

# Work Zone Worker Protection Field Guide



Developed by

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## Table of Contents

Preface .....	3
Introduction .....	4
Worker Safety Considerations .....	6
Recommended Practices for Worker Safety & Protection .....	13
1. Sign installation, removal and covering .....	13
2. Installation and removal of lane closures .....	15
3. Installation and removal of detours .....	20
4. Installation and removal of portable barriers .....	21
5. Flagging operations .....	22
6. Repair of crash cushions .....	23
7. Working in close proximity to traffic .....	24
8. Installation and removal of raised pavement markers (RPMs) .....	27
Typical Applications .....	28-58
Figure 6H-1 Work Beyond the Shoulder (TA-1) .....	30-31
Figure 6H-3 Work on the Shoulders (TA-3) .....	32-33
Figure 6H-4 Short-Duration or Mobile Operation on a Shoulder (TA-4) .....	34-35
Figure 6H-6 Shoulder Work with Minor Encroachment (TA-6) ...	36-37
Figure 6H-17 Mobile Operations on a Two-Lane Road (TA-17) .....	38-39
Figure 6H-30 Interior Lane Closure on a Multi-Lane Street (TA-30) .....	40-41
Figure 6H-33 Stationary Lane Closure on a Divided Highway (TA-33) .....	42-43
Figure 6H-34 Lane Closure with a Temporary Traffic Barrier (TA-34) .....	44-47
Figure 6H-35 Mobile Operation on a Multi-Lane Road (TA-35) ...	48-51
Figure 6H-42 Work in the Vicinity of an Exit Ramp (TA-42) .....	52-53
Figure 6H-43 Partial Exit Ramp Closure (TA-43) .....	54-55
Figure 6H-44 Work in the Vicinity of an Entrance Ramp (TA-44) ...	56-58

## Preface

The purpose of this field guide is to discuss highway worker safety considerations and provide practical how-to information to help workers improve their safety in a variety of commonly encountered situations. This handy reference presents information on the options available to workers on highway construction sites.

Although some information is based on the standards and guidelines found in the 2009 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD), the information in this guide should be treated as recommended practices or guidelines for methods and procedures in order to give guidance to the user. Use of any or all elements of these recommended practices is discretionary; it may be used as stated or modified by the user to meet specific needs.

This field guide does not constitute a standard, recommended procedure or regulation of any kind. Specific standards and procedures that apply to the application of these practices may vary from jurisdiction to jurisdiction, depending on the type of work, its duration and several other factors. Users are encouraged to obtain information about state-specific standards and guidelines, local requirements, best practices and successful lessons learned.

## Introduction

Highway work zones can be dangerous to both highway users and field workers. Passenger and commercial vehicles are often traveling in very close proximity to highway workers and construction crews. Distracted motorists may miss or purposely ignore regulatory and advisory work zone warning signs resulting in work zone crashes. These crashes often involve highway workers and can be deadly.

Because of the type, location and duration of work, and roadway/traffic characteristics, work zones can be very diverse. Applicable standards and procedures may vary from jurisdiction to jurisdiction, depending on the type of work, its duration, and several other factors. Often times, these standards and procedures do not address every conceivable situation. Designers, contractors and sometimes the workers themselves must rely on their judgment and discretion to adapt to the specific conditions.

The 2009 edition of the *Manual on Uniform Traffic Control Devices* (MUTCD), which defines minimum national standards and guidelines for temporary traffic control (TTC) provides little guidance on the installation and removal of TTC devices. Nationwide, however, procedures are being used to protect workers while minimizing the impact of the work zones to the motoring public.

This field guide presents some of these procedures. Although some information is based on the standards and guidelines found in the MUTCD, the information in this guide should be treated as recommended practices or guidelines for methods and procedures in order to give guidance to the user. Use of any or all elements of these recommended practices is discretionary; it may be used as stated or modified by the user to meet specific needs.

These guidelines are intended to help highway workers stay safe as they build and maintain our nation's highways. It is designed to be used as a field reference, in bullet format, to be carried by workers assigned to work in highway work zones for quick consultation. It is best used as a supplement, and not as a replacement, to the training module with the same name, available from ATSSA.

Its objectives are:

- To discuss worker safety considerations, and
- To provide practical how-to information to highway workers to help them improve their safety as they work in a variety of situations commonly encountered

This field guide does not constitute a recommended procedure or regulation of any kind. The reader should supplement the information in this guide with applicable regulations, standards and requirements, and training.

## Worker Safety Considerations

### Issues with Worker Safety and Exposure in Temporary Traffic Control Zones

- Constantly changing conditions
- Moving equipment and vehicles within the activity area
- Workers on foot
- Distracted/impaired drivers
- Short duration projects
- Barriers not always feasible

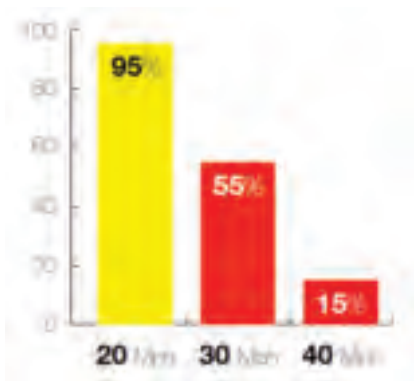
### Workers are Vulnerable!

- 15% of work zone fatalities are workers!
- Distracted/ impaired drivers
- Unforgiving environment

### Pedestrian Survival Rate by Vehicle Speed

(Source: Smart Growth America)

- 95% at 20 mph
- 55% at 30 mph
- 15% at 40 mph



## Addressing Worker Safety

### 1. Avoid or minimize worker exposure

- Full road closures
- Diversions
- Median crossovers
- Ramp closures
- Rolling roadblocks
- Accelerated construction techniques

### 2. If exposed, use of appropriate positive protection devices<sup>1</sup>

- Temporary barriers
- Truck-Mounted attenuators (TMA)

### 3. Apply intrusion countermeasures

- Law enforcement officers
- Speed management
- Higher fines

### 4. Full compliance with TTC standards and guidelines

- Traffic control devices
  - Crash-tested
  - Approved
  - Inspected
  - Good quality

## The Manual on Uniform Traffic Control Devices (MUTCD)

- Minimum national TTC standards and guidelines
- Section 6D.03 addresses **Worker Safety Considerations**
  - *Worker safety in TTC zones should be an **integral and high-priority element** of every project from planning through design and construction.*

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<sup>1</sup> Positive protection devices are approved (crashworthy) devices that contain and/or redirect errant vehicles in accordance with the National Cooperative Highway Research Program (NCHRP) Report 350 and/or the Manual for Assessing Safety Hardware (MASH) crash testing criteria.

## Key Elements To Improve Worker Safety

### 1. Training

- Everyone! From upper-level management through the field workers
- Protects against tort liability
- Training saves lives!
- MUTCD: *Only trained individuals should supervise the selection, placement, and maintenance of TTC devices*
- Consider worker certification
  - [www.atssa.com](http://www.atssa.com)

### 2. Positive Protection

- The application of devices that:
  - Contain or redirect errant vehicles
  - Are crash-tested
  - Are approved by the State
- Positive protection devices include:
  - Temporary Traffic Barriers
    - Positive protection devices
    - Prevent vehicular penetration
    - Minimize intrusions
    - Their use should be based on an engineering study
  - Shadow/Barrier Vehicles
    - Truck-mounted attenuators (TMAs)<sup>2</sup>
  - Vehicle Arresting Systems

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<sup>2</sup> Includes both truck-mounted and trailer-mounted attenuators.



- Other Exposure & Traffic Control Measures<sup>3</sup>
  - Portable rumble strips
  - Intrusion alarms

### 3. Speed Management

- Speed limit reduction should be warranted
  - Speed study, for instance
- Reduction of no more than ten mph
  - MUTCD: *Reduced speed limits should be used only in the specific portion of the TTC zone where conditions or restrictive features are present. However, frequent changes in the speed limit should be avoided. A TTC plan should be designed so that vehicles can travel through the TTC zone with a speed limit reduction of no more than 10 mph. A reduction of more than 10 mph in the speed limit should be used only when required by restrictive features in the TTC zone. 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.*
- Use approved regulatory signs
- MUTCD: 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.
- Speed Deterrence and Enforcement
  - Law Enforcement Officers
    - Not immune to crashes
    - Not a TMA!
    - Law enforcement officers SHOULD NOT BE located in the buffer space

<sup>3</sup> The application of positive protection devices is not always feasible or practical. Consideration of exposure control and other traffic control measures that would avoid or minimize worker exposure to motorized traffic may decrease the overall need for positive protection devices. Technically, these are not positive protection devices.

- Law enforcement officers SHOULD BE located in the advance warning area
- Officers should be shielded by a TMA
- Automated Speed Enforcement (ASE)
  - Sensors generate recorded images of violators above a defined threshold (decided by the implementing agency)
  - Citations are mailed
  - Deters speeding
- Radar Speed Display Trailers
  - Immediate speed feedback
  - Encourage speed limit compliance
  - Increase safety
  - Delineate when in use
  - Remove when not in use
  - Use sporadically for increased effectiveness
- Variable Speed Limits (VSL)
  - Dynamically changes the speed limit based on conditions
  - Realistic speed limit = higher compliance

### **Internal Traffic Control Plans (ITCP)**

- Minimizes maneuvering of construction vehicles inside the work space to:
  - Reduce worker exposure
  - Isolate workers from equipment
  - Limit access points
  - Reduce the need to reverse (backup)
  - Develop and share with project personnel
  - Update daily
  - Require contractors to attend ITCP briefings
  - Consider MUTCD signs where not seen by passing motorists

- Reducing The Need To Reverse
  - Adopt a one-way system
  - If not possible, consider
    - Drive-thru zones
    - Turning areas
    - “Reverse” areas
    - Fit mirrors and cameras
    - Proximity detection systems
    - Use trained spotters, but only when all other options have been exhausted
- Using spotters<sup>4</sup>
  - To spot the movement of construction vehicles inside the work space
  - Use standard signals



<sup>4</sup> This refers to spotters inside the work space, not traffic spotters, which are discussed later.

## 5. Worker Safety Planning

- Conduct a basic hazard assessment
  - Work zone safety audit
- Compliance with Occupational Safety and Health Administration (OSHA)
  - General Duty Clause
  - Imminent Danger Clause
  - Imminent Danger
    - Any conditions or practices that are likely to cause worker death or serious physical harm
  - OSHA “Imminent Danger” Requirements
    - There must be a threat of death or serious physical harm
    - Reasonable expectation of injury or fatality
    - Threat must immediate or imminent
    - OSHA inspector must inform affected parties
    - OSHA has the right to order the employer to eliminate the imminent danger

## 6. Worker Visibility

- All workers within the highway’s right-of-way shall wear:
  - ANSI 107 Class 2 apparel or higher<sup>5</sup>
  - Class 3 recommended at night
- Clean
- Good quality
- Personal Protective Equipment (PPE)
  - Protects:
    - Eyes and face
    - Feet
    - Hands
    - Head
    - Hearing

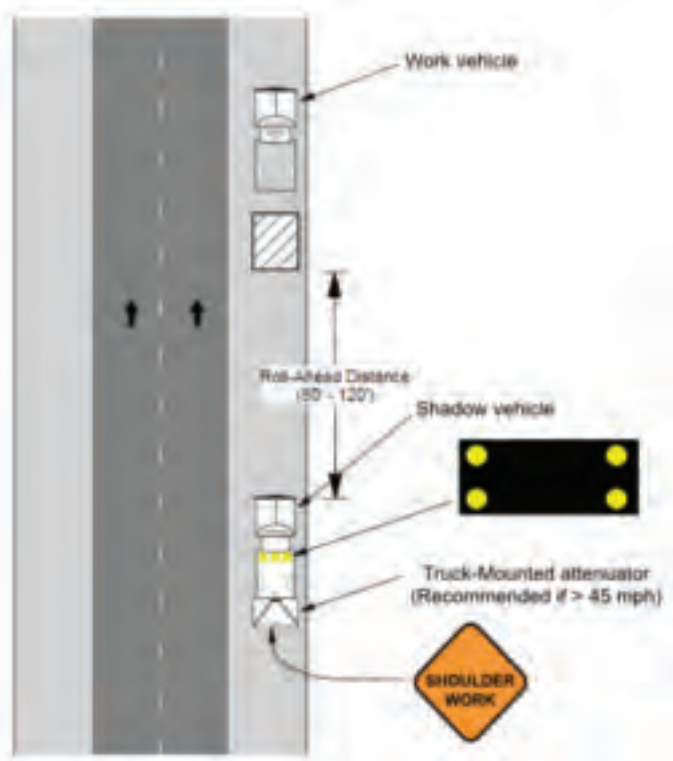
<sup>5</sup> ANSI/ISEA 107–2004 (or 2010) publication entitled “American National Standard for High-Visibility Apparel and Headwear”. ANSI 107 Class 3 may be required in some jurisdictions.

## Recommended Practices for Worker Safety and Protection

This section discusses recommended practices for a variety of situations commonly encountered. They are not presented in any predetermined order and may not be necessarily related.

### 1. Sign Installation, Removal and Covering

- Treat as a mobile or short-duration operation
  - Mobile is work that moves intermittently or continuously
  - Short duration is work that occupies a location up to 1 hour
- TMA if  $>45$  mph
  - Caution mode
  - High-intensity rotating, flashing, oscillating, or strobe lights on all vehicles
  - Allow for roll-ahead distance
    - In accordance with the manufacturer's instructions
    - 80-120 feet (2-3 skip lines)
- Consider traffic spotters
- Face traffic at all times
- Vehicle may block line of sight
- Do not encroach in the lane
- Do not cross high-speed lanes
- Minimize exposure

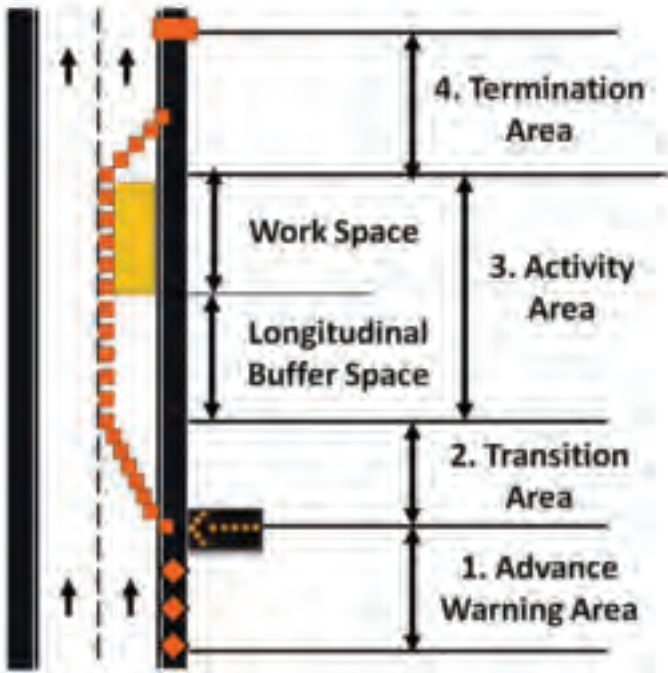


- Sign installation on left side
  - Install first (for right lane closures)
  - Consider traffic spotter w/audible device
  - Have line of sight to traffic
    - TMA may block the line of sight
  - Do not run across freeway lanes!

- Sign covering
  - Use only approved covers
  - Fully covered
  - Expedite operation
  - From the ground

## 2. Installation And Removal Of Lane Closures

- Most TTC zones are divided into four areas: 1) the advance warning area, 2) the transition area, 3) the activity area, and 4) the termination area. These areas are illustrated in the following figure:



- Laying Out (marking) the Temporary Traffic Control
  - Treat as a short-duration operation<sup>6</sup>
  - MUTCD: *Simplified control procedures may be warranted for short-duration work. A reduction in the number of devices may be offset by the use of other more dominant devices such as high-intensity rotating, flashing, oscillating, or strobe lights on work vehicles.*
- Use pink inverted marking paint (Survey marks)
- Determine and locate the beginning of the work space
- Mark from there AGAINST the flow of traffic
- Face traffic at all times
- High-intensity rotating, flashing, oscillating, or strobe lights on work vehicles
- High-Visibility Safety Apparel on all workers
- Develop and approve TTC Plan and permits
- Advance preparation and coordination are key
- Take TTC Plan to the site and make sure it will work
- Mark location of all TCDs
  - Utility location
- Load the truck in the reverse order of installation
  - END ROAD WORK first
- If applicable, install signs on side streets first, starting with the first sign drivers will see
- If signs on both sides, install signs on the opposite (open lane) side first
- Drive to next exit/median opening, make U-turn and return to the area
  - Do not run or walk across live lanes of high speed traffic!

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<sup>6</sup> Short duration is work that occupies a location up to 1 hour.

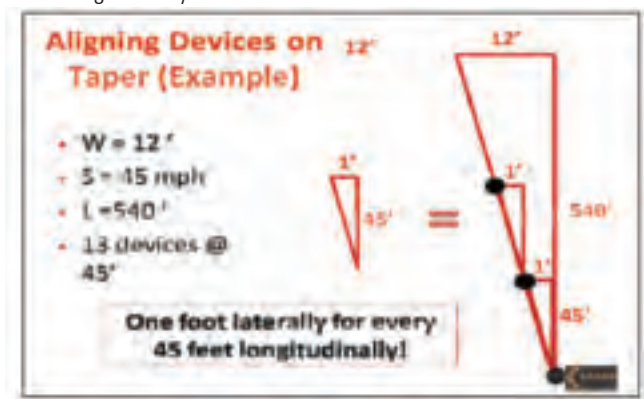


- Install signs on the side to be closed
- Proceed with the flow of traffic until completing the installation of all signs in the advance warning area
- Depending on conditions, consider:
  - Shadow vehicle with TMA
  - Rolling block
  - Law enforcement support
- Facing traffic, install shoulder taper, if used
- Locate arrow board on shoulder and TURN ON
- Separate TMA highly recommended
- Install taper at the specified device spacing
  - Merging taper  $L$  is the speed of the facility  $\times$  the width of the offset (with of lane for merging situations). For example,  $55 \text{ mph} \times 12 \text{ ft} = 660 \text{ ft.}$  minimum merging taper length ( $L$ ).

## Merging Taper Length, Min. Number of Devices, Device Spacing and Buffer Table

	Min. Merging Taper Length (L) in Feet Width of offset (w) in Feet				Minimum Number of Devices Width of offset (w) in Feet				Maximum Device Spacing in Feet			Buffer Space
	9'	10'	11'	12'	9'	10'	11'	12'	Along Taper	Along Tangent	in Feet	
Speed (mph)												
25 or below	95	105	115	125	5	6	6	6	25	50	155	
30	135	150	165	180	6	6	7	7	30	60	200	
35	185	205	225	245	7	7	8	8	35	70	250	
40	240	270	295	320	7	8	9	9	40	80	305	
45	405	450	495	540	10	11	12	13	45	90	360	
50	450	500	550	600	10	11	12	13	50	100	425	
55	495	550	605	660	10	11	12	13	55	110	495	
60	540	600	660	720	10	11	12	13	60	120	570	
65	585	650	715	780	10	11	12	13	65	130	645	
70	630	700	770	840	10	11	12	13	70	140	730	
75	675	750	825	900	10	11	12	13	75	150	820	
80	720	800	880	960	10	11	12	13	80	160		

- Use skip lines as a reference for aligning devices
- If using maximum device spacing (posted speed in feet), offset the devices one foot laterally for every 45 feet longitudinally



- Install devices on tangent at the specified spacing
  - May use skip lines as a reference
  - If using maximum device spacing (twice the posted speed in feet), separate the devices every other skip line
- Locate barrier vehicle in position, if used<sup>7</sup>
  - Trained operator
  - Equip with TMA if high-speed (i.e., > 45 mph):
  - Follow manufacturer's instructions
  - Allow for roll-ahead distance
  - Inside the work space
  - Not in the buffer space
  - No driver!
  - In gear/park
- Install devices in the termination area
  - Downstream taper
  - END ROAD WORK

<sup>7</sup> The use of TMAs is optional in the MUTCD. Several jurisdictions require TMAs for high speed facilities such as freeways and expressways.

- Best TMA Practices
  - Workers should not stand or be near a deployed TMA
  - No operator for stationary operations
  - In gear/park
  - Nothing loose in cab
  - TMA operator training
    - Critical to his/her safety and the safety of other workers
    - ATSSA has a TMA operator certification course
- Removal of Stationary Lane Closures
  - Reverse the installation process
  - Remove termination area first
  - Remove tangent AGAINST the flow of traffic
  - May need to go in reverse with TMA
  - Remove taper and arrow board
  - Remove advance warning signs
  - With or against the flow of traffic, depending on conditions
  - Drive to next exit/median opening , make U-turn and return to the area
    - Do not run or walk across live lanes of high speed traffic!

### 3. Installation and Removal of Detours

- Treat as short-duration operation
- Install against the flow of traffic
- Remove with the flow of traffic
- Consider one crew for each direction
- Install all signs first, then do the actual closure last!



- Flare
- Crash cushion
- Out of clear zone
- Length of need
- Positive connections
- Anchoring Barriers
  - Requirements vary by state, usually if:
    - No deflection space
    - Separating opposing flows
    - Bridge railings
  - Anchor on traffic side, if required
- Longitudinal Channelizing Devices (LCDs)
  - Do NOT contain or redirect a vehicle
  - Do not prevent vehicle intrusions
  - NOT A POSITIVE PROTECTION DEVICE! DO not use for worker protection!
  - Do provide a “continuous detectable edge”

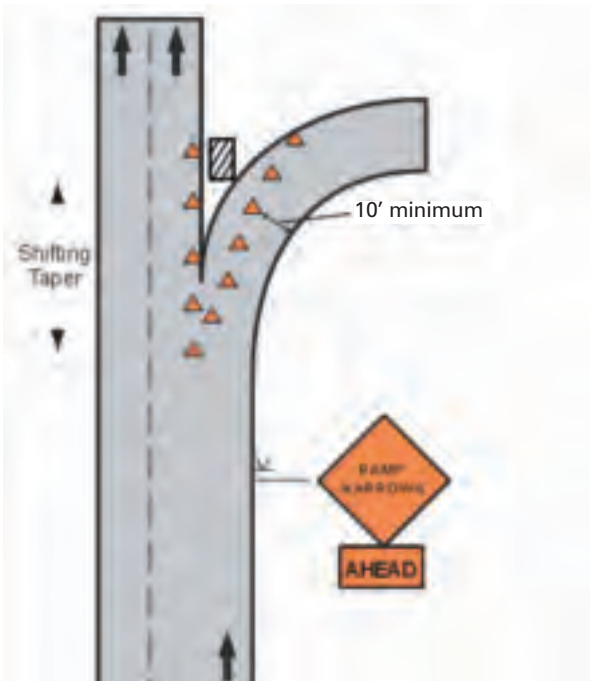
## 5. Flagging Operations

- Train all flaggers
- Proper equipment
  - STOP/SLOW paddle
  - Flags for emergencies only
  - ANSI 107 Class2 apparel or higher
- Proper signals
- Proper position
  - On the shoulder
  - Not in the path of vehicles
  - Not inside intersections
- Illuminated station
- 500 ft. sight distance
- Escape route

- Enhanced flagger stations
- Workers should not stand near the flagger

## 6. Repair of Crash Cushions

- Consider lane and/or ramp closure or narrowing
- Minimize exposure
- Working in the Gore Area (The triangular area where roads merge or split)
  - Delineate gore area with channelizing devices, 5-10 feet apart
  - Use traffic spotters
    - Last resort!





## 7. Working In Close Proximity To Traffic

- Advance warning signs
- Portable changeable message signs
- Police support
- Good visibility
- Barrier vehicles
  - TMA if more than 45 mph, even if not required
- Traffic spotters
- Minimize exposure



- Lateral buffer spaces
- Speed limit reduction
- Mobile barriers
  - Mobile positive protection
  - Minimizes exposure
  - Reduces set-up time
  - Minimizes foot print and manpower by placing tools and materials on one vehicle
  - Balsi Beam
    - Designed by Caltrans
    - Provides 30 feet of protected space
- Safety Procedures
  - Plan and assess the position of workers, equipment and materials
  - Use situational awareness
  - Maintain appropriate separation distances from traffic
  - Park work vehicles away from passing traffic
  - Seat belts must be worn at all times
  - Only the driver of a parked vehicle should remain in the vehicle
  - Secure all items in the cargo and cab area
  - Improve vehicle visibility
- Do's
  - Find the safest available location to park or unload equipment
  - Use the work vehicle as protection and warning signs whenever possible
  - Take advantage of any resources providing protection and warning without causing additional exposure
    - TMAs
    - Buffer/shadow vehicles
    - Portable Changeable Message Signs
    - High-intensity rotating, flashing, oscillating, or strobe lights on work vehicles

- Plan ahead
- Avoid high traffic volume hours and locations
- Consider alternate work operations
- Work on the same side of the road as the work vehicle and whenever possible
- Don'ts
  - Take "short cuts" or hurry to accomplish work
  - Run across or "dodge" traffic in live lanes
  - Work in a live lane under without proper traffic control in place
  - Assume that shoulder areas are automatically safe
  - Turn your back to oncoming traffic
  - Put yourself in an unexpected location that may surprise a driver
- Consider Using a Traffic Spotter When...
  - It is the last resort!
  - Workers must have their backs to traffic
  - Working in a live travel lane
  - Work encroaches into the roadway
  - Limited sight distances
  - Posted speeds are 45 mph or higher
- Location of Traffic Spotter
  - Within visual and verbal contact of employee(s) that are being protected
  - If not possible, use
    - Air-horn/ marine whistle
    - Two-way radio, or
    - Other warning device
- Alert call
  - Needs to be clearly heard above all surrounding noise levels
  - Shall be understood and agreed upon
- Escape route
  - Predetermined/agreed for both the spotter and the protected employee(s) prior to beginning work

- Spotter Roles and Responsibilities
  - Spotting is the ONLY role
  - Be within sight or sound
  - Optimum location
  - Know the “Alert Call”
  - Be on alert to sound the alarm
  - Be in place before the operation begins.
  - Confirm that all affected parties understand the action plan

## 8. Installation and Removal of Raised Pavement Markers (RPMs)

- Conducted from special approved vehicle only or
- On foot
  - If moving slowly, treat as stationary operation (lane closure)
- Rolling blocks
- Pop and install in one pass
- Law enforcement support
- Lateral buffers
- OSHA- approved procedures must be used to assure the safety of workers
- Straps and harnesses are required
- A TMA for protection is highly recommended
- **Automated RPM Placement Systems**
  - No manual labor
  - No exposed workers!













## Typical Applications

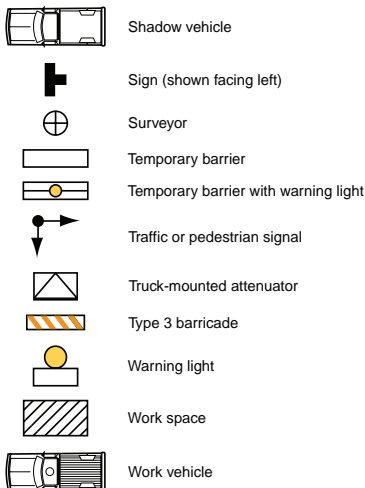
The following example illustrations show typical applications of various highway work zones, as included in the Manual on Uniform Traffic Control Devices (MUTCD), 2009 Edition (<http://mutcd.fhwa.dot.gov/>). These examples cover a variety of situations commonly encountered in work zones and can be useful in understanding and applying the worker safety practices discussed in this Field Guide. Refer to the MUTCD for additional information and additional typical applications

In general, these illustrations show minimum solutions. The information can be adapted to a broad range of conditions. Refer to MUTCD, Chapter 6H.

They are intended as a guide to help you identify possible inappropriate and unsafe temporary traffic control applications.

### Table 6H-2

	Arrow board
	Arrow board support or trailer (shown facing down)
	Changeable message sign or support trailer
	Channelizing device
	Crash cushion
	Direction of temporary traffic detour
	Direction of traffic
	Flagger
	High-level warning device (Flag tree)
	Longitudinal channelizing device
	Luminaire
	Pavement markings that should be removed for a long-term project



## Table 6H-3

Table 6H-3. Meaning of Letter Codes on Typical Application Diagrams

Road Type	Distance Between Signs**		
	A	B	C
Urban (low speed)*	100 feet	150 feet	100 feet
Urban (high speed)*	500 feet	550 feet	550 feet
Rural	500 feet	500 feet	500 feet
Expressway / Freeway	1,000 feet	1,000 feet	1,400 feet

\* Speed category to be determined by highway agency

\*\* The column headings A, B, and C are the dimensions shown in Figures 6H-1 through 6H-45. 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 "second sign" is the sign that is farthest upstream from the TTC zone.)

## Table 6H-4

Table 6H-4. Formulas for Determining Taper Length

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

Where: L = taper length in feet

W = width of offset in feet

S = posted speed limit, on off-peak 85th-percentile speed prior to work starting, or the anticipated operating speed in mph

## Notes for Figure 6H-1—Typical Application 1 Work Beyond the Shoulder

### *Guidance:*

1. *If the work space is in the median of a divided highway, an advance warning sign should also be placed on the left side of the directional roadway.*

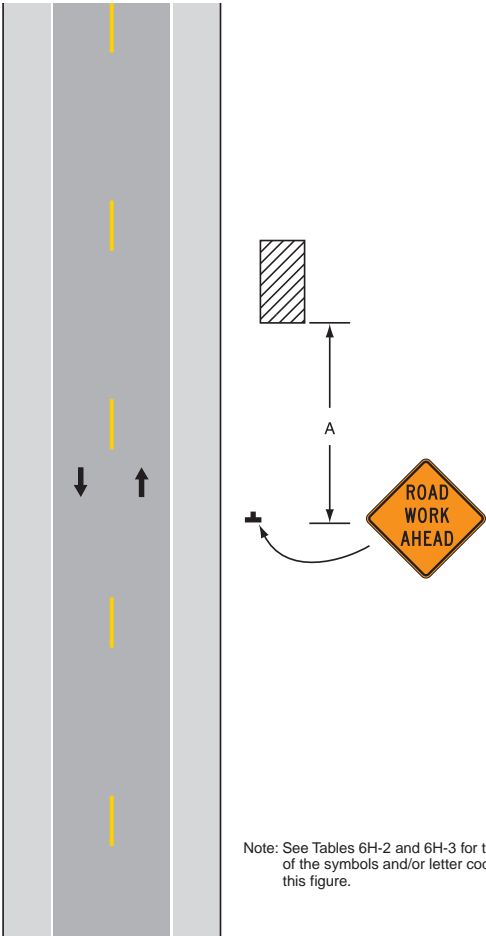
### *Option:*

2. The ROAD WORK AHEAD sign may be replaced with other appropriate signs such as the SHOULDER WORK sign. The SHOULDER WORK sign may be used for work adjacent to the shoulder.
3. The ROAD WORK AHEAD sign may be omitted where the work space is behind a barrier, more than 24 inches behind the curb, or 15 feet or more from the edge of any roadway.
4. For short-term, short duration or mobile operation, all signs and channelizing devices may be eliminated if a vehicle with activated high-intensity rotating, flashing, oscillating, or strobe lights is used.
5. Vehicle hazard warning signals may be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights.

### **Standard:**

6. **Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**

**Figure 6H-1 Work Beyond the Shoulder (TA-1)**



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

**Typical Application 1**

## Notes for Figure 6H-3—Typical Application 3 Work on the Shoulders

### Guidance:

1. A *SHOULDER WORK* sign should be placed on the left side of the roadway for a divided or one-way street only if the left shoulder is affected.

### Option:

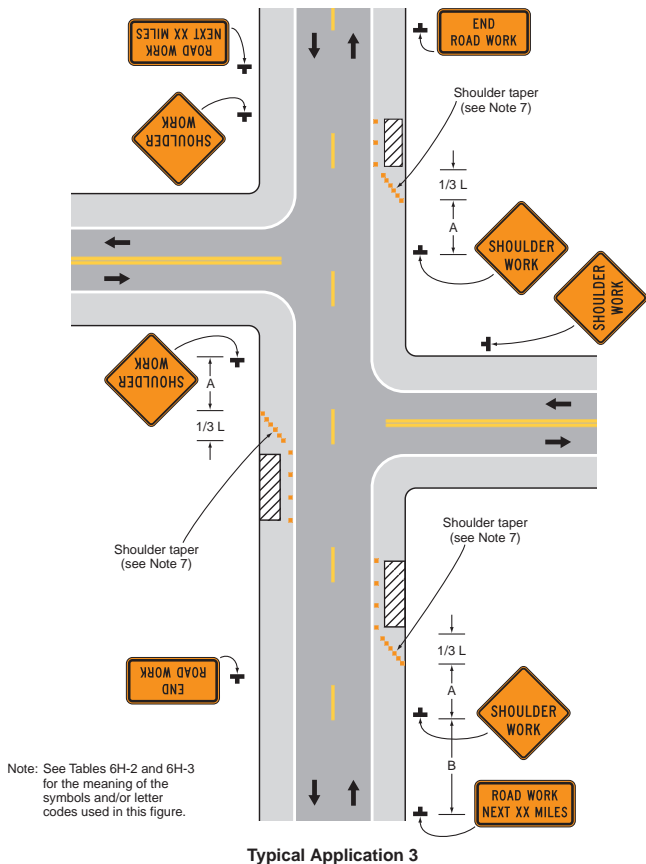
2. The Workers symbol signs may be used instead of SHOULDER WORK signs.
3. The SHOULDER WORK AHEAD sign on an intersecting roadway may be omitted where drivers emerging from that roadway will encounter another advance warning sign prior to this activity area.
4. For short duration operations of 60 minutes or less, all signs and channelizing devices may be eliminated if a vehicle with activated high-intensity rotating, flashing, oscillating, or strobe lights is used.
5. Vehicle hazard warning signals may be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights.

### Standard:

6. **Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**
7. **When paved shoulders having a width of 8 feet or more are closed, at least one advance warning sign shall be used. In addition, channelizing devices shall be used to close the shoulder in advance to delineate the beginning of the work space and direct vehicular traffic to remain within the traveled way.**



**Figure 6H-3 Work on the Shoulders (TA-3)**



## Notes for Figure 6H-4—Typical Application 4 Short Duration or Mobile Operation on a Shoulder

### Guidance:

1. *In those situations where multiple work locations within a limited distance make it practical to place stationary signs, the distance between the advance warning sign and the work should not exceed 5 miles.*
2. *In those situations where the distance between the advance signs and the work is 2 miles to 5 miles, a Supplemental Distance plaque should be used with the ROAD WORK AHEAD sign.*

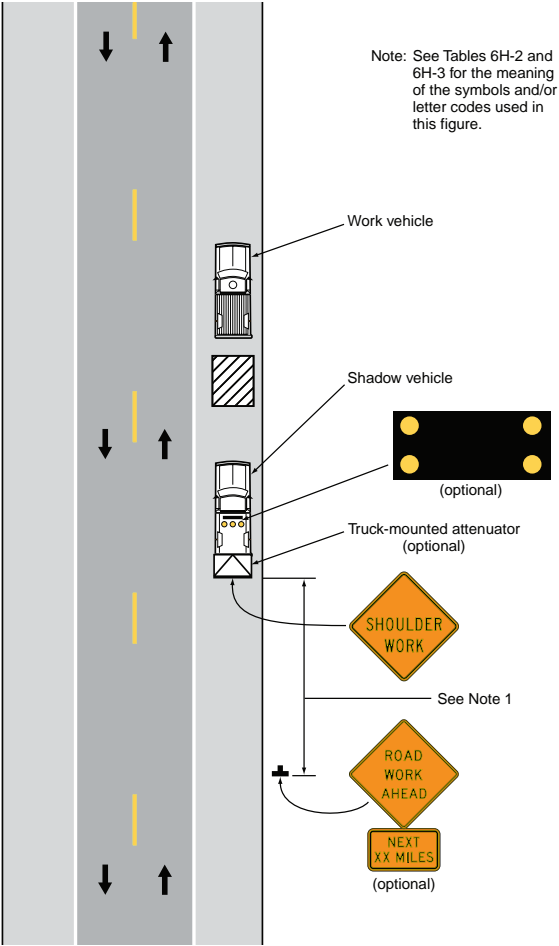
### Option:

3. The ROAD WORK NEXT XX MILES sign may be used instead of the ROAD WORK AHEAD sign if the work locations occur over a distance of more than 2 miles.
4. Stationary warning signs may be omitted for short duration or mobile operations if the work vehicle displays high-intensity rotating, flashing, oscillating, or strobe lights.
5. Vehicle hazard warning signals may be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights.

### Standard:

6. **Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**
7. **If an arrow board is used for an operation on the shoulder, the caution mode shall be used.**
8. **Vehicle-mounted signs shall be mounted in a manner such that they are not obscured by equipment or supplies. Sign legends on vehicle-mounted signs shall be covered or turned from view when work is not in progress.**

**Figure 6H-4 Short-Duration or Mobile Operation on a Shoulder (TA-4)**



**Typical Application 4**

## Notes for Figure 6H-6—Typical Application 6 Shoulder Work with Minor Encroachment

### Guidance:

1. *All lanes should be a minimum of 10 feet in width as measured to the near face of the channelizing devices.*
2. *The treatment shown should be used on a minor road having low speeds. For higher-speed traffic conditions, a lane closure should be used.*

### Option:

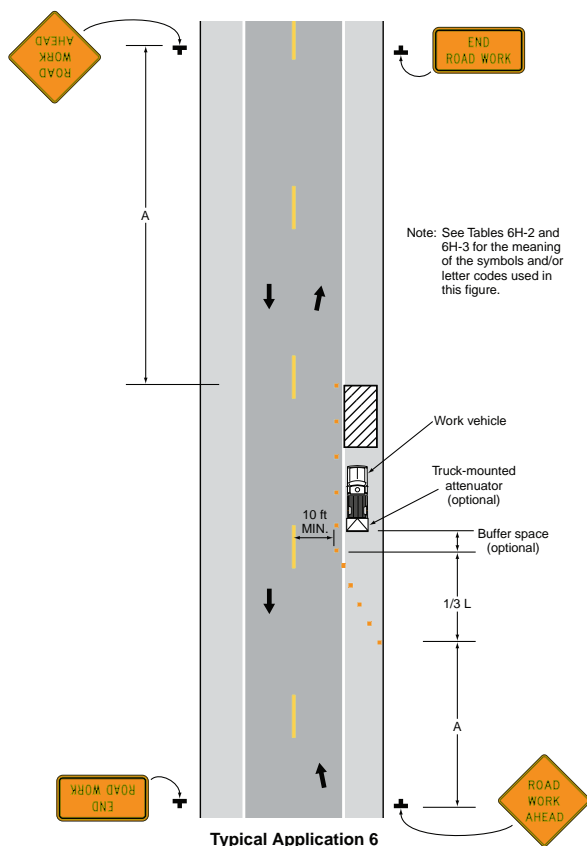
3. For short-term use on low-volume, low-speed roadways with vehicular traffic that does not include longer and wider heavy commercial vehicles, a minimum lane width of 9 feet may be used.
4. Where the opposite shoulder is suitable for carrying vehicular traffic and of adequate width, lanes may be shifted by use of closely-spaced channelizing devices, provided that the minimum lane width of 10 feet is maintained.
5. Additional advance warning may be appropriate, such as a ROAD NARROWS sign.
6. Temporary traffic barriers may be used along the work space.
7. The shadow vehicle may be omitted if a taper and channelizing devices are used.
8. A truck-mounted attenuator may be used on the shadow vehicle.
9. For short-duration work, the taper and channelizing devices may be omitted if a shadow vehicle with activated high-intensity rotating, flashing, oscillating, or strobe lights is used.
10. Vehicle hazard warning signals may be used to supplement high-intensity rotating, flashing, oscillating, or strobe lights.

### Standard:

11. **Vehicle-mounted signs shall be mounted in a manner such that they are not obscured by equipment or supplies. Sign legends on vehicle-mounted signs shall be covered or turned from view when work is not in progress.**

12. Shadow and work vehicles shall display high-intensity rotating, flashing, oscillating, or strobe lights.
13. Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.

## Figure 6H-6 Shoulder Work with Minor Encroachment (TA-6)



## Notes for Figure 6H-17—Typical Application 17 Mobile Operations on a Two-Lane Road

### Standard:

1. **Vehicle-mounted signs shall be mounted in a manner such that they are not obscured by equipment or supplies. Sign legends on vehicle-mounted signs shall be covered or turned from view when work is not in progress.**
2. **Shadow and work vehicles shall display high-intensity rotating, flashing, oscillating, or strobe lights.**
3. **If an arrow board is used, it shall be used in the caution mode.**

### Guidance:

4. *Where practical and when needed, the work and shadow vehicles should pull over periodically to allow vehicular traffic to pass.*
5. *Whenever adequate stopping sight distance exists to the rear, the shadow vehicle should maintain the minimum distance from the work vehicle and proceed at the same speed. The shadow vehicle should slow down in advance of vertical or horizontal curves that restrict sight distance.*
6. *The shadow vehicles should also be equipped with two high-intensity flashing lights mounted on the rear, adjacent to the sign.*

### Option:

7. The distance between the work and shadow vehicles may vary according to terrain, paint drying time, and other factors.
8. Additional shadow vehicles to warn and reduce the speed of oncoming or opposing vehicular traffic may be used. Law enforcement vehicles may be used for this purpose.
9. A truck-mounted attenuator may be used on the shadow vehicle or on the work vehicle.
10. If the work and shadow vehicles cannot pull over to allow vehicular traffic to pass frequently, a DO NOT PASS sign may be placed on the rear of the vehicle blocking the lane.

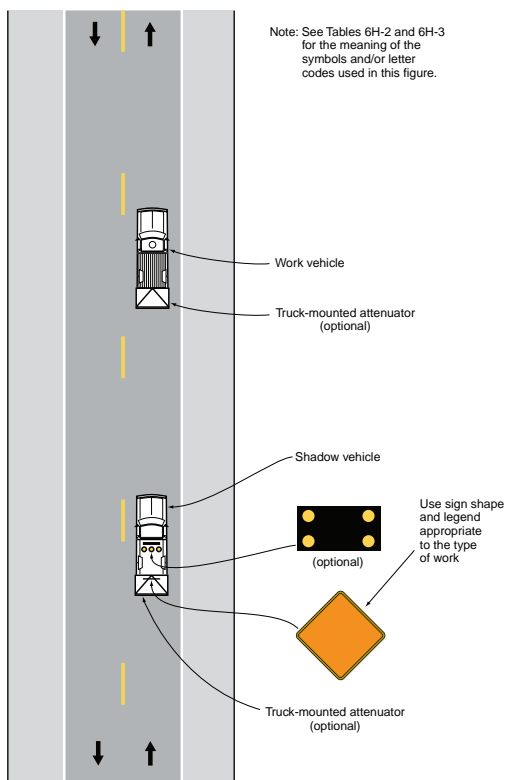
Support:

- Shadow vehicles are used to warn motor vehicle traffic of the operation ahead.

**Standard:**

- Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights.**

## Figure 6H-17 Mobile Operations on a Two-Lane Road (TA-17)



**Typical Application 17**

## Notes for Figure 6H-30—Typical Application 30 Interior Lane Closure on a Multi-Lane Street

### *Guidance:*

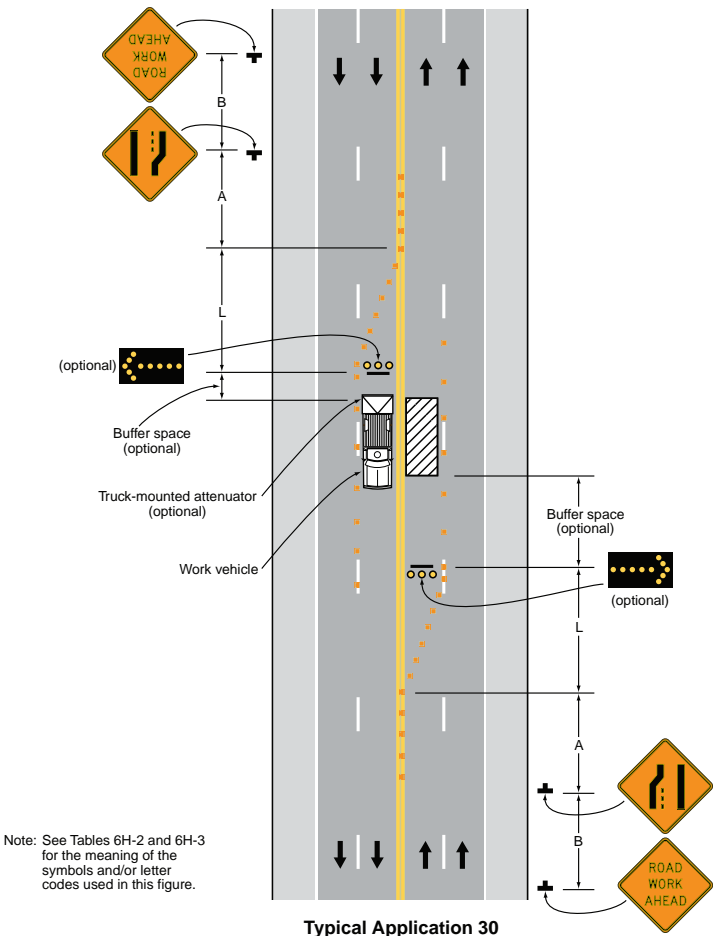
1. *This information applies to low-speed, low-volume urban streets. Where speed or volume is higher, additional signing such as LEFT LANE CLOSED XX FT should be used between the signs shown.*

### Option:

2. The closure of the adjacent interior lane in the opposing direction may not be necessary, depending upon the activity being performed and the work space needed for the operation.
3. Shadow vehicles with a truck-mounted attenuator may be used.



# **Figure 6H-30 Interior Lane Closure on a Multi-Lane Street (TA-30)**



## Notes for Figure 6H-33—Typical Application 33 Stationary Lane Closure on a Divided Highway

### Standard:

1. **This information also shall be used when work is being performed in the lane adjacent to the median on a divided highway. In this case, the LEFT LANE CLOSED signs and the corresponding Lane Ends signs shall be substituted.**
2. **When a side road intersects the highway within the TTC zone, additional TTC devices shall be placed as needed.**

### Guidance:

3. *When paved shoulders having a width of 8 feet or more are closed, channelizing devices should be used to close the shoulder in advance of the merging taper to direct vehicular traffic to remain within the traveled way.*

### Option:

4. A truck-mounted attenuator may be used on the work vehicle and/or shadow vehicle.

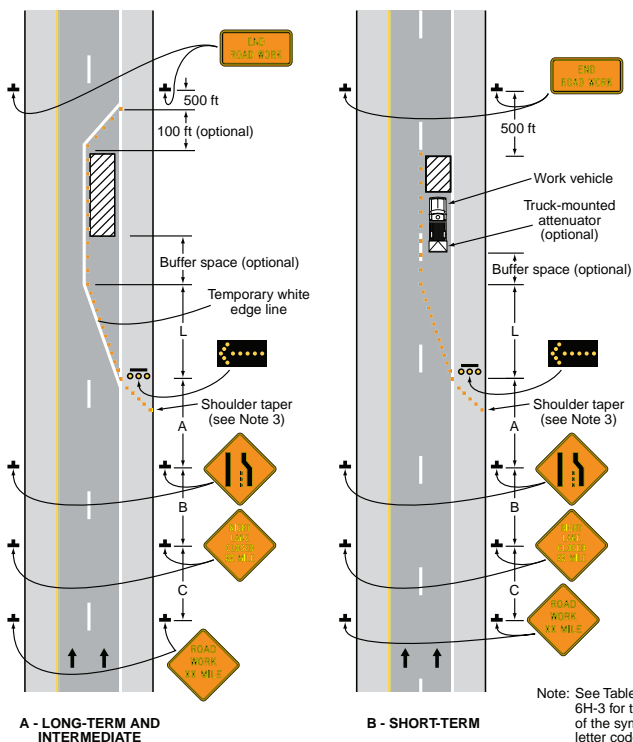
### Support:

5. Where conditions permit, restricting all vehicles, equipment, workers, and their activities to one side of the roadway might be advantageous.

### Standard:

6. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

## Figure 6H-33 Stationary Lane Closure on a Divided Highway (TA-33)



Typical Application 33

## Notes for Figure 6H-34—Typical Application 34 Lane Closure with a Temporary Traffic Barrier

### Standard:

1. **This information also shall be used when work is being performed in the lane adjacent to the median on a divided highway. In this case, the LEFT LANE CLOSED signs and the corresponding Lane Ends signs shall be substituted.**

### Guidance:

2. *For long-term lane closures on facilities with permanent edge lines, a temporary edge line should be installed from the upstream end of the merging taper to the downstream end of the downstream taper, and conflicting pavement markings should be removed.*
3. *The use of a barrier should be based on engineering judgment.*

### Standard:

4. **Temporary traffic barriers, if used, shall comply with the provisions of Section 6F.85.**
5. **The barrier shall not be placed along the merging taper. The lane shall first be closed using channelizing devices and pavement markings.**

### Option:

6. Type C Steady-Burn warning lights may be placed on channelizing devices and the barrier parallel to the edge of pavement for nighttime lane closures.
7. The barrier shown in this typical application is an example of one method that may be used to close a lane for a long-term project. If the work activity permits, a movable barrier may be used and relocated to the shoulder during non-work periods or peak-period vehicular traffic conditions, as appropriate.

**Standard:**

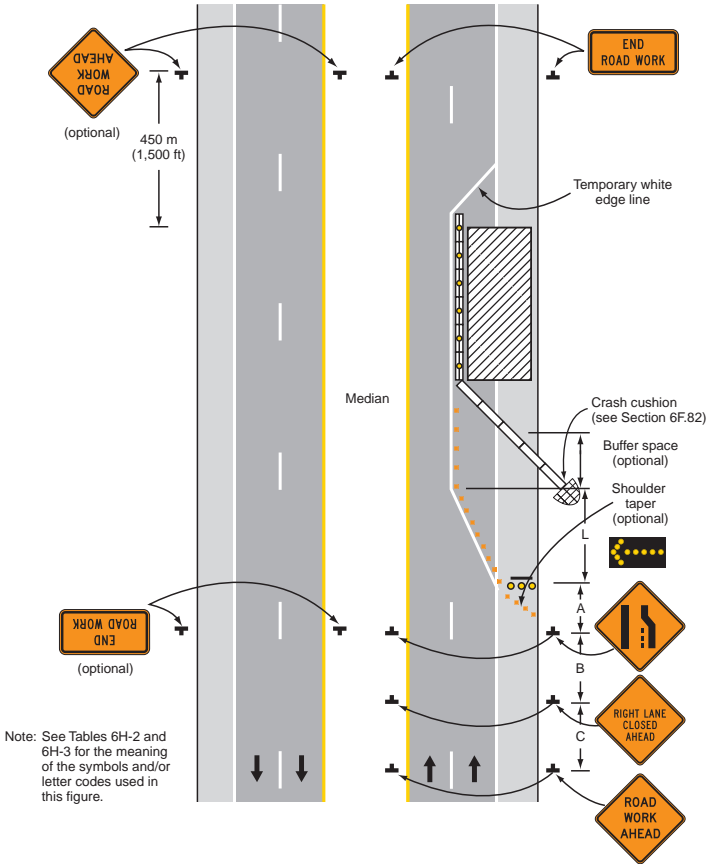
8. **If a movable barrier is used, the temporary white edge line shown in the typical application shall not be used. During the period when the right-hand lane is opened, the sign legends and the channelization shall be changed to indicate that only the shoulder is closed, as illustrated in Figure 6H-5. The arrow board, if used, shall be placed at the downstream end of the shoulder taper and shall display the caution mode.**

*Guidance:*

9. *If a movable barrier is used, the shift should be performed in the following manner. When closing the lane, the lane should be initially closed with channelizing devices placed along a merging taper using the same information employed for a stationary lane closure. The lane closure should then be extended with the movable-barrier transfer vehicle moving with vehicular traffic. When opening the lane, the movable-barrier transfer vehicle should travel against vehicular traffic from the termination area to the transition area. The merging taper should then be removed using the same information employed for a stationary lane closure.*

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### Figure 6H-34 Lane Closure with a Temporary Traffic Barrier (TA-34)



## Notes for Figure 6H-35—Typical Application 35

### Mobile Operation on a Multi-Lane Road

#### Standard:

1. **Arrow boards shall, as a minimum, be Type B, with a size of 60 x 30 inches.**
2. **Vehicle-mounted signs shall be mounted in a manner such that they are not obscured by equipment or supplies. Sign legends on vehicle-mounted signs shall be covered or turned from view when work is not in progress.**
3. **Shadow and work vehicles shall display high-intensity rotating, flashing, oscillating, or strobe lights.**
4. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

#### Guidance:

5. *Vehicles used for these operations should be made highly visible with appropriate equipment, such as flags, signs, or arrow boards.*
6. *Shadow Vehicle 1 should be equipped with an arrow board and truck-mounted attenuator.*
7. *Shadow Vehicle 2 should be equipped with an arrow board. An appropriate lane closure sign should be placed on Shadow Vehicle 2 so as not to obscure the arrow board.*
8. *Shadow Vehicle 2 should travel at a varying distance from the work operation so as to provide adequate sight distance for vehicular traffic approaching from the rear.*
9. *The spacing between the work vehicles and the shadow vehicles, and between each shadow vehicle should be minimized to deter road users from driving in between.*
10. *Work should normally be accomplished during off-peak hours.*



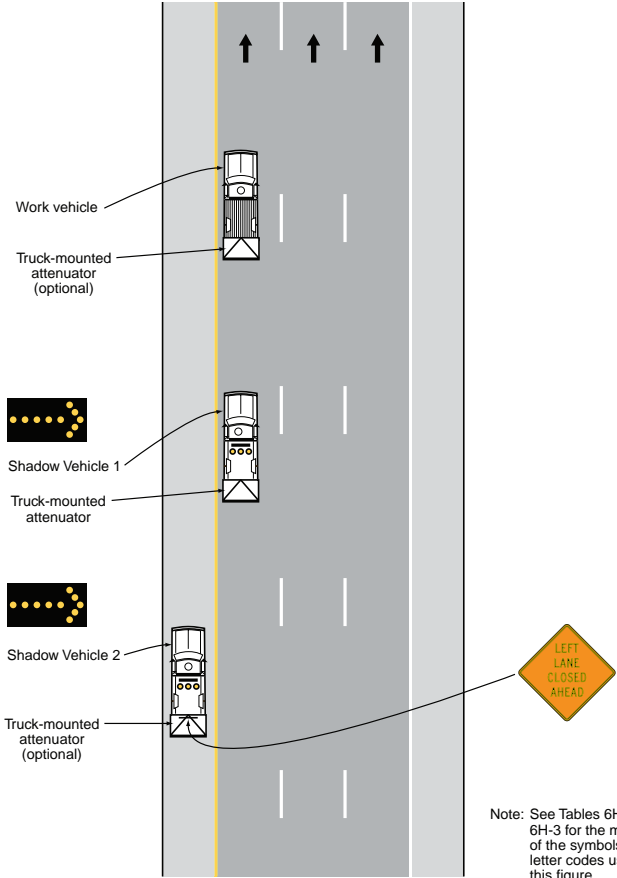
11. *When the work vehicle occupies an interior lane (a lane other than the far right or far left) of a directional roadway having a right-hand shoulder 10 feet or more in width, Shadow Vehicle 2 should drive the right-hand shoulder with a sign indicating that work is taking place in the interior lane.*

Option:

12. A truck-mounted attenuator may be used on Shadow Vehicle 2.
13. On high-speed roadways, a third shadow vehicle (not shown) may be used with Shadow Vehicle 1 in the closed lane, Shadow Vehicle 2 straddling the edge line, and Shadow Vehicle 3 on the shoulder.
14. Where adequate shoulder width is not available, Shadow Vehicle 3 may also straddle the edge line.

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**Figure 6H-35 Mobile Operation on a Multi-Lane Road (TA-35)**



**Typical Application 35**

## Notes for Figure 6H-42—Typical Application 42 Work in the Vicinity of an Exit Ramp

### Guidance:

1. *The guide signs should indicate that the ramp is open, and where the temporary ramp is located. However, if the ramp is closed, guide signs should indicate that the ramp is closed.*
2. *When the exit ramp is closed, a black on orange EXIT CLOSED sign panel should be placed diagonally across the interchange/ intersection guide signs.*
3. *The design criteria contained in the AASHTO “Policy on the Geometric Design of Highways and Streets” (see Section 1A.11) should be used for determining the alignment.*

### Standard:

4. **A temporary EXIT sign shall be located in the temporary gore. For better visibility, it shall be mounted a minimum of 7 feet from the pavement surface to the bottom of the sign.**

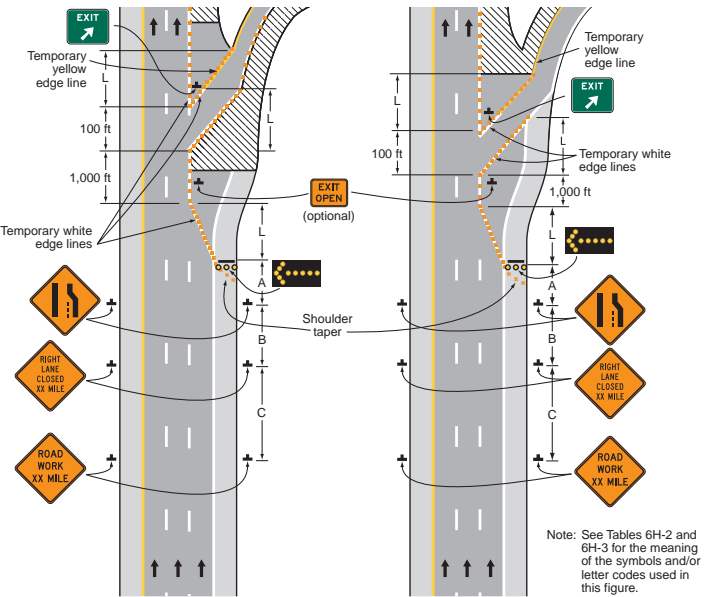
### Option:

5. The temporary EXIT sign placed in the temporary gore may be either black on orange or white on green.
6. An alternative procedure that may be used is to channelize exiting vehicular traffic onto the right-hand shoulder and close the lane as necessary.

### Standard:

7. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

# **Figure 6H-42 Work in the Vicinity of an Exit Ramp (TA-42)**



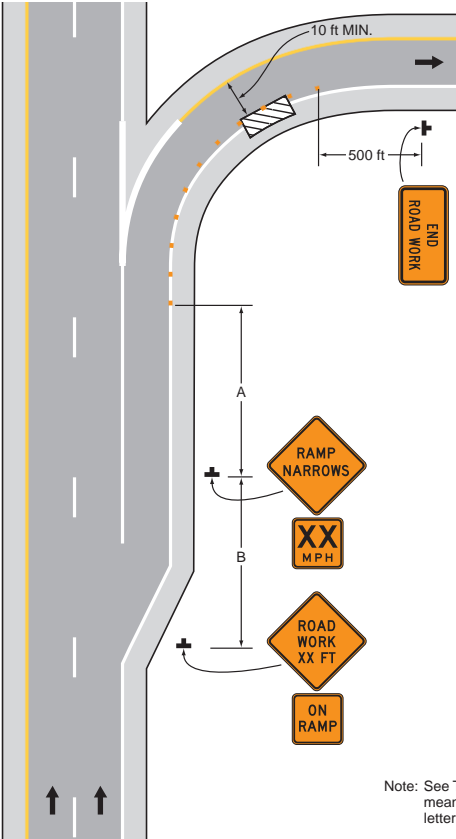
**Typical Application 42**

## Notes for Figure 6H-43—Typical Application 43 Partial Exit Ramp Closure

*Guidance:*

1. *Truck off-tracking should be considered when determining whether the minimum lane width of 10 feet is adequate (see Section 6G.08).*

# **Figure 6H-43 Partial Exit Ramp Closure (TA-43)**



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

**Typical Application 43**

## Notes for Figure 6H-44—Typical Application 44

### Work in the Vicinity of an Entrance Ramp

#### *Guidance:*

1. *An acceleration lane of sufficient length should be provided whenever possible as shown on the left diagram.*

#### **Standard:**

2. **For the information shown on the diagram on the right-hand side of the typical application, where inadequate acceleration distance exists for the temporary entrance, the YIELD sign shall be replaced with STOP signs (one on each side of the approach).**

#### *Guidance:*

3. *When used, the YIELD or STOP sign should be located so that ramp vehicular traffic has adequate sight distance of oncoming mainline vehicular traffic to select an acceptable gap in the mainline vehicular traffic flow, but should not be located so far forward that motorists will be encouraged to stop in the path of the mainline traffic. Also, a longer acceleration lane should be provided beyond the sign to reduce the gap size needed. If insufficient gaps are available, consideration should be given to closing the ramp.*
4. *Where STOP signs are used, a temporary stop line should be placed across the ramp at the desired stop location.*
5. *The mainline merging taper with the arrow board at its starting point should be located sufficiently in advance so that the arrow board is not confusing to drivers on the entrance ramp, and so that the mainline merging vehicular traffic from the lane closure has the opportunity to stabilize before encountering the vehicular traffic merging from the ramp.*
6. *If the ramp curves sharply to the right, warning signs with advisory speeds located in advance of the entrance terminal should be placed in pairs (one on each side of the ramp).*



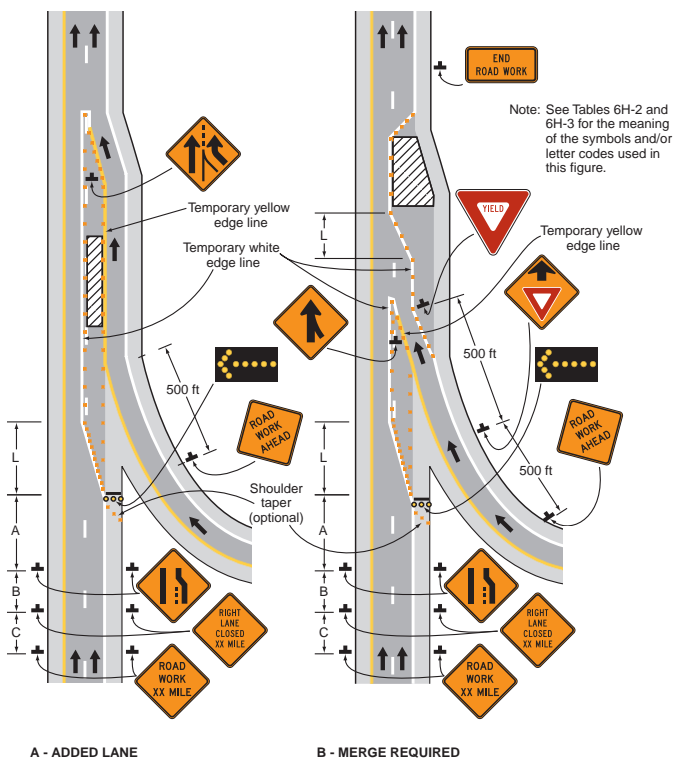
Option:

7. A Stop Beacon (see Section 4L.05) or a Type B high-intensity warning flasher with a red lens may be placed above the STOP sign.
8. Where the acceleration distance is significantly reduced, a supplemental plaque may be placed below the Yield Ahead sign reading NO MERGE AREA.

**Standard:**

9. **An arrow board shall be used when a freeway lane is closed. When more than one freeway lane is closed, a separate arrow board shall be used for each closed lane.**

## Figure 6H-44 Work in the Vicinity of an Entrance Ramp (TA-44)



Typical Application 44

Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the Federal Highway Administration.



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