Guidelines

on the Use of Positive Protection in Temporary Traffic Control Zones

This document summarizes available guidance on the use of positive protection in temporary traffic control zones and provides a decision support tool on the use of various positive protection devices. It is a companion to a document titled “Work Zone Positive Protection Toolbox”[1] produced by the American Traffic Safety Services Association (ATSSA) under the Federal Highway Administration (FHWA) Work Zone Safety Grant. While the toolbox provides both specific information on the various types of positive protection devices currently in use, and guidance on where and how each is typically used, this document provides additional detail on how to determine when positive protection may be warranted.

The determination of when to use positive protection is typically based on either a project-specific engineering study or agency guidelines (which also should be based on an engineering study). Both the project-specific study and agency guidelines typically consider the actual conditions expected to be encountered in the work zone combined with the characteristics of the various devices that may be available. The *Roadside Design Guide* (RDG) states that “the design and selection of work-zone safety features should be based on expected operating speeds and proximity of vehicles to workers and pedestrians.” Additional factors that may impact the decision are provided in these guidelines.

This document is organized into three sections. The *first section* provides information on the various types of devices and their features. The *second section* includes information that should be considered in determining the need for positive protection and locations and project types where positive protection may provide benefit. The *third section* includes decision support tools (Table 1 and Chart 1) for use in determining the most appropriate positive protection device(s) based on project characteristics.

[1] Refer to http://www.atssa.com for a copy of this document.

What Are Positive Protection Devices?

The FHWA defines Positive Protection Devices as ***devices that contain and/or redirect vehicles and meet the crashworthiness evaluation criteria contained in the National Cooperative Highway Research Program (NCHRP) Report 350.***[2] Examples of different types of positive protection devices, their typical uses, relative costs, benefits, and specific considerations for use are listed here. Devices covered in this document include portable concrete barriers, ballast filled barriers, steel barriers, moveable concrete barriers, shadow vehicles with attenuators, and vehicle arresting systems.

Portable Concrete Barriers

Typical Uses

- Projects where work space remains active for an extended period, where work zone width is limited (often limited width places workers closer to traffic), and either worker exposure to traffic or road user exposure to work space hazards, such as a drop-off condition, are present on a regular basis.

Relative Costs and Benefits

- Substantial installation and removal costs make them less cost-effective for shorter term installations.
- They are less cost effective when used throughout longer work zones where work activities are present at a specific locaton for relatively short periods of time, as in the case of pavement repairs or pavement resurfacing projects where the activity frequently moves.

Other Considerations

- Adequate space is required for heavy equipment to install and remove the barriers.
- Impact deflection (lateral movement) of portable concrete barriers must be limited to the space available behind the barrier. Some portable concrete barrier systems can be anchored to the pavement to minimize deflection when hit by a vehicle without degrading the structural integrity of the design.
- Adequate consideration must be given to access and egress points within the work zone.
- For access points, exposed barrier ends must be protected and designed to attenuate vehicle impacts.
- Worker and road user exposure to hazards during installation and removal make them impractical for short duration use.

[2] Ross, H., D. Sicking, and R. Zimmer. *NCHRP Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features*. Transportation Research Board of the National Academies, 1993.

Ballast Filled Barriers

Typical Uses

- Work zones where large barrier deflections are less likely due to the lower traffic speeds or low impact angles.
- Projects where space behind the barrier is large enough to accommodate large impact deflections (some water filled barriers are designed to minimize deflection).
- Urban projects requiring pedestrian protection and accommodation.
- Projects where space is too limited to allow heavy equipment to place concrete barriers.
- Projects where the travel lanes are narrow and the speed is low, thereby reducing the possible angle of impact and the resulting deflection.

Relative Costs and Benefits

- Minimal installation and removal cost due to their light weight and easy handling.

Other Considerations

- Typical ballasts include water and sand. Water would lend itself more to short-term or temporary work activities, while sand would be more suitable for longer periods. Water is easier to transport, handle, and dispose of, but may not be desirable in cold weather due to freezing. Additionally, the exterior shell may become brittle due to exposure to cold weather, potentially causing issues with the ballast material.
- Consideration must be given to releasing the water in the barrier. Where will it flow? Will it flood an open lane? Are additional advance warning signs necessary for water over the roadway?

Steel Barriers

Typical Uses

- Short-term work zones, such as short activity areas where the barrier must be placed and removed on a daily basis.

Relative Costs and Benefits

- Relatively easy and quick installation and removal make them comparatively cost-effective for short-term use.
- Lightweight, stackable design reduces transport costs compared with other barriers.

Other Considerations

- Lateral displacement is usually in the range of 6 to 8 feet when impacted by a full-size pick-up truck. They can be anchored down to minimize deflection.

Moveable Concrete Barriers

Typical Uses

- Projects where the work zone must be reconfigured frequently – such as locations where lengthy sections of lanes are opened and closed on a daily or nightly basis or where the work zone is reconfigured daily. For example, work zones with median crossovers during active work periods.

Relative Costs and Benefits

- Substantial cost and effort to install, limiting their use to longer duration applications.
- Barrier reconfiguration (once initial installation is complete) proceeds quickly and with minimal disruption to traffic flow, maximizing work productivity within the work shift because setup time is minimized. Further, both workers and motorists are protected during the barrier move.

Other Considerations

- They are useful in areas with a high percentage of commuters, where traffic volumes are high in one direction in the morning and in the other direction in the afternoon.
- They may be used in combination with fixed barriers to protect the work space – the moveable barrier protects opposing traffic flows.
- They are typically moved laterally with a transfer/transport "zipper" vehicle.

Shadow Vehicles with Truck or Trailer Mounted Attenuators (TMA)

Typical Uses

- Used in longer term, mobile, short duration, and short-term stationary work zones where other types of barriers may not be feasible due to the time needed for installation and removal and due to the length of the area being protected.
- For protection of isolated work crews on large projects where a portable concrete barrier may not be practical throughout the entire work zone.

Relative Costs and Benefits

- Portable sand-filled attenuators or trailer-mounted attenuators may provide a lower cost option than a shadow vehicle with TMA for work locations where the attenuator remains in a fixed location for the entire shift, especially if the expense of a driver can be averted.
- Since undamaged TMAs can be used on multiple projects, the cost of the equipment may be spread over several projects.
- Having a driver may add substantially to project costs compared to benefits, so careful consideration should be given to whether a driver is necessary if the vehicle rarely moves.

Other Considerations

- Shadow vehicles require adequate roll-ahead distance to keep workers safe in the event they are struck. However, consideration should also be given to the potential for intrusion in front of the shadow vehicle.
- If there is a need for a shadow vehicle at a single spot for more than 3 days (long-term temporary traffic control zones), another type of device should be considered.
- They are easily moved to keep up with the location of workers.

Vehicle Arresting Systems

Typical Uses

- Useful to prevent access into a closed section of highway during periods when work is active. They are especially useful where a section of highway is closed and reopened daily over an extended period of time.

Relative Costs and Benefits

- Fixed end anchors require substantial effort to install, providing minimal return for very short-term use.
- Temporary anchors are available for short-term applications.

Other Considerations

- They may require a work vehicle entrance that bypasses the arrestor net, with a watchman or police officer to prevent unauthorized entrances to work space.
- Past history of unauthorized or unintentional entry into the work space on a closed highway section may indicate that this system is worthwhile for a project.
- One vehicle arresting system requires a buffer space behind the arrestor net that equates to 120 ft for a 60 mph approach speed.

What Should be Considered When Determining the Need for a Positive Protection Device?

Recently, FHWA published the Temporary Traffic Control Devices Rule (23 CFR 630, Subpart K) that provides additional information and emphasizes the need to appropriately consider and manage worker and road user safety as part of the project development process. The Rule provides guidance on key factors to consider in reducing worker exposure and risk from motorized traffic. It also requires highway agencies to consider positive protection where such devices offer the highest benefits to worker safety, such as situations where workers may be at increased risk of serious injury from exposure to traffic.

The following list highlights factors to consider in determining need, along with examples of situations where consideration of positive protection devices is required.

(1) Project scope and duration

Positive protection devices such as barriers become more cost effective when used on longer term projects. The *Manual on Uniform Traffic Control Devices* (MUTCD) defines long term as more than three days, but projects with duration of longer than two weeks may be especially appropriate for positive protection devices requiring substantial effort to install as these projects might otherwise result in substantial worker exposure to motorized traffic. For example, a relatively long section of portable concrete barrier may not be feasible for a project duration shorter than the time it takes to install the barrier.

(2) Anticipated traffic speeds through the work zone

Work Activity Near High Speed Traffic – Workers are at increased risk when traffic speeds are higher. Agencies may define high speed versus low speed, but generally 45 mph or greater is considered a high-speed facility. Consideration should be given to the average speed or the 85th percentile speed in addition to the posted speed limit when determining operating speed. For projects with free flow traffic conditions or limited sight distance, positive protection may be used to shield workers from higher speed traffic.

(3) Anticipated traffic volume

Work Activity Near High Volume Traffic – Workers may be at increased risk when traffic volumes are higher. Volume to capacity ratios may help determine high versus low volume locations. High volume may approach a ratio of 1.0 but not exceed it since congestion will slow traffic naturally, resulting in less volume over time as compared with traffic flow at higher speeds. In general, volumes greater than a few hundred vehicles per lane per hour are considered high volumes. Urban areas may commonly have higher traffic volumes; therefore, consideration of positive protection in such settings is important.

(4) Vehicle mix

Projects on roadways with a high percentage of truck and heavy vehicle traffic may benefit from positive protection due to the greater impact potential of a heavy vehicle intrusion into a work space.

(5) Type of work (as related to worker exposure and crash risks)

The type of construction or maintenance work should also be considered when determining when to use positive protection devices. Work activities that place workers close to moving traffic for extended periods entail the greatest risk to workers and provide the greatest benefit for the use of positive protection. Examples include shoulder maintenance, bridge slab replacement, and widening projects. In addition, shadow vehicles with TMAs and rolling roadblocks can be used to shield workers from traffic during temporary traffic control device installation and removal. Rolling roadblocks that include law enforcement personnel provide time for workers to install and remove devices without direct exposure to traffic.

(6) Distance between traffic and workers, and extent of worker exposure

For operations that place workers close to travel lanes that are open to traffic, positive protection devices provide the greatest value in shielding workers. The value of these devices is enhanced where adequate lateral buffer space does not provide separation between motorists and workers or devices, and a longitudinal buffer is not available to protect workers by giving motorists adequate room to stop upon leaving the traffic space. This may be especially important for bridge projects or confined areas such as tunnels.

(7) Limited escape paths

Projects with limited or no available escape paths within a work zone restrict workers from avoiding errant vehicles that have entered the work space. Bridge and tunnel projects are examples of locations where positive protection can help protect workers with limited escape paths. Likewise projects with a heavy presence of equipment and materials in a confined area, which restrict workers ability to avoid an errant vehicle, can also benefit from positive protection.

(8) Time of day (e.g., night work)

Performing work during off-peak periods may reduce exposure compared with higher traffic levels during peak periods. Even with reduced exposure to higher traffic, consideration should be given to the time of day and potential impacts on visibility during nighttime work when determining the need for positive protection. Paving projects are often performed at night to minimize impacts to traffic flow. Some issues with nighttime work that may help warrant use of positive protection include higher speeds, drowsy drivers, and impaired drivers.

Special consideration should be given to the factors that affect night work operations (lighting, visibility, etc.). The MUTCD does not address night work specifically, but enhancements to temporary traffic control setup for night work zones can be found in NCHRP 475 – *A Procedure for Assessing and Planning Nighttime Highway Construction and Maintenance*, NCHRP 476 - *Guidelines for Design and Operation of Nighttime Traffic Control for Highway Maintenance and Construction*, and NCHRP 498 – *Illumination Guidelines for Nighttime Highway Work.*

(9) Consequences to road users resulting from roadway departure

This situation occurs in areas where motorists are at increased exposure to roadside hazards or are at higher risk of injury from roadway departure, such as where side slopes are greater than 4:1 (horizontal: vertical). Other potential hazards include vertical drop-offs, bridge piers, and construction materials and equipment located in the work space or on the roadside. Agency policy should dictate the magnitude of the drop-off condition that would warrant use of positive protection (the RDG references 3 inches or greater for a drop-off hazard).The RDG should be consulted to determine additional roadway departure hazard considerations.

(10) Potential hazard to workers and road users presented by the device itself and during device placement and removal

Consideration should be given to the exposure created during placement and removal of the positive protection device itself. Additionally, a general rule of thumb is that the device should be protecting against the risk of striking something that may result in worse damage than striking the positive protection device itself (i.e., the damage resulting from driving into a hazard or over a dropoff would be greater than the damage associated with striking the positive protection device). Impacts involving temporary barriers are potentially harmful, and may result in serious injuries to vehicle occupants.

(11) Geometrics and/or work area restrictions that may increase crash risk

Work area restrictions and/or geometric characteristics that increase risk to workers or motorists can also benefit from the use of positive protection devices. For example severe curvature, narrow lanes, restricted sight distance, or narrow shoulders could place workers and motorists at increased risk, and warrant consideration of positive protection. Sufficient advance warning should also be provided to ensure maximum levels of traffic safety around the protective devices.

(12) Access to/from work space

For longer term work zones such as some pavement rehabilitation projects where work vehicles and equipment cannot readily gain access from the ends of the work space, consideration should be given to equipment and construction vehicle access points throughout the work space. In some cases positive protection might cause ingress/egress issues resulting in safety hazards or constructability problems and therefore should be considered carefully in advance. If positive protection is used, crash cushions may be needed to protect the blunt end of barrier sections that provide construction vehicle access when longitudinal barriers are used.

(13) Roadway classification

Positive protection devices should be considered for all roadways when needed, but may be especially important for higher speed, higher mobility roadways such as freeways. For example, portable concrete barriers should be used to separate opposing traffic flows on a freeway crossover and the resulting shared mainline.

(14) Impacts on project cost and duration

Consideration should be given to the cost of the positive protection devices relative to the project duration when determining need. Additionally, methods to minimize or eliminate exposure for workers and motorists should be considered early on in the planning stages of a project. These methods may include traffic diversion, full roadway closures, or work during off-peak periods such as nights and weekends. Positive protection devices can be selected and included in the project design, but should be preceded by consideration of these alternatives to determine the most appropriate plan that will minimize impacts to the safety of workers and motorists, while considering the impacts on project cost and duration. It is important to consider all options for managing traffic prior to determining the need for positive protection.

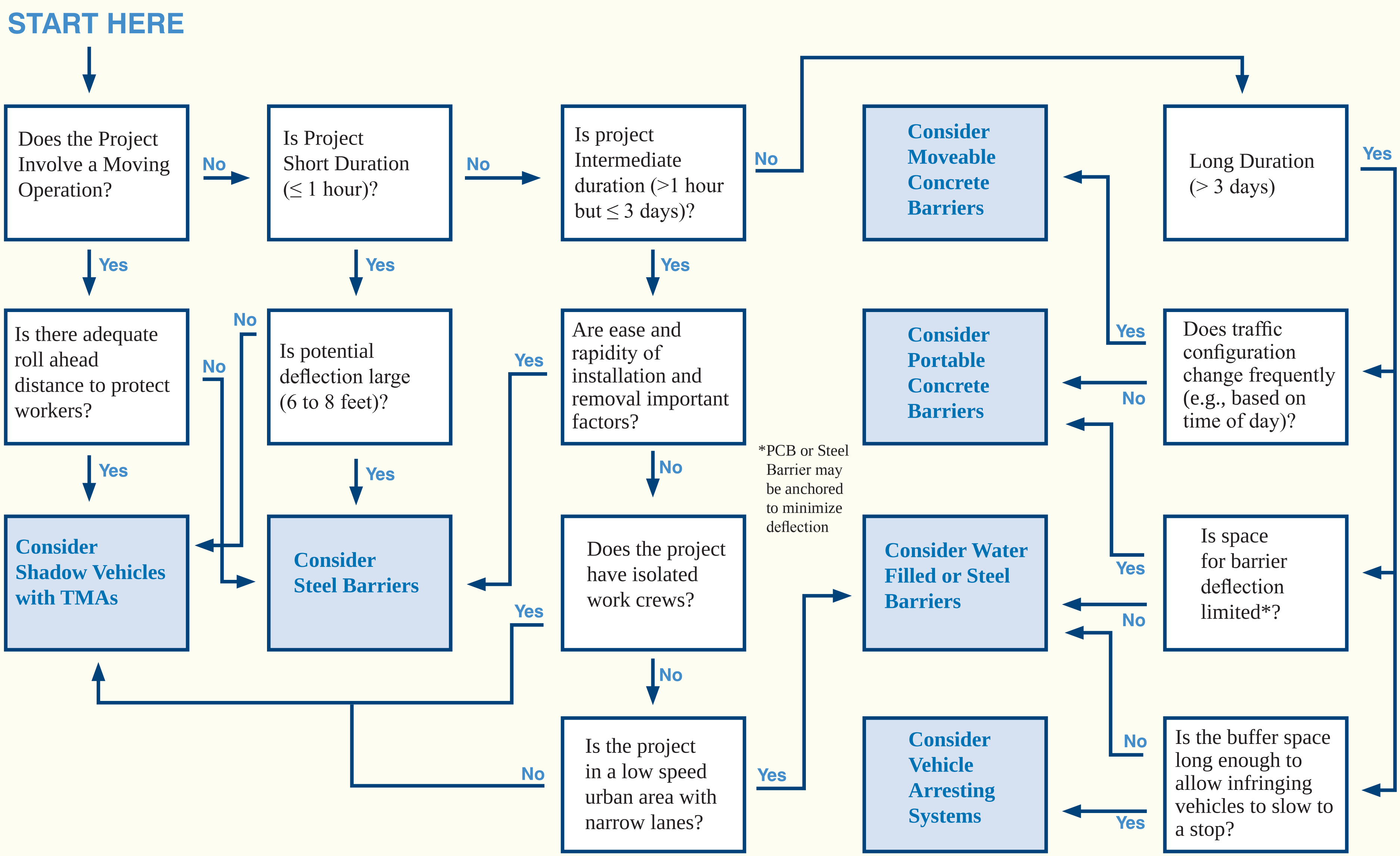
Table 1 provides guidance on when the various types of positive protection devices may be beneficial. Engineering judgment should be used to determine the appropriate types, but the table provides a summary of the guidance contained in this document to assist practitioners with selection of the appropriate device or devices. Chart 1 provides a decision tool to assist practitioners in determining the most appropriate types of positive protection devices for consideration based on characteristics of the project. Again, engineering judgment should always be used to determine the appropriate type of positive protection.

Table 1. Decision Support Tool for Selecting Various Positive Protection Devices

Positive Protection Device	Most Appropriate Projects and Locations For Use	Relative Costs and Benefits	Other Considerations
Portable Concrete Barriers	Longer duration stationary projects; areas with limited room for barrier deflection such as bridges and tunnels; drop-off conditions; worker exposure concerns	Substantial installation and removal costs; provide greater benefit on stationary activities compared with those that move such as pavement resurfacing	Require space for placement equipment; contractor access to work area; protection for exposed barrier ends
Ballast Filled Barriers	Low-speed urban projects; projects with limited space for concrete barrier placement equipment; areas with room for larger deflection, if needed (some water filled barriers are designed to minimize deflection)	Potentially lower installation and removal costs as they can be placed and removed by hand when unfilled	May be filled with water or sand; consider ballast material transport options, handling, and disposal, along with potential temperature issues (mitigated with environmentally sensitive anti-freeze)
Steel Barriers	Short-duration projects such as pavement rehabilitation and maintenance; areas with room for larger deflection (if anchored, deflection can be minimized). May also be used on long-term projects	Lower transport costs due to their lightweight, stackable design, quick installation	Lateral displacement is generally 6 to 8 feet (depending on impacting vehicle); may be anchored to minimize deflection
Moveable Concrete Barriers	Longer duration projects; projects where the traffic control configuration is changed frequently (where lanes are opened and/or closed on a daily or nightly basis)	Substantial cost and effort to install; provide benefit on projects where lane configuration changes often	Reconfiguration of the barrier can be accomplished quickly and safely; may be used to optimize directional capacity
Shadow Vehicles with TMAs	Mobile, short-duration, and short-term stationary projects such as striping, signal maintenance, vegetation control, pavement patching and repairs, and joint and crack sealing; locations where other barriers may be impractical due to the mobility of the operation	Costs include those for truck, attenuator, and driver – undamaged attenuator may be reused on other projects to spread costs	Adequate roll ahead distance is required to protect workers; consider the potential for motorists to access area between shadow vehicles and workers
Vehicle Arresting Systems	Longer term projects where the installation is used over an extended period, such as nightly closure of a roadway over an extended period; used to close an entire area and stop errant vehicles from intruding	Fixed end anchors require substantial effort to install; temporary anchors provide a lower cost solution for short-term applications	Requires adequate buffer space to allow vehicle to slow to a stop; consider work vehicle access to the closed area

Chart 1: Decision Tool for Selecting Various Types of Positive Protection Devices

Since the barrier may be a hazard itself, first check to make sure that the hazard you are protecting is more dangerous than traffic exposure to the barrier. Hazards may include worker exposure to traffic, a slope steeper than 6:1, drop-off conditions greater than 3 inches, etc. If protection is needed, then use the following chart to determine which type to use.



How Can I Locate More Information Regarding This Topic?

Three main sources of guidance for this topic include the *Work Zone Rule Subpart K*, *the Manual on Uniform Traffic Control Devices* (MUTCD), and the American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide*. Additionally, agency-specific standards, policies, and guidelines may define strategies to be used based on project and roadway characteristics. NCHRP 20-7 (174) – *Use of Positive Protection in Work Zones* also provides information on practices in use by transportation agencies.

The following links provide additional resources, and some include more information on positive protection and the techniques described in this document:

FHWA Work Zone Mobility and Safety Program:
http://ops.fhwa.dot.gov/wz/

FHWA Work Zone Peer-to-Peer Program:
http://ops.fhwa.dot.gov/wz/p2p/index.htm

The *Manual on Uniform Traffic Control Devices*:
http://mutcd.fhwa.dot.gov/

“Work Zone Positive Protection Toolbox”:
http://www.atssa.com/galleries/default-file/WZ%20Positive%20
Protection%20Toolbox%20LL%20-%20FINAL.pdf

AASHTO:
http://www.aashto.org

NCHRP 20-7 (174) – *Positive Protection Practices in Highway Work Zones*: unpublished - Available upon request from NCHRP staff.

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