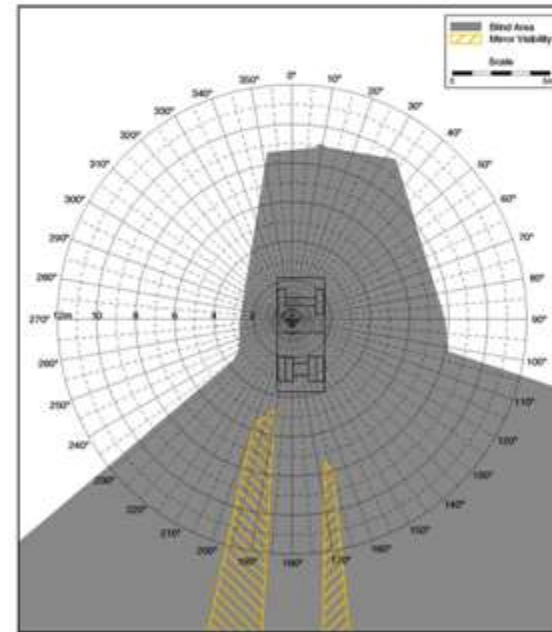
43

Caterpillar Inc.
PO Box 1875
Peoria, Illinois 61656-1875

Contract # 200-2002-00563

Blind Area Diagram for Construction Vehicle – Ground Plane

Dump Truck (Manufacturer and Model)	GMC 7000
GVW	28,000 lb
Serial #	1GDL7D1B7KV500943
Machine Dimensions	9'0" wide 23'0" long
Operator Enclosure	Closed ROPS
Attachments	None
Other Information	None
Measurement Technique	Physical



4



Worker Safety Tips

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Runovers/Backovers ROADWAY SAFETY+



What About Construction Equipment?

Treat equipment and vehicles with caution.

Around equipment, vehicles

- Stay out of "blind spots"
- Communicate with operators by radio and/or eye contact
- Don't approach until you communicate with operator and he/she acknowledges you
- Stay outside a "safety circle" around equipment
- Stay clear of vehicles, know traffic control plan
- Use spotters when you must work with your back to equipment or traffic



Nighttime Work Activities

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Night Work ROADWAY SAFETY+



What Are the Special Challenges?

Night operations change the work environment.

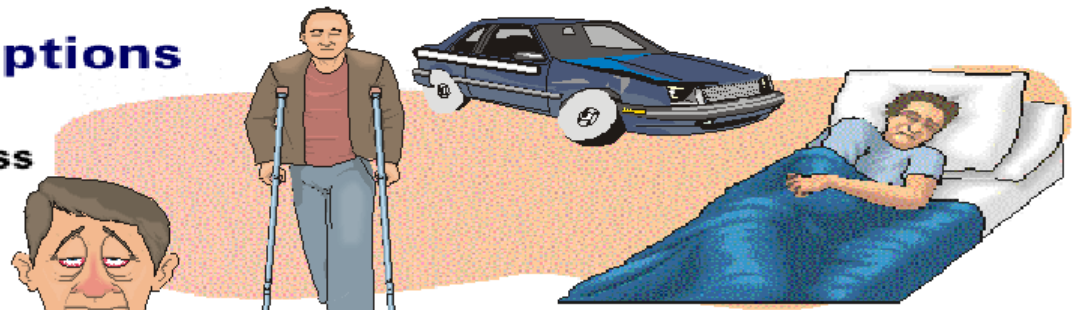
On the worksite

- Poor visibility for motorists
- Poor visibility for workers
- Communication between shifts
- Impaired or drowsy drivers



Physical and social disruptions

- Sleep disruption
- Risk of injury from drowsiness
- Impaired family or social relationships



Nighttime Work Activities

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Night Work ROADWAY SAFETY+



How Can We Protect Ourselves at Night?

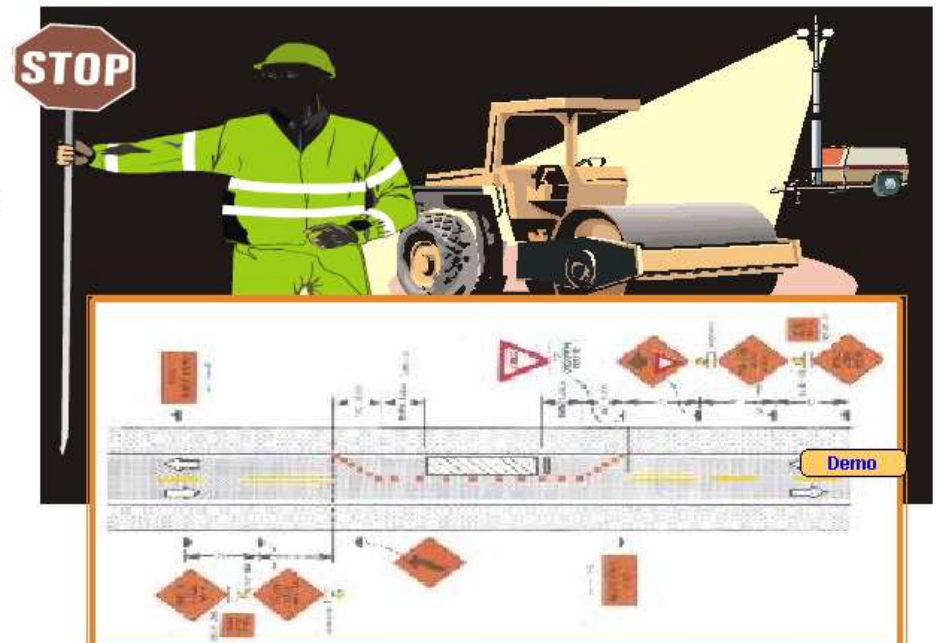
Use SPECIAL PRECAUTIONS at the site for night work.

Increase visibility

- Retro-reflective clothing
- Flashing lights on body/clothing
- Retro-reflective tape on equipment
- Good work area lighting

Know your surroundings

- Vehicle and equipment paths
- Assigned work areas
- Safe paths to/from work locations
- On foot, watch out for equipment
- On equipment, watch for workers



Nighttime Work Activities

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Night Work ROADWAY SAFETY+



How Can We Protect Ourselves at Night?

Use SPECIAL PRECAUTIONS at the site for night work.

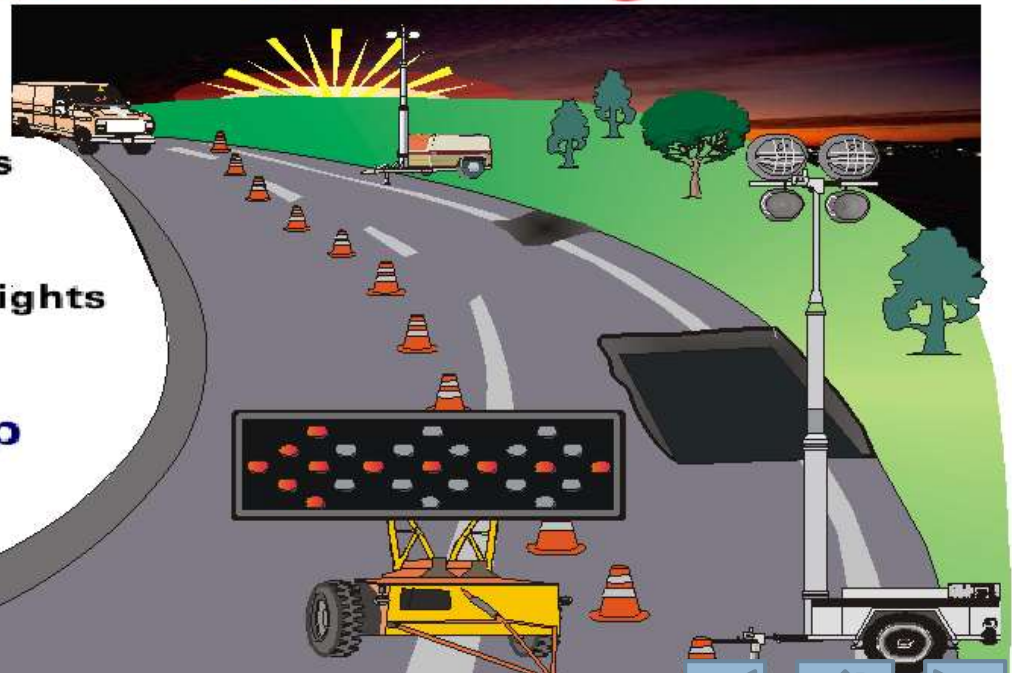
Provide clear signage

Demo

- Position signs for best visibility
- Use changing message/arrow signs
- Space drums, cones closer
- Proper lighting, contrast work lights from warning lights

Inspect traffic control setup

- Test drive to find problems
- Inspect frequently



Temporary Lighting for Night Work



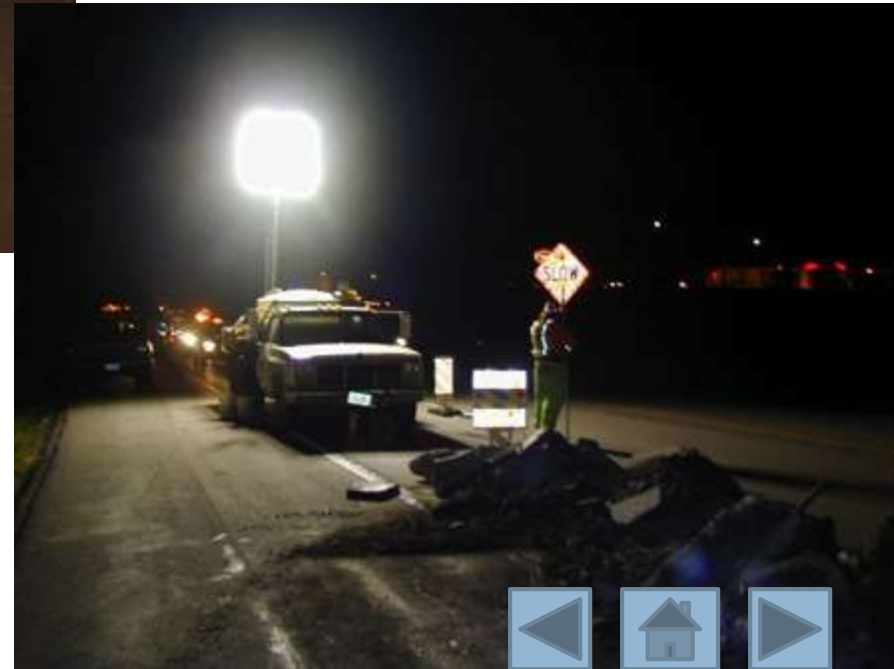
- Good lighting is essential
 - ▣ Safety of workers
 - ▣ Quality of work
 - ▣ Higher productivity and morale
 - ▣ Glare control
- Fixed roadway lighting provided less than 20 lux (2 fc)
- NCHRP 498 recommendations
 - ▣ Level I 54 lux (5 fc) – general illumination, all areas
 - ▣ Level II 108 lux (10 fc) – paving, milling, equipment areas
 - ▣ Level III 215 lux (20 fc) – mechanical, electrical, detail work



One light tower for 1/2 mile long work area... enough?

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Module 6



MUTCD CHAPTER 6E - FLAGGER CONTROL (PLEASE REFER TO THE PDF VERSION)

[Press Here](#)



Flagger Safety Tips

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Flagger Safety ROADWAY SAFETY+

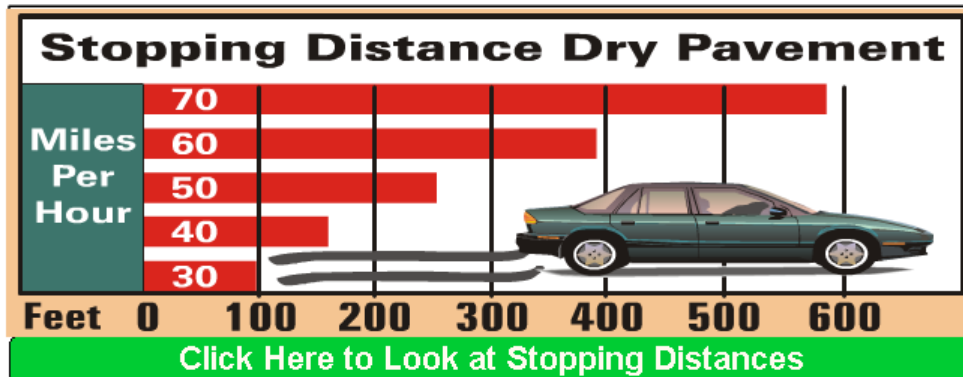


What Are the Main Hazards of Flagging?

Motorists kill about 20 flaggers each year.

Flagging can be dangerous

- High speed traffic
- Angry or aggressive drivers
- After seeing flagger, a motorist going 60 mph needs almost 400 feet to stop



Qualifications for Flaggers



- A flagger **shall** be a person who provides TTC
- Responsible for public safety
- Greatest contact with public
- Should be trained in safe traffic control practices and public contact techniques

Qualifications for Flaggers



- Should be able to satisfactorily demonstrate the following abilities:
 1. Receive and communicate specific instructions clearly, firmly, and courteously;
 2. Move and maneuver quickly in order to avoid danger from errant vehicles;
 3. Control signaling devices (such as paddles and flags) in order to provide clear and positive guidance to drivers approaching a TTC zone in frequently changing situations;
 4. Understand and apply safe traffic control practices, sometimes in stressful or emergency situations; and
 5. Recognize dangerous traffic situations and warn workers in sufficient time to avoid injury

High-Visibility Safety Apparel



- **Standard** – For daytime and nighttime activity, flaggers **shall** wear safety apparel meeting the ANSI 107-1999 standard performance for Class 2 risk exposure
 - Material color **shall** be either fluorescent orange-red or fluorescent yellow-green
 - Retroreflective material **shall** be either orange, yellow, white, silver, yellow-green, or a fluorescent version of these colors
 - **Shall** be visible at a minimum distance of 300 m (1,000 ft)
 - **Shall** be designed to clearly identify the wearer as a person
- **Guidance** – For nighttime activity, safety apparel for Class 3 risk exposure should be considered



Hand-Signaling Devices



- Primary and preferred device → **STOP/SLOW paddle**
 - **Shall** have an octagonal shape on a rigid handle
 - **Shall** be at least 450 mm (18 in) wide with letters at least 150 mm (6 in) high
 - Background of the STOP face **shall** be red with white letters and border
 - Background of the SLOW face **shall** be orange with black letters and border
 - When used at night, the STOP/SLOW paddle **shall** be retroreflectorized

STOP/SLOW paddle

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Hand-Signaling Devices



- Emergency situations → **red flags**
 - **Shall** be a minimum of 600 mm (24 in) square, made of a good grade of red material,
 - **Shall** be securely fastened to a staff that is approximately 900 mm (36 in) in length
 - When used at nighttime, flags **shall** be retroreflectorized red

Flagger Procedures

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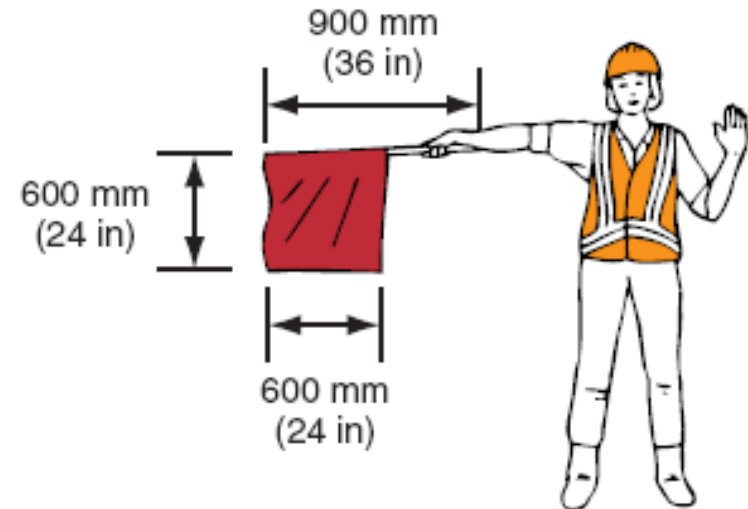
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PREFERRED METHOD STOP/SLOW Paddle



EMERGENCY SITUATIONS ONLY Red Flag



TO STOP TRAFFIC



Flagger Procedures

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PREFERRED METHOD STOP/SLOW Paddle



EMERGENCY SITUATIONS ONLY Red Flag



TO LET
TRAFFIC PROCEED



Flagger Procedures

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PREFERRED METHOD STOP/SLOW Paddle



EMERGENCY SITUATIONS ONLY Red Flag



TO ALERT AND
SLOW TRAFFIC



Flagger Stations



- **Shall** be located such that approaching road users will have sufficient distance to stop at an intended stopping point
- Should be located such that an errant vehicle has additional space to stop without entering the work space
- Except in emergency situations,
 - **Shall** be preceded by an advance warning sign or signs
 - **Shall** be illuminated at night



Flagger Stations, MUTCD 2003 Edition



Table 6E-1. Stopping Sight Distance as a Function of Speed

Speed* (km/h)	Distance (m)	Speed* (mph)	Distance (ft)
30	35	20	115
40	50	25	155
50	65	30	200
60	85	35	250
70	105	40	305
80	130	45	360
90	160	50	425
100	185	55	495
110	220	60	570
120	250	65	645
		70	730
		75	820

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed



Flagger Stations, MUTCD 2009 Edition



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**Table 6E-1. Stopping Sight Distance
as a Function of Speed**

Speed*	Distance
20 mph	115 feet
25 mph	155 feet
30 mph	200 feet
35 mph	250 feet
40 mph	305 feet
45 mph	360 feet
50 mph	425 feet
55 mph	495 feet
60 mph	570 feet
65 mph	645 feet
70 mph	730 feet
75 mph	820 feet

* Posted speed, off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed



Flagger Safety Tips

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Flagger Safety ROADWAY SAFETY+



How Can We Protect Ourselves?

Stay alert and out of harm's way.

Keep your guard up

- Stand alone on shoulder in clear view, not in open traffic lane
- Plan an escape route for emergencies
- Stay in communication with other flaggers
- Stay alert, keep focused on work
- Make sure your hand signals don't conflict with traffic signals
- Treat motorists with respect and courtesy, don't pick fights or respond to anger, notify law enforcement when motorists do not obey flaggers



Flagger Safety Tips

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Flagger Safety ROADWAY SAFETY+



What Should Flaggers Avoid?

Flaggers must avoid dangerous behavior.

Flagging Don'ts:

- Don't stand where you can be crushed
- Don't stand in the shade, over the crest of a hill, or around a sharp curve
- Don't leave your position until properly relieved
- Don't stand near equipment
- Don't stand in a group
- Don't make unneeded conversation
- Don't read or daydream on duty
- Don't listen to music or use ear phones
- Don't turn your back to the traffic



Flagger Safety Tips

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Temporary Traffic Control Devices ROADWAY SAFETY+



How Do You Deal with an Angry Public?

Things you and your employer should try to do.

- Stay calm and respond in a nonviolent manner
- Keep yourself in visible and in well lit areas
- Make sure you can communicate with co-workers and can call for help
- Make allowances for quick egress
- Create procedures to report violence to employers so they know trouble spots
- Respond to public violence immediately; provide workers with media to record events, attackers, license tag numbers, and so on
- Provide extra police protection and security when necessary
- Provide positive separation between workers and motorists, when feasible



Module 7



TTC Zone Devices



Temporary Traffic Control Zones

Devices Definition

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- **Standard**
- All signs, signals, markings, and other devices used to regulate, warn, or guide road users, placed on, over, or adjacent to a street, highway, pedestrian facility, or bikeway by authority of a public body or official having jurisdiction.
- All traffic control devices used on street and highway construction, maintenance, utility, or incident management operations **shall** conform to the applicable provisions of the MUTCD.



Function of Traffic Control Devices (TCD)

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- Promote highway safety
 - ▣ Provide for the orderly and predictable movement of all traffic
 - ▣ Provide guidance and warning as needed

- Types of TCD
 - ▣ Warning signs
 - ▣ Channelizing devices
 - ▣ Lighting devices
 - ▣ Shadow vehicles / advanced warning truck



Human Factor and Information Processing in Work Zones

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- People drive normally through work zones, even when there are traffic control devices present in the roadway, unless there is evident activity (workers, equipment, etc.)
- Lack of driver familiarity with temporary traffic control signals
- Unexpected conditions along work zone

Traffic Control Devices - **Standard**

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- The colors for regulatory signs **shall** follow the Standards for regulatory signs in Table 2A-4.
- Warning signs in TTC zones **shall** have a black legend and border on an orange background except:
 - Highway-Rail Grade Crossing Advance Warning (W10-1) sign which shall have a black legend and border on a yellow background.
 - Signs that are permitted to have fluorescent yellow-green backgrounds.



W10-1



Temporary Traffic Control Zones

Devices Regulations

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Standard

- All signs used at night **shall** be either retroreflective with a material that has a smooth, sealed outer surface or illuminated to show the same shape and similar color both day and night.
- The requirement for sign illumination **shall** not be considered to be satisfied by street, highway, or strobe lighting.

Temporary Traffic Control Zones

Devices Regulations

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Standard

- When standard orange flags or flashing warning lights are used in conjunction with signs, they **shall** not block the sign face.
- For freeways and expressways, the size of diamond shaped TTC warning signs **shall** be a minimum of 1200 x 1200 mm (48 x 48 in).



Figure 6F-1. Height and Lateral Location of Signs—Typical Installations

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Standard

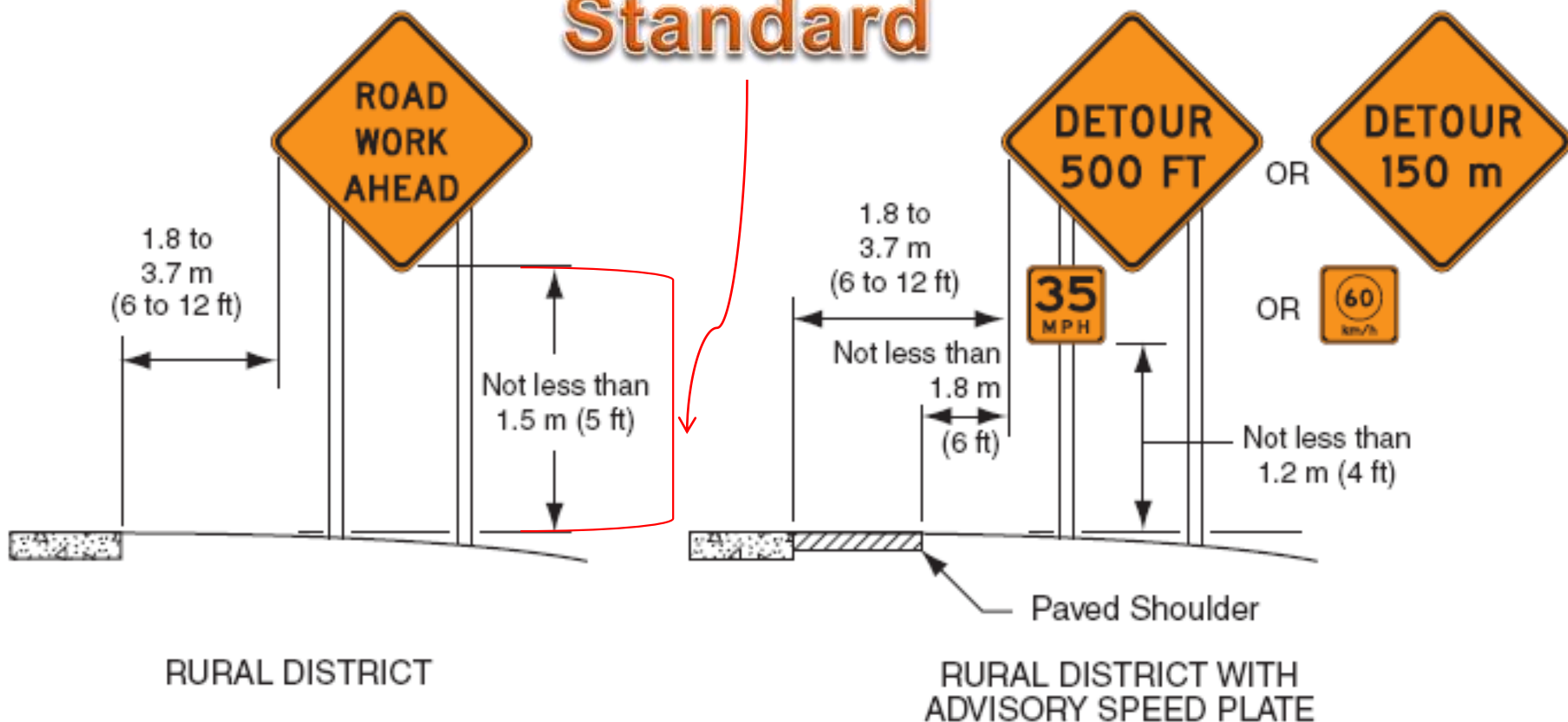
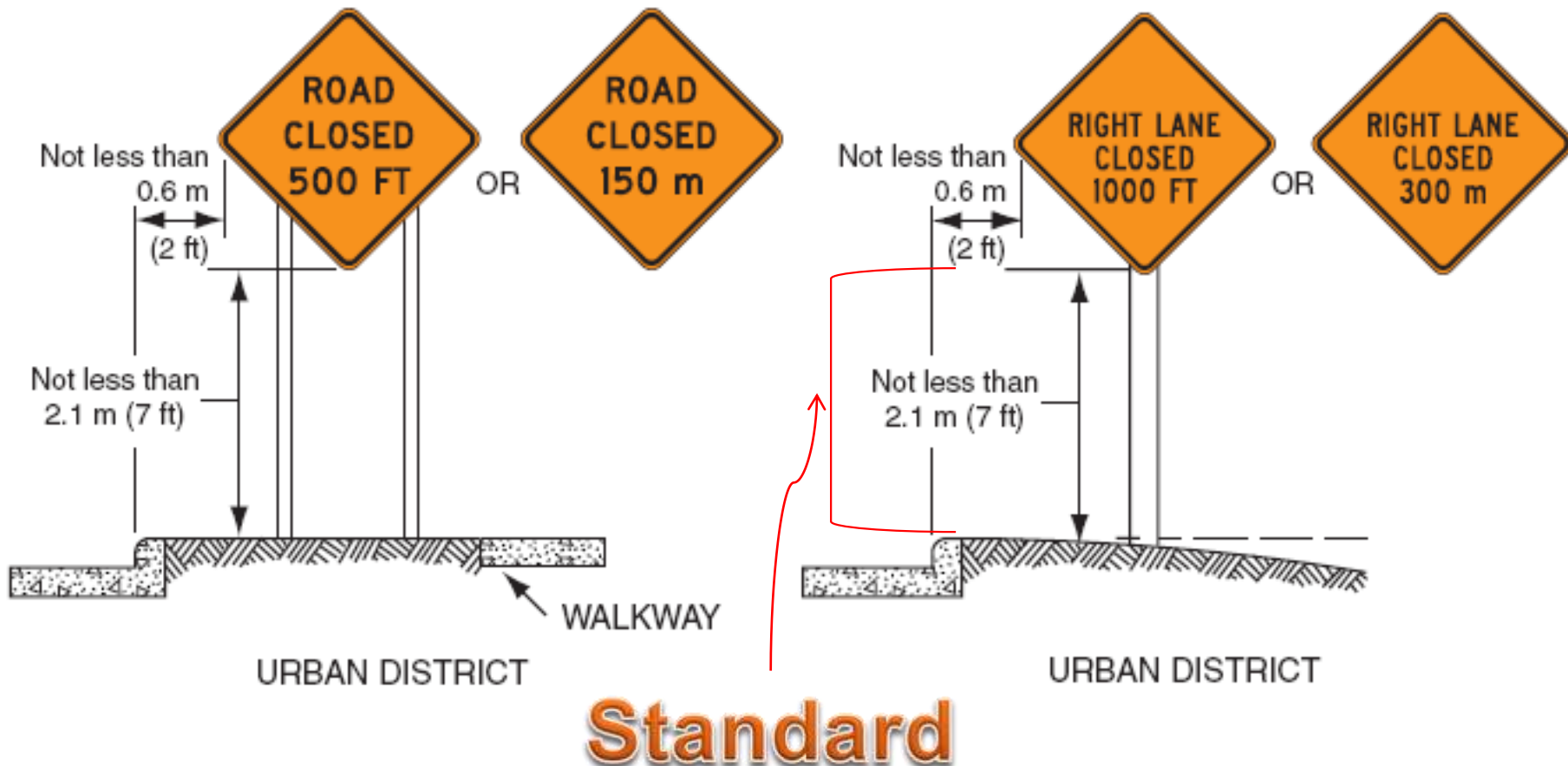


Figure 6F-1. Height and Lateral Location of Signs—Typical Installations

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Temporary Traffic Control Zones

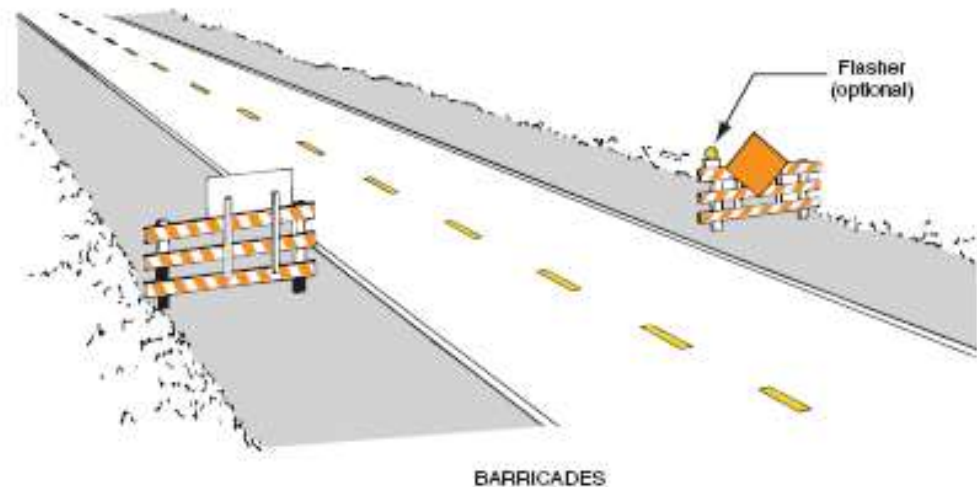
Devices Site Placement Standard

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- Signs mounted on barricades and barricade/sign combinations **shall** be crashworthy



- Where it has been determined that the accommodation of pedestrians with disabilities is necessary, signs **shall** be mounted and placed in accordance with Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).



Temporary Traffic Control Zones

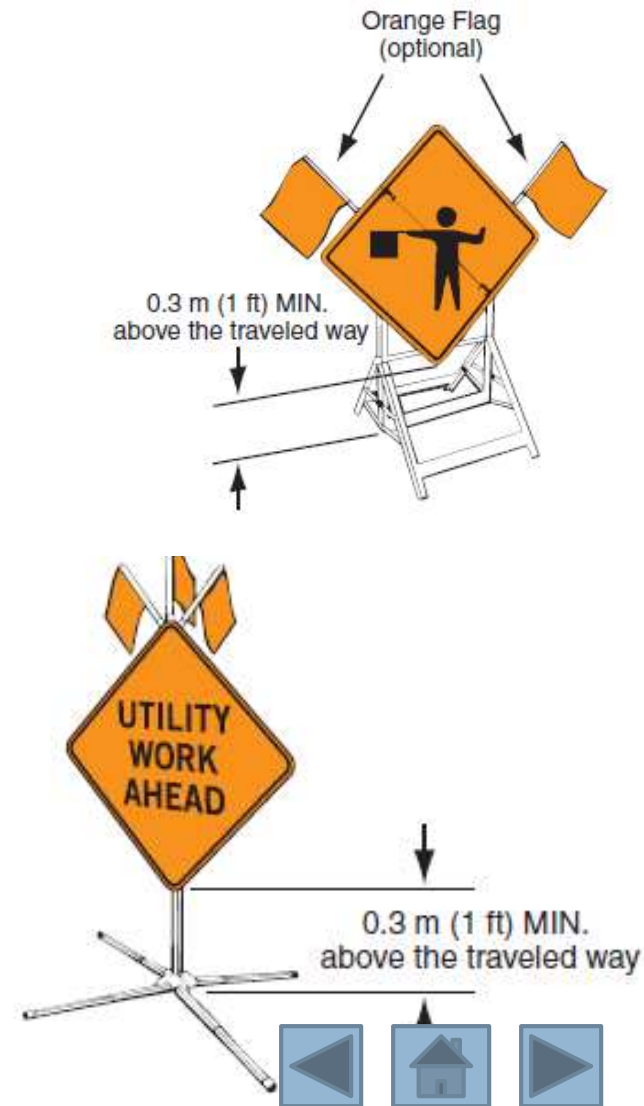
Devices Site Placement Standard

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- Sign supports **shall** be crashworthy.
- Large signs having an area exceeding 5 square meters (50 ft²) that are installed on multiple breakaway posts **shall** be mounted a minimum of 2.1 m (7 ft) above the ground.
- Signs mounted on barricades, or other portable supports, **shall** be no less than 0.3 m (1 ft) above the traveled way.



Temporary Traffic Control Zones

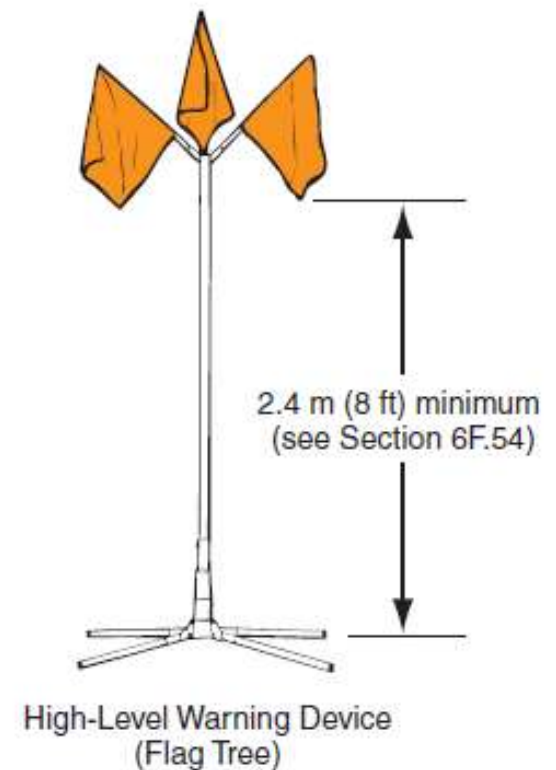
Devices Site Placement

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- Neither portable nor permanent sign supports should be located on sidewalks, bicycle facilities, or areas designated for pedestrian or bicycle traffic.
- Except as noted in the Option, signs mounted on portable supports should not be used for a duration of more than 3 days.



Traffic Control Devices Site Placement

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- For mobile operations, a sign may be mounted on a work vehicle, a shadow vehicle, or a trailer stationed in advance of the TTC zone or moving along with it.
- The work vehicle, the shadow vehicle, or the trailer may or may not have an impact attenuator.



PORTABLE AND TEMPORARY MOUNTINGS



TTC Devices - Portable Changeable Message (PCM) Signs

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- PCM signs **shall** be TTC devices with the flexibility to display a variety of messages.
- Each message **shall** consist of either one or two phases.
- A phase **shall** consist of up to three lines of eight characters per line.



TTC Devices - Arrow Panels

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- **Shall** be a sign with a matrix of elements capable of either flashing or sequential displays.
- **Shall** provide additional warning and directional information to assist in merging and controlling road users through or around a TTC zone.
- A vehicle displaying an arrow panel **shall** be equipped with high-intensity rotating, flashing, oscillating, or strobe lights.



TTC Devices - Arrow Panels



- Type A - use on low-speed urban streets.
- Type B - for intermediate-speed facilities and for maintenance or mobile operations on high-speed roadways.
- Type C - intended to be used on high-speed, high-volume motor vehicle traffic control projects.
- Type D - intended for use on authorized vehicles.

Panel Type	Minimum Size	Minimum Legibility Distance	Minimum Number of Elements
A	1200 x 600 mm (48 x 24 in)	0.8 km (1/2 mi)	12
B	1500 x 750 mm (60 x 30 in)	1.2 km (3/4 mi)	13
C	2400 x 1200 mm (96 x 48 in)	1.6 km (1 mi)	15
D	None*	0.8 km (1/2 mi)	12

*Length of arrow equals 1200 mm (48 in), width of arrowhead equals 600 mm (24



TTC Devices - Arrow Panels



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Operating Mode

- I. At least one of the three following modes shall be provided:

Flashing Arrow

Sequential Arrow

Sequential Chevron

- II. The following mode shall be provided:
Flashing Double Arrow

- III. The following mode shall be provided:
Flashing Caution

Panel Display (Type C panel illustrated)

(Right arrow shown; left is similar)



Move/Merge Right



Move/Merge Right



Move/Merge Right



Caution

or



Caution



Channelizing Devices

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- ☐ Cones
- ☐ Tubular Markers
- ☐ Vertical Panels
- ☐ Drums
- ☐ Barricades



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-

Diagram illustrating the minimum height requirements for retroreflective bands on traffic signs.

Left Diagram (700 mm MIN. height):

- Retroreflective Band
- 50 mm (2 in)
- 75 mm (3 in)
- 50 to 150 mm (2 to 6 in)
- 75 mm (3 in)
- 700 mm (28 in) MIN.

Right Diagram (450 mm MIN. height):

- Retroreflective Band
- 50 mm (2 in)
- 75 mm (3 in)
- 450 mm (18 in) MIN.

Day and Low-Speed
Roadway (≤ 60 km/h)
(≤ 40 mph)

TUBULAR MARKERS



Category 1 Devices

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- **Shall** be predominantly orange.
- **Shall** be made of a material that can be struck without causing damage to the impacting vehicle.
- For nighttime use - **shall** be retroreflectorized or equipped with lighting devices for maximum visibility.



Cones - Standards



CONES

Note: If drums, cones, or tubular markers are used to channelize pedestrians, they shall be located such that there are no gaps between the bases of the devices, in order to create a continuous bottom, and the height of each individual drum, cone, or tubular marker shall be no less than 900 mm (36 in) to be detectable to users of long canes.

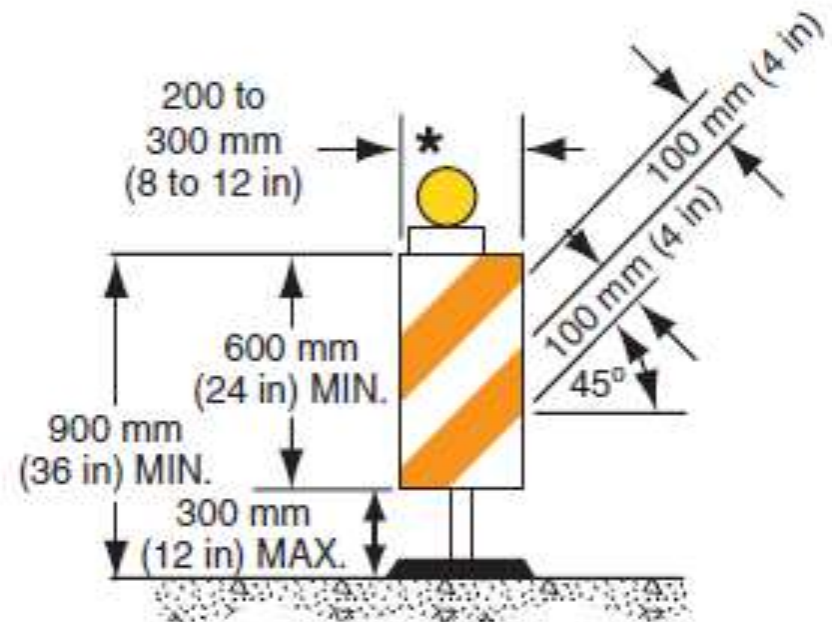
Category 2 Devices

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- Vertical panels, Type I, II, or III barricades, portable sign stands
- Category 1 devices w/ attachments (< 45 kg (100 lbs) up to 100 kg)
- Must be crash tested by approved agency



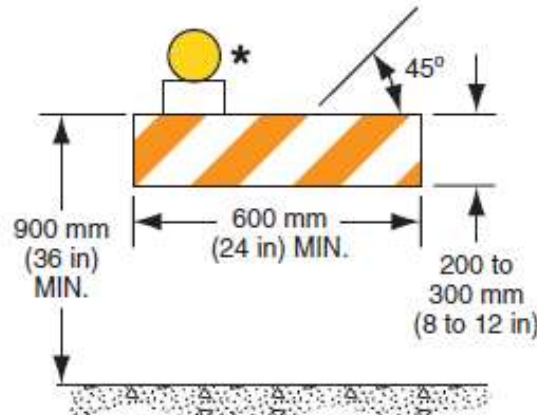
VERTICAL PANEL



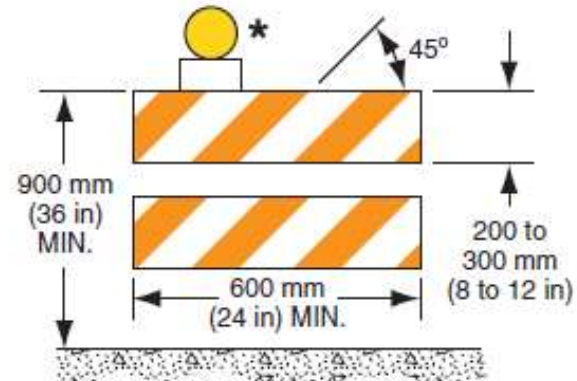
Cone w/ vertical panel and light



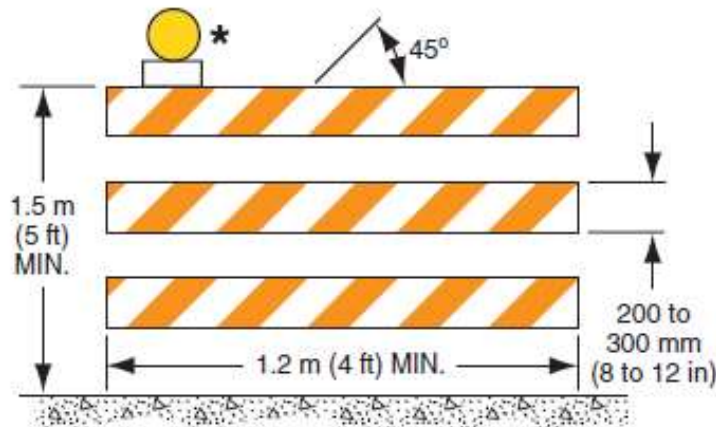
Category 2 Devices



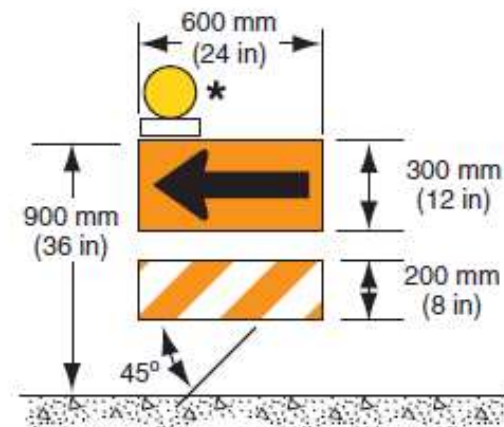
TYPE I BARRICADE **



TYPE II BARRICADE **



TYPE III BARRICADE **



DIRECTION INDICATOR BARRICADE **

* Warning lights (optional)

** Rail stripe widths shall be 150 mm (6 in), except that 100 mm (4 in) wide stripes may be used if rail lengths are less than 900 mm (36 in). The sides of barricades facing traffic shall have retroreflective rail faces.

Barricades

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Type II



Type III



X-stands w/ vinyl roll-ups

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MiDOT's combination sign w/ wood panels

Pass @ 0 deg & Failure @ 90 deg

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Example of Windshield Penetration

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-
- Diagram illustrating a lane closure work zone configuration. The diagram shows a two-lane road with a temporary white edge line and a crash cushion. A buffer space (optional) is shown between the crash cushion and the shoulder taper (optional). The shoulder taper is marked with orange flags. Advance warning signs are shown: a yellow diamond sign with a black arrow pointing right, a red diamond sign with a black arrow pointing left, and a red diamond sign with the text "RIGHT LANE CLOSED AHEAD". The diagram also shows a red diamond sign with the text "ROAD WORK AHEAD". The diagram is labeled "Application 34".

Uses for Temporary Longitudinal Barriers

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- Prevent Access to Work Zone
- Provide Positive Protection for Workers
- Separate Two-Way Traffic
- Protect Falsework



Temporary Safety Barriers



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	PCB	Quickchange®	Low Profile	Plastic Shell/Steel
Structural Adequacy	Varies depending on the type of joint	TL-3*	TL-2*	TL-2 & TL-3*
Deflection	0 – 1.5 m [0 – 5 ft]	1.5 m [5 ft]	0.125 m [5 in]	3.8 & 3.9 – 6.9 m [22.6 ft]
Uses	Two-lane, two-way operation Shielding obstacles and falsework Shielding pavement edge drop-offs	Shielding for changeable lanes	Work sites in urban and suburban areas where sight distance is a problem	Shielding where high portability is desired; i.e., rapidly changing and emergency traffic control measures Protection in congested urban work sites

* NCHRP Report 350 Test Level



PCB – Portable Concrete Barrier

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- Positive protection to road workers
- Avoid penetration in work area
- Modular design
 - ▣ Impact angle: 15° - 25°
 - ▣ Height: 32"
 - ▣ Base width: 24"
 - ▣ Top width: 6"
 - ▣ Length: 84" (7')
 - ▣ Maximum deflection: 0 – 5 feet



Portable Concrete Barrier

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Steel Portable Barriers

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**ArmorGuard
TL-2, TL-3**

**Steel Barrier Guard 800
TL-3,4**



**Vulcan
TL-3**



Example of Plastic Portable Barriers



Quickchange Moveable Barrier



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- ❑ Chain of modified F-shape barrier segments
- ❑ T-shape on top to allow pick up of segments
- ❑ Lateral movement from 4 to 18 ft
- ❑ Maximum deflection of 28 in at TL-3 design impact
- ❑ Transfer speed of 5 to 10 mph





Work Zone Crash Cushions

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Triton CET Concrete End Treatment

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Sample Crash Cushions for Work Zones

Quadguard TL-3

React 350 TL-1/2/3



Absorb 350



Category 4 Devices

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- Portable, usually trailer-mounted devices
- Lighting supports, flashing arrow panels, temporary traffic signals, & changeable message signs
- Should be delineated or shielded
- Use good placement practices



Worker Safety Tips

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show help



Temporary Traffic Control Devices ROADWAY SAFETY+



English

What Are Best Practices?

Precautions make TTCD placement safer.

Contractors should

- Place, relocate, remove TTCDs when traffic is light
- Install TTCDs from the first TTCD motorist sees to the last
- Remove TTCDs from the last TTCD motorist sees to the first
- Prohibit workers on foot from operating behind a backing vehicle, behind vehicles that might back up, or in equipment blind spots
- Plan “moving work zones” with proper mobile warning devices [MUTCD](#)
 - Arrow panels
 - Changeable message boards
 - flashing vehicle lights
 - truck/trailer-mounted attenuators



Worker Safety Tips

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Temporary Traffic Control Devices ROADWAY SAFETY+



English

How Are TTCDs Installed and Removed?

Install from the first TTCD motorists sees to the last. Remove from the last seen to the first seen.

Remove TTCDs



Worker Safety Tips

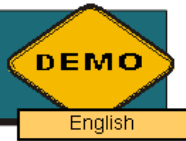
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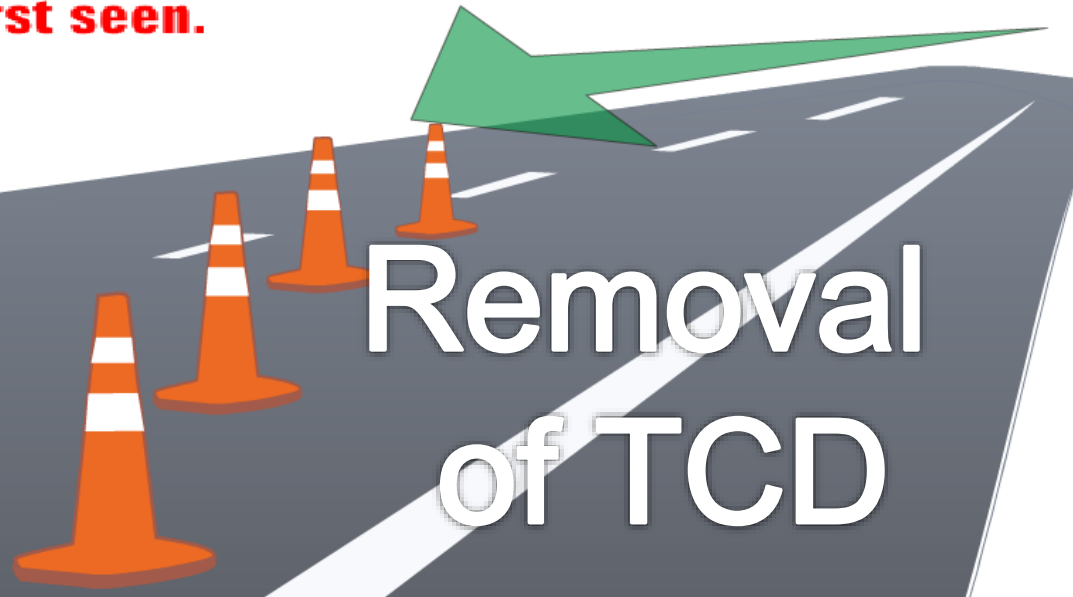
Temporary Traffic Control Devices ROADWAY SAFETY+



How Are TTCDs Installed and Removed?

Install from the first TTCD motorists sees to the last. Remove from the last seen to the first seen.

Install TTCDs



Worker Safety Tips

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Runovers/Backovers ROADWAY SAFETY+



How Can We Be Safe When Placing TCDs?

Simple precautions make placement of TCDs (Traffic Control Devices) safer.

Workers should

- Wear Class III vests to be easily seen
- Place, relocate, or remove TCDs when traffic flow is light
- When possible, work from platform on vehicle
- Use seat, seatbelt, fall restraint, or guardrail and a handhold when guardrail must be removed
- Stay in constant communication with driver
- Use shadow vehicle to warn drivers



Worker Safety Tips

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How Do We Protect Ourselves?

Use platforms designed for TTCD deployment and retrieval



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BEGIN
INSTRUCTION
ZONE

Temporary Traffic Control Devices ROADWAY SAFETY+

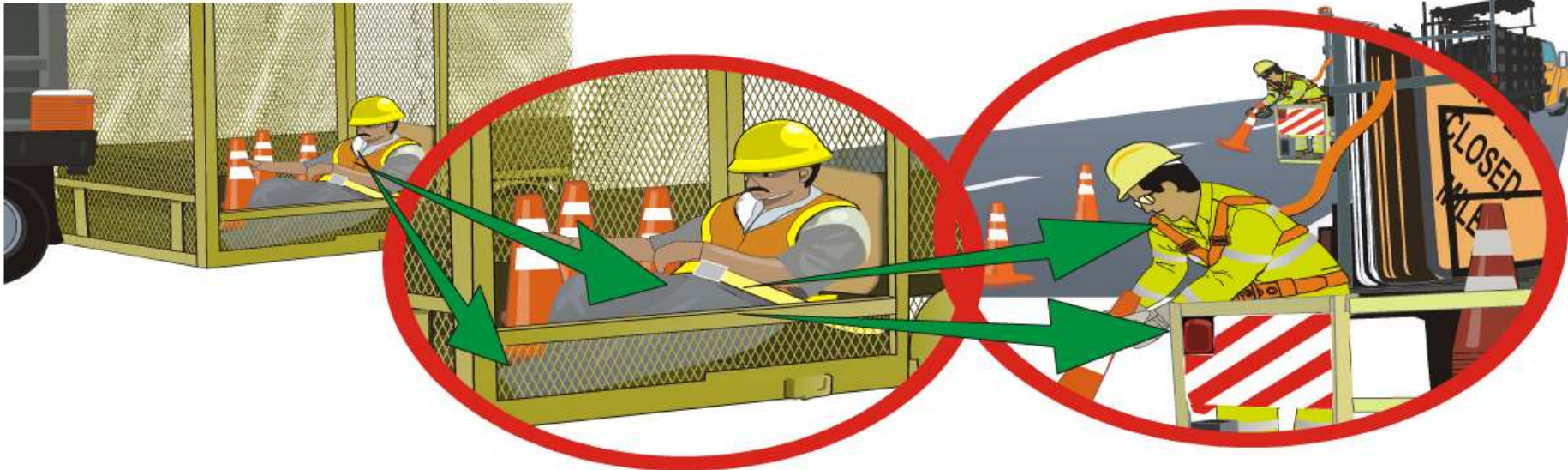
DEMO

English

How Do We Protect Ourselves?

Use Seat Belts, Harnesses and Restraints.

[View Seat Belt Demos](#)



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Temporary Traffic Control Devices ROADWAY SAFETY+



How Do We Protect Ourselves?

Use Shadow Vehicles and Attenuators.

[Review Attenuator Applications](#)

[Show Attenuator Use](#)



Worker Safety Tips

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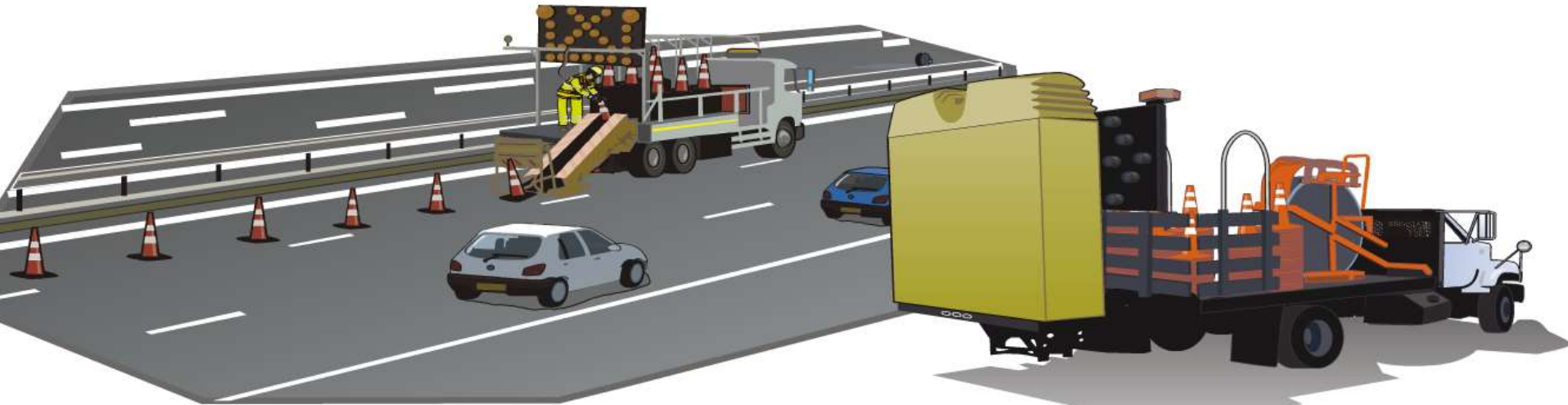


Temporary Traffic Control Devices ROADWAY SAFETY+



How Do We Protect Ourselves?

Use automated systems for TTCD deployment and retrieval.



Several automated systems for deploying and retrieving TTCDs are currently available. Expect more in the future.



Worker Safety Tips

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BEGIN
INSTRUCTION
ZONE

Temporary Traffic Control Devices ROADWAY SAFETY+

DEMO

English

How Do We Protect Ourselves?

Use Communication Systems to stay in contact.



Communication Demo



Module 8



Brainstorming for creating awareness of TTC in USVI



Module 9



Examples of adequate and inadequate use of TTC in highway and utility work zones



Module 10



*Workshop: Development of a TTC Plan for
(a) Rural, (b) Urban using PDF version*





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University of Puerto Rico at Mayagüez

Course Evaluation

