FIELD GUIDE FOR THE USE AND PLACEMENT OF SHADOW VEHICLES IN WORK ZONES



This field guide provides guidelines on the use of shadow vehicles and Truck Mounted Attenuators (TMAs) in highway work zones.

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Introduction

This field guide provides guidelines on the use of shadow vehicles and Truck Mounted Attenuators (TMAs) in highway work zones. It summarizes information from various sources into a compact format for use as a field reference when considering the use of shadow vehicles in advance of workers or other equipment or work vehicles.

The guide is intended for use by **contractors, subcontractors, utility and maintenance forces, and other field staff** and provides easy access to information from multiple sources. This field guide provides enhance portability for use in the field. The guide is based on the Roadside Design Guide (RDG) and the Manual on Uniform Traffic Control Devices (MUTCD). It is also intended for use by **highway agency staff** to develop procedures and standards for shadow vehicle use.

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What Are Shadow Vehicles?

Shadow vehicles are moving trucks with attenuators spaced a short distance from a moving operation, giving physical protection to workers from traffic approaching from the rear. Similar to truck-mounted devices, trailer-mounted attenuators may also be used on the shadow vehicle on a project-specific basis to protect workers.

In addition to shadow vehicles, advance warning vehicles, equipped with appropriate signs and warning lights, may be used upstream of the work space to warn road users of downstream work activity.

When Should Shadow Vehicles With TMAs Be Used?

When determining when to use shadow vehicles, driver sight distance and reaction time should be considered in addition to other factors such as speed and the type of work activity. While Average Daily Traffic (ADT) values can be a supplemental factor and may indicate exposure levels, ADT should not be used to determine shadow vehicle use.

Typically, use of shadow vehicles will be addressed in contract documents or traffic control plans that are implemented in the field.

For short-term, intermediate, and long term **stationary work zones**, a shadow vehicle may be used in the work space in advance of work operations to protect workers from vehicle intrusions. This vehicle is normally unoccupied (it may be occupied for short duration work that occupies a location up to one hour) and may be equipped with a Truck Mounted Attenuator or Trailer Mounted Attenuator (TMA). When equipped with a TMA, it also protects occupants of intruding vehicles from impacts with work vehicles and equipment. The shadow vehicle should be placed in the work space in advance of workers or equipment to account for roll-ahead. Placement is also discussed on page 6 of this guide. The shadow vehicle should not be parked in a buffer space.

For **mobile operations**, a shadow vehicle may be positioned prior to the work operation to protect workers from vehicle intrusions as the operation moves with the flow of traffic. For this application, the shadow vehicle is occupied by a driver and also should be equipped with a TMA. When equipped with a lighted arrow panel or static signing, shadow vehicles used in mobile operations also serve to warn approaching drivers that the shoulder or travel lane is occupied by work activities and that the driver must move into the adjoining open lane.

Devices such as radios should be used to provide communication between the driver of the shadow vehicle and other personnel in the work zone, including other advance warning vehicles.

When using shadow vehicles, be sure to follow highway agency guidelines, manufacturer's recommendations, and guidance provided in the Manual on *Uniform Traffic Control Devices (MUTCD) and the Roadside Design Guide (RDG)*.

How To Use This Guide

The following pages provide guidelines based on the recommended priority for application of shadow vehicles in the American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide.

To use these guidelines, first determine the facility type (freeway or other), determine the type of activity (stationary or mobile), and determine whether the activity will involve a lane closure or a shoulder closure. Then use the appropriate table on pages 4 and 5 to find the priority for the use of a shadow vehicle, and use the applicable traffic speed to determine the priority for use of a TMA on the shadow vehicle. The mass of the shadow vehicle used should be within 5 percent of the mass of the shadow vehicle on which the TMA was crash tested (9000kg or 19,800lb).

Recommended priority on the use of TMAs on shadow vehicles is based on facility type and actual traffic speed for non-freeways. The actual traffic speed may or may not be the posted speed for the facility. Additionally, NCHRP 350 tests determined that a TMA is crashworthy to test level 2 for speeds of 45 mph and under, and is crashworthy to test level 3 for speeds at or below 62 mph.

Mobile Freeway Applications

The following guidelines are applicable to freeways **with no stationary lane closures (NoLC) or with no stationary shoulder closures (NoSC).**

If the type of activity involves:	The priority for use of shadow vehicles is:	The priority for use of a TMA on the vehicle is:
Exposed personnel – crack pouring, patching, utility work, striping, coning (No LC)	Very highly recommended	Very highly recommended
Exposed personnel – pavement repair, pavement marking, delineator repair (No SC)	Highly recommended	Highly recommended
No exposed personnel – sweeping, chemical spraying (No LC)	May be justified based on the specific project need if it would lessen impacts	Very highly recommended
No exposed personnel – open excavation, temporarily exposed bridge pier (No SC)	May be justified based on the specific project need if it would lessen impacts	Highly recommended

Stationary Freeway Applications

The following guidelines are applicable to freeways **with stationary lane closures (LC) or stationary shoulder closures (SC).**

If the type of activity involves:	The priority for use of shadow vehicles is:	The priority for use of a TMA on the vehicle is:
Exposed personnel – pavement repair, pavement marking (LC)	Highly recommended	Highly recommended
Exposed personnel – pavement repair, pavement marking, guardrail repair (SC)	Recommended	Recommended
Significant obstruction – open excavation (LC)	May be justified based on the specific project need if it would lessen impacts	Highly recommended
Significant obstruction – open excavation (SC)	May be justified based on the specific project need if it would lessen impacts	Recommended

General Note: stationary lane closures use ground-mounted channelizing devices, signs, and other traffic control devices. Mobile lane closures and some short duration operations typically rely primarily on truck-mounted signs and fewer traffic control devices.

Mobile Non-Freeway Applications

The following guidelines are applicable to roadways (other than freeways) that have **no stationary lane closures (NoLC) or with no stationary shoulder closures (NoSC).**

If the type of activity involves:	The priority for use of shadow vehicles is:	And, if the speed is:	The priority for use of a TMA on the vehicle is:
Exposed personnel – crack pouring, patching, utility work, striping, coning (No LC)	Very highly recommended	50 mph	Highly recommended
		45 mph	Recommended
		40mph or less	Desirable
Exposed personnel – pavement repair, pavement marking, delineator repair (No SC)	Highly recommended	50 mph	Recommended
	Recommended	45 mph	
	Recommended	40mph or less	
No exposed personnel – sweeping, chemical spraying (No LC)	May be justified based on the specific project need if it would lessen impacts	50 mph	Highly recommended
		45 mph	Recommended
		40mph or less	Desirable
No exposed personnel – open excavation, temporarily exposed bridge pier (No SC)	May be justified based on the specific project need if it would lessen impacts	50 mph	Recommended
		45 mph	Desirable
		40mph or less	May be justified based on the project

Stationary Non-Freeway Applications

The following guidelines are applicable to roadways (other than freeways) that have **stationary lane closures (LC) or stationary shoulder closures (SC).**

If the type of activity involves:	The priority for use of shadow vehicles is:	And, if the speed is:	The priority for use of a TMA on the vehicle is:
Exposed personnel – pavement repair, pavement marking (LC)	Highly recommended	50 mph	Recommended
	Recommended	45 mph	Desirable
	Desirable	40 mph or less	May be justified based on the project
Exposed personnel – pavement repair, pavement marking, guardrail repair (SC)	Recommended	50 mph	Desirable
	Desirable	45 mph	May be justified based on the project
	Desirable	40mph or less	
Significant obstruction – open excavation (LC)	May be justified based on the specific project need if it would lessen impacts	50 mph	Recommended
		45 mph	Desirable
		40mph or less	May be justified based on the project
Significant obstruction – open excavation (SC)	May be justified based on the specific project need if it would lessen impacts	50 mph	Desirable
		45 mph	May be justified based on the project
		40mph or less	

Where Should Shadow Vehicles Be Placed?

Adequate space should be provided on the roadway to allow for post-collision roll ahead of the shadow vehicle, but without creating enough space to encourage or permit a vehicle to mistakenly enter the area between the shadow vehicle and the workers or hazard.

If used, advance warning vehicles should be placed a considerable distance upstream of the work area to warn road users prior to entering the activity area. The shadow vehicle should be placed in the work space.

The following tables provide guidelines based on the weight of the shadow vehicle and the traffic operating speed for the facility. Guidelines may vary by location. Therefore, check with your highway agency to determine if local guidelines exist.

Some agencies, such as Michigan DOT, follow a general rule of thumb for use of shadow vehicles to be limited to three days. If protection is needed for a period of time longer than three days, another type of positive protection device should be used.

Spacing Guidelines for Shadow Vehicles

The following tables provide guidelines for spacing shadow vehicles upstream from the beginning of the work area.

Operating Speed[a]	Recommended Spacing[b] for Vehicles Weighing > 22,000 lbs.	
	Stationary Operation	Moving Operation[c]
Greater than 55 mph	150 feet	172 feet
45 to 55 mph	100 feet	150 feet
Less than 45 mph	74 feet	100 feet

Operating Speed[a]	Recommended Spacing[b] for Vehicles Weighing 9,900 to 22,000 lbs.	
	Stationary Operation	Moving Operation[c]
Greater than 55 mph	172 feet	222 feet
45 to 55 mph	123 feet	172 feet
Less than 45 mph	100 feet	100 feet

[a] *Should use operating speed if higher than posted speed limit.*

[b] *Recommended spacing is distance between front of shadow vehicle and beginning or work area, that is the first worker/operation/vehicle to be protected.*

[c] *Distances are appropriate for shadow vehicle speeds up to 15.5 mph*

Notes from the Roadside Design Guide Recommended Spacing Tables

- The heaviest shadow vehicle should be used to optimize protection of maintenance or construction workers. Because roll-ahead is minimized with heavier shadow vehicles, they can be placed closer to the work space to minimize the risk of vehicles cutting in ahead of the shadow vehicles.
- The spacing distance is good with or without a TMA. A vehicle equipped with a TMA may move less than a truck not equipped with a TMA. However, the recommended spacing is conservative enough to allow the same spacing for a vehicle with a TMA versus one without.
- Distances are intended as minimum guidelines. However, engineering judgment should be used to increase distances to take into account traffic conditions, vehicle mix, sight distance, and other site conditions.

Approximating Distances

Lane-Line Spacing — On multilane roadways, distances can be approximated in the field based on the spacing of broken lane lines.

- Most states use a common line length and space between each broken line.
- Painted lines are commonly 10 feet and the gap is 30 feet.
- This equates to 40 feet from the beginning of one line to the beginning of the next.

- Actual spacing should be verified in the field because they may vary for a number of reasons.
- Once the actual spacing is determined, the distance between the shadow vehicle and the workers can be estimated by counting the appropriate number of lane-line spacings.
- On single lane roadways, or two-lane, two-way roadways, another method to determine the distances for placement of the shadow vehicle must be used.

Typical Applications

The following typical applications show where and how shadow vehicles may be used. These examples cover a variety of situations commonly encountered in work zones.

In general, these illustrations from the MUTCD show typical solutions and may require additional traffic control and safety devices to meet the needs of specific work zones. The information provided in these typical applications can be adapted to a broad range of conditions by applying the principles and guidance provided in the MUTCD and RDG.

State and local standards, guidelines and regulations for work zone traffic control may vary, and should be consulted in determining the actual traffic control plan to be applied in a work zone. For additional details regarding traffic control layout, consult the MUTCD.

Most temporary traffic control zones are divided into four areas: the advance warning area, the transition area, the activity area, and the termination area. Figure 1 illustrates these areas as included in the MUTCD.

Figure 1. Component Part of a Temporary Traffic Control Zone

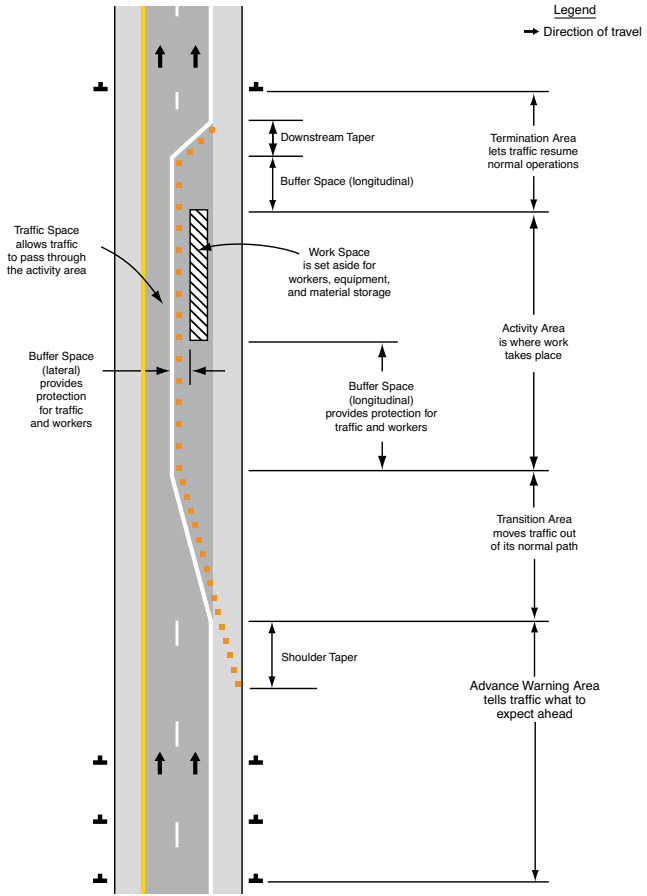
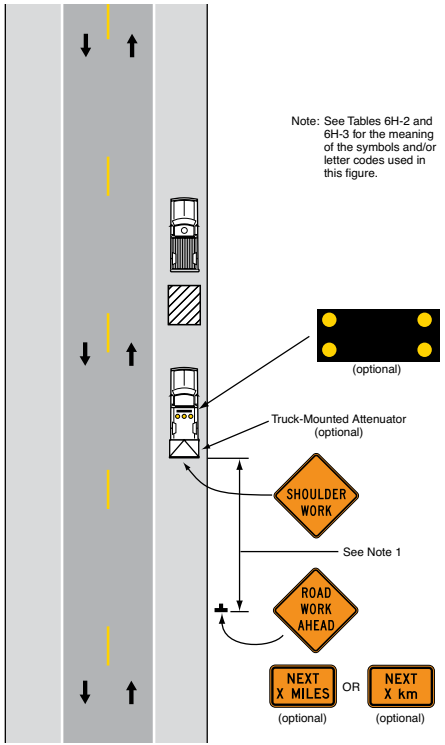


Table 1. Meaning of Symbols on Typical Application Diagram (MUTCD 6H-2)

	Arrow panel
	Arrow panel 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)
	Luminaire
	Pavement markings that should be removed for a long term project
	Sign (shown facing left)
	Surveyor
	Temporary barrier
	Temporary barrier with warning lights
	Traffic or Pedestrian signal
	Truck mounted attenuator
	Type III Barricade
	Warning lights
	Work space
	Work vehicle

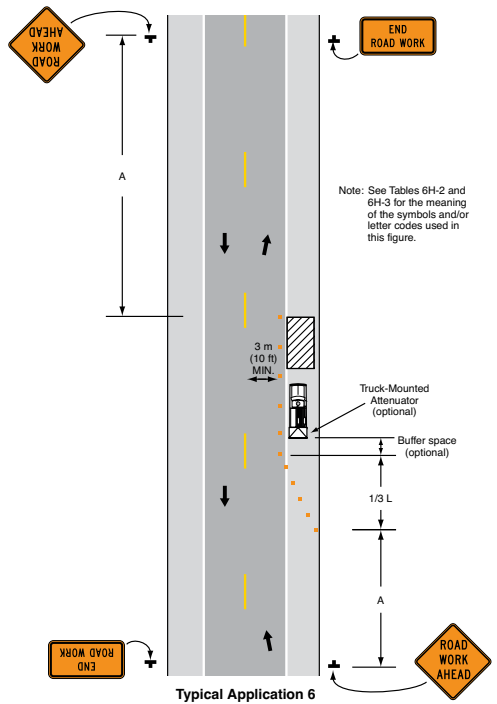
Figure 2. Short-Duration or Mobile Operation on Shoulder (Typical Application 4)



Typical Application 4

MUTCD Standard: Vehicle hazard warning signals shall not be used instead of the vehicle's high-intensity rotating, flashing, oscillating, or strobe lights. If an arrow panel is used for an operation on the shoulder, the caution mode shall be used.

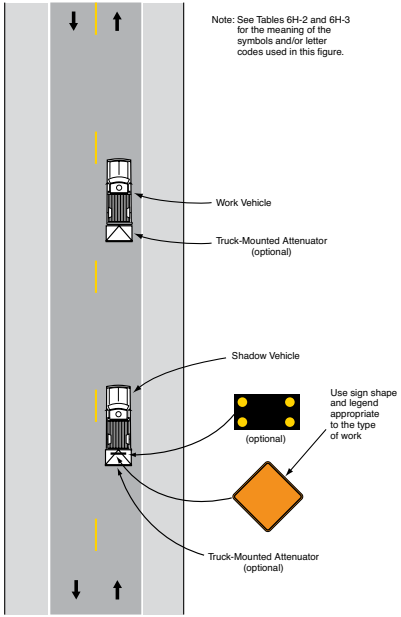
Figure 3. Shoulder Work with Minor Encroachment (Typical Application 6)



Typical Application 6

MUTCD Option Information: The shadow vehicle may be omitted if a taper and channelizing devices are used. A truck-mounted attenuator may be used on the shadow vehicle. 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.

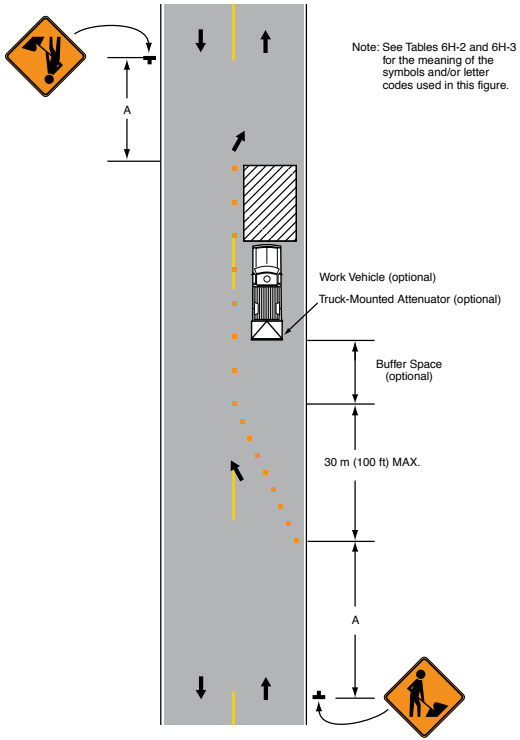
Figure 4. Mobile Operations on Two-Lane Road (Typical Application-17)



Typical Application 17

MUTCD Guidance: Where practical and when needed, the work and shadow vehicles should pull over periodically to allow vehicular traffic to pass. 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. The shadow vehicles should also be equipped with two high-intensity flashing lights mounted on the rear, adjacent to the sign.

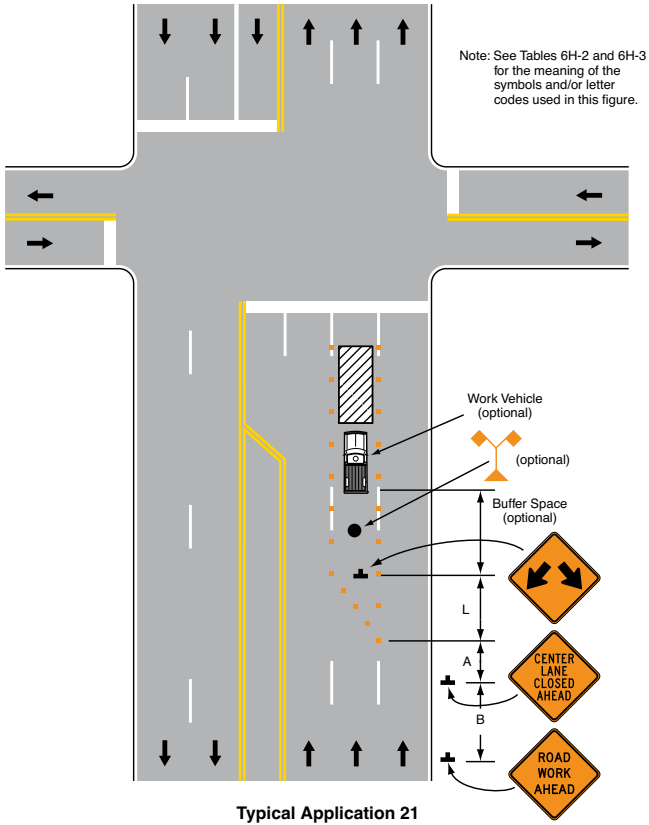
Figure 5. Lane Closure on Minor Street (Typical Application 18)



Typical Application 18

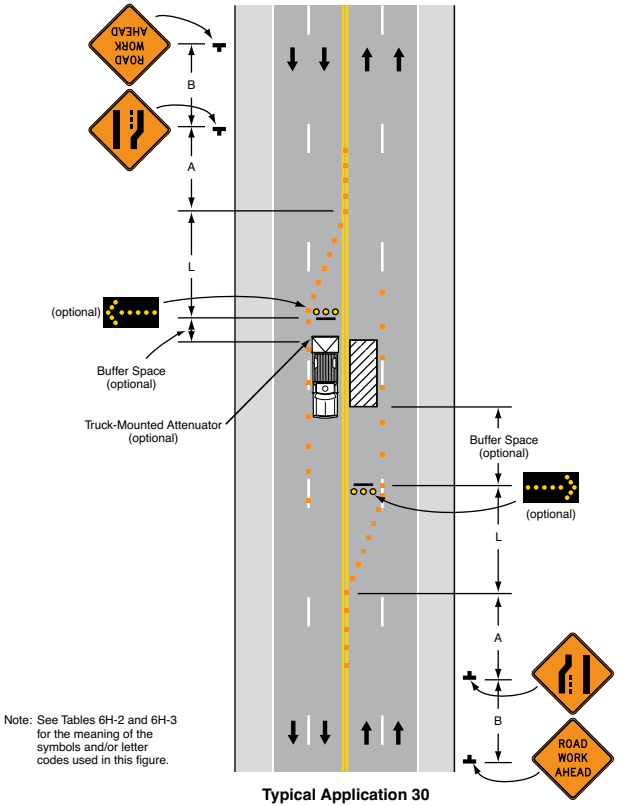
MUTCD Option Information: A truck-mounted attenuator may be used on the work vehicle and the shadow vehicle.

Figure 6. Lane Closure on Near Side of Intersection (Typical Application 21)



Typical Application 21

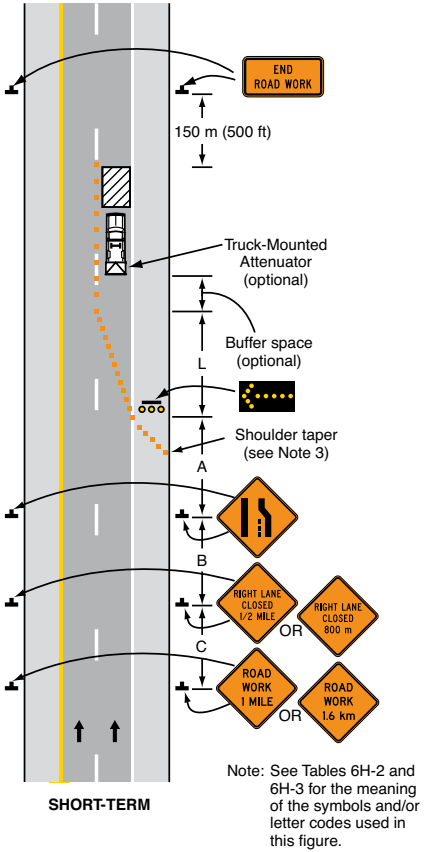
Figure 7. Interior Lane Closure on Multi-Lane Street (Typical Application 30)



Typical Application 30

MUTCD Option Information: A work vehicle or a shadow vehicle may be equipped with a truck-mounted attenuator.

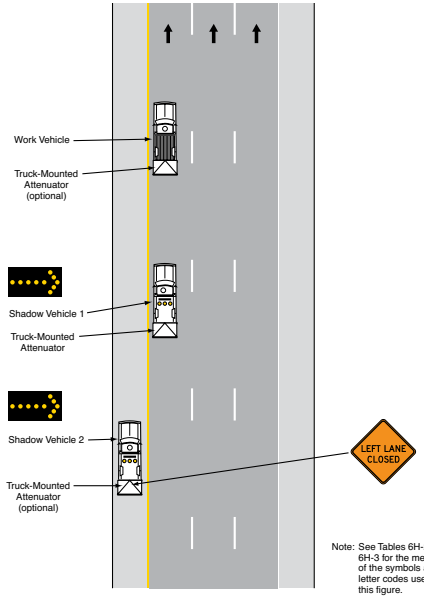
Figure 8. Stationary Lane Closure on Divided Highway (Typical Application 33)



SHORT-TERM

MUTCD Option Information: A truck-mounted attenuator may be used on the work vehicle and/or shadow vehicle.

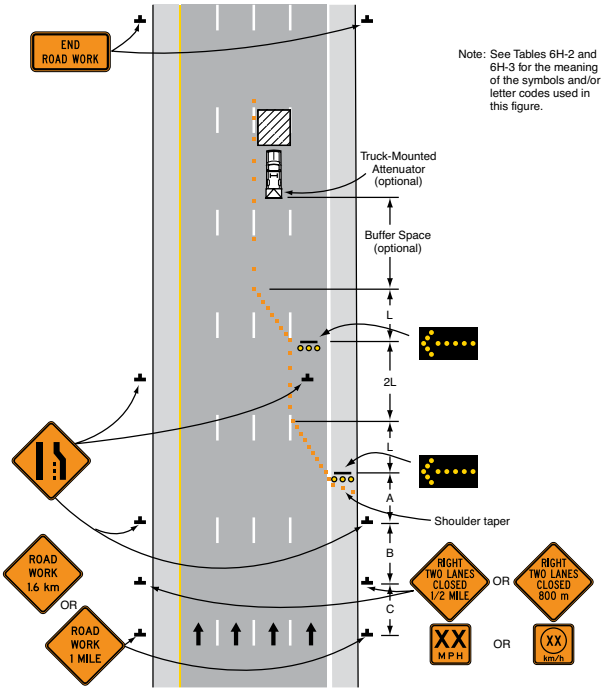
Figure 9. Mobile Operation on Multi-lane Road (Typical Application 35)



Typical Application 35

MUTCD Guidance: Shadow Vehicle 1 should be equipped with an arrow panel and truck-mounted attenuator. Shadow Vehicle 2 should be equipped with an arrow panel. An appropriate lane closure sign should be placed on Shadow Vehicle 2 so as not to obscure the arrow panel. 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. 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.

Figure 10. Double-Lane Closure on Freeway (Typical Application 37)



Typical Application 37

MUTCD Option Information: A truck-mounted attenuator may be used on Shadow Vehicle 2. 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. Where adequate shoulder width is not available, Shadow Vehicle 3 may drive partially in the lane.

MUTCD Guidance: Ordinarily, the preferred position for the second arrow panel is in the closed exterior lane at the beginning of the second merging taper. However, the second arrow panel should be placed in the closed interior lane at the end of the second merging taper in the following situations: (a) When a shadow vehicle is used in the interior closed lane, and the second arrow panel is mounted on the shadow vehicle; (b) If alignment or other conditions create any confusion as to which lane is closed by the second arrow panel; and (c) When the first arrow panel is placed in the closed exterior lane at the end of the first merging taper (the alternative position when the shoulder is narrow).

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American Association of State Highway and Transportation Officials, *Roadside Design Guide, 3rd Edition* (Washington, DC: 2002)

Federal Highway Administration, Manual on *Uniform Traffic Control Devices, 2003 Edition* (Washington, DC: 2003).

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