



Portable Positive Protection: A Guide for Short Duration and Short Term Work Zones

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Developed by ATSSA for the FHWA Work Zone Safety Grant Program

Note: This document cites specific products solely to illustrate the concept of portable positive protection, not as an endorsement of any manufacturer's products over others that may or may not be mentioned. Trade or manufacturer names appear herein solely because they are considered essential to the objectives of this guide.



American Traffic Safety
Services Association



U.S. Department of Transportation
Federal Highway Administration





The Need for Portable Positive Protection

Transportation agencies, contractors, researchers, and private vendors are actively looking for new methods and devices to help make construction and maintenance work zones safer while maximizing mobility. Short-term and short-duration work zones are no exception, especially as fewer devices can be used in a practical way than in long-term work zones due to the limited installation time available. Practitioners commonly cite the challenge of using traditional devices for protection, as installation costs are high relative to the project and it may take longer to install the devices than perform the planned activities. This situation creates the need for more portable positive protection devices in lieu of traditional devices (such as temporary concrete barrier) that are commonly used on long-term projects, but can't be repositioned easily.

Devices mentioned in this guide may be used on long-term projects as well since many of the work zones in use could vary from short to long duration. So what do we mean by “portable positive protection?” This label applies to approved devices that provide acceptable crashworthy levels of protection – near that of temporary concrete barrier – but much more portable and relatively quick to install and remove when compared to more traditional devices. While temporary portable concrete barrier is generally considered a device for use on long term projects (those lasting more than 3 days), the definition of portable for the purposes of this guide is a device that is feasible for shorter work operations. Devices are available that can be easily placed and removed (or moved from the travel way) to provide protection for short-term and short-duration operations.

Once installed, moving concrete barrier requires heavy equipment. Steel barrier, however, can be easily pushed to the shoulder using workers, available on-site vehicles and equipment to allow traffic to resume normal operations.

Why Should Portable Positive Protection Be Used?



Shadow Vehicles with Truck Mounted Attenuators Provide Longitudinal Protection

Work zone traffic related fatalities have generally decreased over the past decade, although there are still around 600 fatalities per year in recent years.¹ Workers, who sometimes work in unprotected work areas and are struck by motorists, comprise approximately 10 to 15 percent of these fatalities each year. Supported by the Temporary Traffic Control Devices Rule, which requires consideration of positive protection on projects, there continues to be an increased focus on using positive protection—or devices that ensure protection for workers by physically separating workers and traffic—in work zones. Portable positive protection also protects road users as well as workers.

¹ National Highway Traffic Safety Administration, “Traffic Safety Facts Research Note,” DOT-HS-811-856 (Washington, DC, 2013). Available at: <http://www-nrd.nhtsa.dot.gov/Pubs/811856.pdf>



Work activities that can benefit from the safety of portable positive protection devices include:

- Concrete deck repairs
- Guardrail repairs
- Overhead bridge work/painting
- Shoulder work
- Pothole repairs
- Crack sealing
- Maintenance in areas with limited escape routes

There are several positive protection solutions for short-duration and short-term work zones. Primarily, industry has followed the American Association of State Highway and Transportation Officials (AASHTO) *Roadside Design Guide* and the Federal Highway Administration's (FHWA) *Manual on Uniform Traffic Control Devices* (MUTCD) by using shadow vehicles with truck- or trailer-mounted attenuators (TMA) for protection on projects where the work space is small and the project duration rules out the use of positive protection devices such as portable concrete barrier because it would take longer to install the barrier than to conduct the work. While lanes can be safely closed for short periods of time with shadow vehicles, there may still be some exposure for workers due to the need for roll-ahead distance in advance of the work operation. In addition, while shadow vehicles protect workers from being struck from behind (longitudinal protection), they may still be exposed to errant vehicles in the adjacent lane that could strike them from the side (lateral exposure).

Portable positive protection may also be useful for work zones where traffic congestion is anticipated since they can be moved to reopen traffic lanes quickly as needed. Additionally, portable positive protection may be less intrusive than traditional methods and thus may reduce congestion and delay relative to other devices and configurations. Motorists also need to be protected from hazards they may encounter by inadvertently intruding into the work space. Crashworthiness is another feature of portable positive protection devices that must be considered.

Improved work productivity is often a benefit of portable positive protection since workers recognize they are less exposed to traffic hazards and can focus on the work without distractions. This can reduce the overall work time and improve efficiency, thus helping to offset the portable positive protection installation time.

Related Industry Terminology References

The MUTCD uses certain terminology for temporary traffic control, and it is important to understand the differences between types of protection and the associated terms. Some common phrases and terms are highlighted here for clarification.

Portable Positive Protection – An easily transportable device that provides both longitudinal and lateral protection for workers on foot and crash protection for road users. For the purposes of this guide, portable positive protection could be a protective or barrier vehicle such as the one shown to the right or a steel barrier that can be easily pushed into place by workers once the wheels are lowered on the ground. Both types of devices are described in more detail later in this guide.



Caltrans Balsi-Beam



Moveable Barrier – This device is referenced here for the purpose of drawing a comparison to portable positive protection. Different from this guide’s definition of portable positive protection, this type of positive protection is used where lengthy sections of lanes are opened and closed on a daily or nightly basis or where the work zone is reconfigured daily. A barrier transfer machine (as shown on the right) moves sections of concrete barrier and repositions them. While this is also a positive protection device, it is important to note the difference between moveable and portable. The moveable barrier has higher costs and longer setup time, making it easier to justify on larger, long-term construction projects for temporary traffic control and providing protection and maximizing traffic flow. Moveable barrier sections can also be opened for ingress/egress using the movable barrier retractable wheels and a pick-up truck with pusher wheel or by hand using a pry bar.



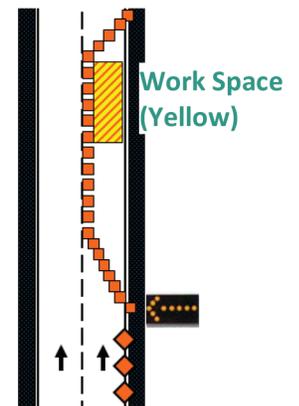
Moveable Barrier

As with short-term maintenance, a long-term project could have a series of short duration closures (closed nightly and opened daily), making it ideal for portable positive protection that can easily be pushed into place and removed daily.

Work Space – For mobile or stationary operations, the “work space” is the area where work is taking place. The work space may include the portable positive protection device along with any shadow vehicles providing protection from behind and their associated roll-ahead distance.

Protected Space – For the purposes of this document, the area behind a portable device that provides positive protection for workers where the risk of any longitudinal and/or lateral impact from traffic is minimized or significantly reduced.

Work Space Detail (Yellow)



Short-Duration Operation (MUTCD Definition) – Work that occupies a location for up to one hour.

Short-Term Operation (MUTCD Definition) – Work that occupies a location for more than one hour within a single daylight period.

Mobile Operation (MUTCD Definition) – Work that moves intermittently or continuously.



Portable Positive Protection Types and Features

There are several types of portable positive protection devices currently available. The following section describes in more detail some of the features and work zone applications currently in use.

Balsi Beam - The California Department of Transportation (CalTrans) Division of Equipment designed and built the Balsi Beam as shown in the image to the right. The Balsi Beam is a tractor/trailer combination that consists of two rotatable telescoping beams that can be deployed to either side and provides up to 30 feet of protected area within the work space.² The image shows a Balsi Beam protecting a work crew in the left lane of a four-lane divided highway. The trailer is transported to the work site at normal highway speeds without the need for any special permits and can be set up from the cab of the truck. CalTrans uses a cargo/utility truck parked in front of the Balsi Beam to carry tools and mounted equipment for use in the work operation. Caltrans may also use presence officers from the California Highway Patrol for extra visibility and enforcement at locations where workers are on foot (a “should” condition in the CalTrans Maintenance Manual).



Protected Space Example - CalTrans Balsi Beam

CalTrans has recommended granting licenses with royalties to allow the use of plans and specifications for the Balsi Beam to others. The device is currently in use by CalTrans for State maintenance forces, but has not been specified for use by contractors to date. Other portable positive protection in the form of a protective trailer has been used in other States including Colorado, Virginia, and Texas. State agencies have used portable positive protection devices for protection of in-house maintenance crews, and maintenance contractors in Virginia and Texas have also used these devices. Additionally, the North Texas Tollway Authority has specified the use of portable positive protection on two routine maintenance contracts.

Steel barrier is another type of positive protection device that provides additional portability relative to that of traditional concrete barrier. While steel barrier requires heavy equipment to unload it from a truck onto the roadway, once unloaded it is easily portable due to the retractable wheels integrated into the base and can be towed or pushed into place on the ground.



Portable Positive Protection – Steel Barrier

Steel barrier application may be used for short-term activity locations where the barrier must be placed and removed on a daily basis. In such cases, the overall project may be long term and span weeks or months, but lane closures may

² No Boundaries Pooled Fund Project, “Mobile Work Zone Barrier, Balsi Beam, California Department of Transportation,” (n.d.). Available at: <http://noboundaries-roadmaintenance.org/PDFs/Balsi-Beam-Flyer.pdf>



be removed on a daily basis to avoid peak hour traffic impacts. As an example, when a lane is closed for a short-term work zone at night for overhead bridge painting, workers may be behind a tarp without good visibility and exposed to approaching traffic. Steel barrier sections can be staged on the shoulder, and, depending on whether the product is equipped with wheels, workers can easily roll sections into place for protection. The barrier can then be rolled to the shoulder by workers to open the lane to traffic during daytime hours. Steel barrier placement time generally exceeds the window of time needed for short-term or stationary operations that last less than six hours; therefore, another form of positive protection may be used for maintenance activities that meet these definitions.

As an example of various uses of terminology, Caltrans defines a short term operation as 20 minutes or less, while a stationary operation is more than 20 minutes, typically 4 to 6 hours.



Steel Barrier Installation

Depending on the product, steel barrier may include wheels for ease of rolling into place by hand. When in place, the barrier sections may be lowered to where high friction pads come into contact with the roadway surface to provide additional stability when impacted. These rubber pads may also add up to 0.5 inches between the pavement and the barrier, allowing for water drainage. Steel barrier sections weigh approximately 3,000 pounds (for 50-foot lengths) and approximately 750 feet of barrier can be transported by semi-truck and trailer in one load. One manufacturer provides 13-, 26-, or 40-foot sections. Barrier sections can be towed into place, moved with a forklift, or moved by hand when on wheels. One advantage of steel barrier is that it

can be easily removed if work activities are suspended due to unforeseen high traffic impacts – providing flexibility in managing the work zone. Speed joints and rigid dovetail joints may be used to connect sections together, while anchoring pockets may be used to attach the section to the pavement for minimal deflection. Steel barrier can easily be aligned to curves compared with traditional portable concrete barrier.

Protective Vehicles - For vehicle-based protection, the AASHTO *Roadside Design Guide* specifies three types of protective vehicles – advance warning, shadow, and barrier vehicles. Similar to a shadow vehicle, a **barrier vehicle** can also be used to provide worker protection. The difference between a shadow vehicle and barrier vehicle is that a barrier vehicle does not have a driver at all times. Caltrans' Maintenance Manual outlines a description of a barrier vehicle as follows:³

A barrier vehicle is an unoccupied vehicle or piece of equipment used to protect workers from errant motorists. Any vehicle at a work site can be used as a barrier. However, workers shall use the heaviest vehicle reasonably available. In

³ Excerpt from Chapter 8 of the CalTrans Maintenance Manual, July 2014.



certain instances, more than one (1) barrier vehicle may be needed. A barrier vehicle does not require a TMA. However, if a TMA is available, it should be used.

Any vehicle that is used should be parked upstream from the work site between approaching traffic and the workers. It should be parked where it will provide the best protection; not too close to the workers, not too far back. It shall be carefully positioned so that it will intercept errant vehicles, but will not roll ahead into the work area. Always park the barrier vehicle with the emergency brake set and lower any attachments to the ground. Channelization devices are recommended to delineate and separate traffic from the barrier vehicle during short term work.

A barrier vehicle without a TMA can be parked a number of ways. It can be parked at an angle or even straight across the lane. If it is parked at an angle, the front of the vehicle should be pointed away from traffic. The wheels shall be turned away from the work zone. If possible, the wheels should be turned away from traffic. This will avoid motorist panic and prevent secondary collisions if the barrier vehicle is hit and pushed ahead. A barrier vehicle with a TMA should normally be parked parallel with the direction of traffic.

Some State DOTs specify (and manufacturers may recommend) that barrier vehicles be positioned with wheels straight ahead.

When Is It Appropriate to Use Portable Positive Protection?

Improved road-user and worker safety is the proven benefit from using portable positive protection. Projects in most short-term, short-response-time, high-traffic-volume work zones place the priority on getting the work done as quickly and safely as possible. These devices protect workers and provide them with a true feeling of safety, which lets them focus on their work, promoting productivity. Any device specified must be approved for use by the agency (see Qualified Products List).

Qualified Products List (QPL) – A list of devices approved for use by an agency on projects. These devices would meet crashworthiness requirements and agency specifications.

Using portable positive protection may be appropriate when the following factors are in place:

- There is limited time as it relates to work hour restrictions, setup and removal, productivity, work area access, transportation routes, and removal and storage of the device.
- Using other exposure control measures may increase worker and road user hazards.
- There are limited escape areas, such as in tunnels and on bridges.
- There is a need for positive protection for exposed work hazards or during night work.



- Where deflection can be accommodated – steel barrier deflects over 5 feet if anchored at the ends only, and minimal deflection can be achieved for at least one type of system where the steel barrier is anchored approximately every 33 feet. Generally, deflection may occur in the range of 6 to 8 feet when impacted by a full size pick-up truck. Steel barrier is more practical for short-term projects than for short-duration work zones. Barrier trailers such as the Balsi Beam typically experience minimal deflection.

In addition, cost is always a consideration and may be relatively high in initial investment depending on the type of device used. Portable positive protection can provide a valuable safety and efficiency benefit that can be used to justify the cost, especially given the potential for greatly reducing exposure to workers. An estimate of the economic value of a statistical life for use in benefit-cost analysis was \$5.2 million in 2013, making the overall benefit-cost ratio very high (even for a several hundred thousand dollar device investment) for saving just one life over a time period of a few years.⁴ One study showed that the cost of portable positive protection could be offset within 5 to 10 years of use for roadways with Average Daily Traffic levels greater than 100,000 vehicles per day.⁵

Renting or leasing, purchasing, developing a contract bid item, agency-provided contract item, or other payment means are some of the payment methods that may be appropriate for your use of portable positive protection devices on a project. Future ownership of the devices in use after the contract term expires should be a consideration for making the device a contract bid item. Including a requirement in the contract for future reimbursement to the agency for the assessed value of the equipment after contract expiration may also be an option. Agencies may want to specify portable positive protection as part of a contract and list examples that will allow contractors to select the most appropriate type to use, consistent with the contract plans and specifications. State and local agencies may benefit substantially from cost participation by FHWA on Federal Aid contracts.

Portable positive protection can be procured in a number of ways including:

- Leasing
- Renting
- Purchasing
- Specifying a Contract Bid Item
- Including an Agency-Provided Contract Item

State DOTs and device manufacturers have developed resource information on work zone applications that should also be referenced when deciding if and when to use portable positive protection. Information source links are provided at the end of this guide.

⁴ U.S. Department of Transportation, "Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses," memorandum dated June 13, 2014.

⁵ Texas Transportation Institute, *Work Zone Positive Protection Guidelines*, Report Number FHWA/TX-11/0-6163-1. (TTI, October 2010).



Ten Suggested Steps to Take When Planning to Use Portable Positive Protection

The following list shows a collection of steps to follow in implementing portable positive protection. This list can be applied to either towable devices or steel barrier sections already staged on the roadside for future use. Many strategies are possible and those that are intended should be defined in the contract plans and provisions or as well detailed temporary traffic control plans (TTCP).

1. Identify crew members who will perform the work and those who will assist with traffic control. A responsible person, such as the Traffic Control Supervisor or Agency Inspector may be charged with this duty.
2. Organize crew members and meet ahead of the scheduled operation to discuss the deployment. Be sure that manufacturer guidance is reviewed and understood in light of State and local requirements. Some agencies follow a Pre-Activity Safety Plan process, which is a best practice approach and may include an assessment for portable positive protection. TTCPs should be available for all involved and written instructions may be needed for some activities.
3. Ensure that the necessary equipment is available to perform the work activities. The Traffic Control Supervisor and Agency Inspector should refer to an equipment list developed from equipment shown on the TTCP.
4. Develop and/or review site-specific TTCPs for location of work, type of work activity, time of day and potential lighting needs, safe stopping locations, positioning of semi-trailers for unloading devices, and other temporary traffic control devices such as signs and arrow boards that will accompany the installation.
5. Review the existing traffic data for the work location and analyze the project's effect on traffic flow, including the potential for queuing, speed variability, and the potential hazards associated with slowing traffic as the device is put into place. The higher the traffic levels, the more benefit in reduced exposure to offset cost of the portable positive protection. Work hours may need to be established to minimize traffic impacts.
6. For a right-lane closure it may be necessary to stop on the shoulder in advance of the work space to find the appropriate gap in traffic where the lane can be closed safely, in keeping with accepted safety practices.
7. For a left lane closure, consider the limited inside shoulder area and how the operation will be initiated, including ground placement of advance warning signs, if applicable. This setup may require a mobile lane closure if the inside shoulder is narrow (especially if a median wall exists) and advance warning signs are placed on the ground instead of or in addition to using vehicle-mounted signing.
8. Consider potential lateral and longitudinal displacement and leave room in the event that lateral deflection occurs when a vehicle strikes the protection device. A lateral buffer space may need to be established, usually one lane width.



9. When using trailers, consider slightly angling the cab/tractor away from the side where traffic will pass. This may help avoid cab/tractor impact from an errant vehicle as it travels down the outside of the trailer in the event of impact. When in operation, ensure that a truck mounted attenuator is lowered into place, if applicable.
10. Once the operation is complete, all materials and tools are removed from the site, and all personnel are accounted for in the vehicles, use radio communication from the upstream vehicle (advance warning or shadow vehicle) to determine the appropriate timing for moving the operation back into the flow of traffic and opening the lane. For steel barriers, it may be possible to move the sections back to the shoulder prior to loading back onto a removal vehicle.

Example of a Typical Application of Portable Positive Protection

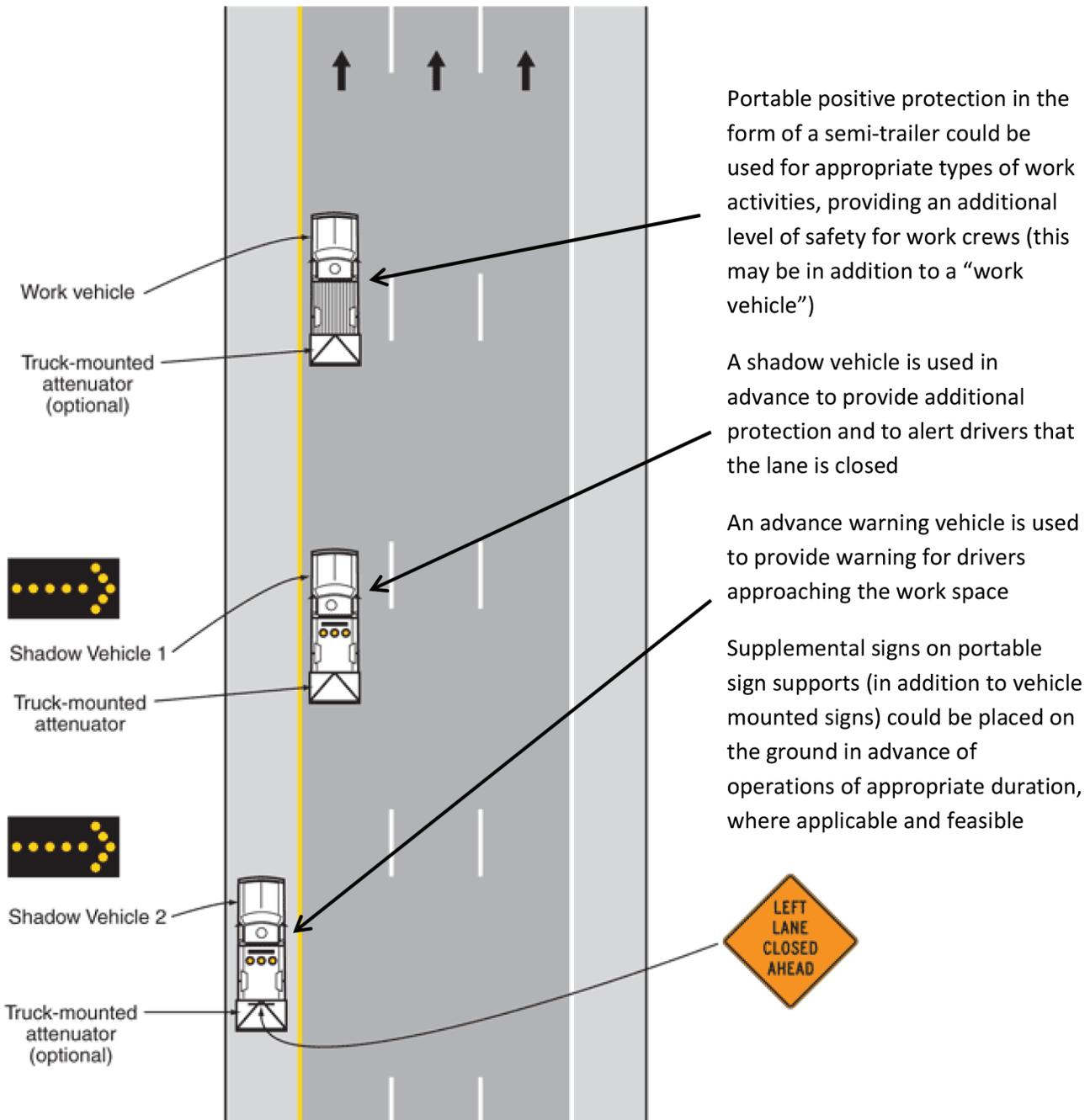
An example of a traffic control configuration for a mobile lane closure can be found in the MUTCD section 6H and is shown in the Figure 6H-35 from the MUTCD (see next page). A similar configuration can be used for portable positive protection as shown in the typical application. This configuration could also be reversed for a right lane closure.

These suggestions are not meant for use in place of the typical application, but are shown using an MUTCD typical application drawing to relay main points about how to use portable positive protection.

It is important to have advance warning of the mobile lane closure using an advance warning vehicle with appropriate signing to warn drivers of the lane closure. The typical application diagram includes a potential approach to executing this mobile lane closure when using portable positive protection. While this approach reflects the MUTCD typical application for mobile operations, other deployments may or may not include the shadow vehicles. In either case, advance warning for drivers is of utmost importance to the safety of the operation.



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





Summary

Protection of workers and road users in work zones is a critical requirement and can usually be accomplished with various work zone strategies. As opposed to workers on foot, drivers and passengers have some level of protection in the relative safety of their vehicles. Protecting workers from errant vehicles can be a more difficult challenge and one that is not always directly addressed. Portable positive protection, such as the Balsi Beam and other mobile devices, steel barriers, shadow vehicles, and barrier vehicles fill the need particularly well in short-term and short-duration work zones where using other device types may not be feasible.

Information Sources

CalTrans Device Demonstration Project

<http://ahmct.ucdavis.edu/wp-content/uploads/pdf/AGBBDemo071211.pdf>

CalTrans Maintenance Manual

http://onramp.dot.ca.gov/hq/maint/imms/Vol106PDF/10_Chpt-8_and_Appendix_T9-T17_July_2014.pdf

CalTrans Office of Materials and Infrastructure Research

http://www.dot.ca.gov/newtech/researchreports/two-page_summaries/balsi_beam_2-pager.pdf

Field Guide for the Placement of Shadow Vehicles in Work Zones

https://www.workzonesafety.org/fhwa_wz_grant/atssa/area2_field_guide_shadow_vehicles

Guidelines on the Use of Positive Protection in Temporary Traffic Control Zones

https://www.workzonesafety.org/fhwa_wz_grant/atssa/atssa_positive_protection_guidelines

Manual on Uniform Traffic Control Devices – Part 6 sections 6F and 6G

<http://mutcd.fhwa.dot.gov>

North Texas Tollway Authority publication on portable positive protection use in work zones

http://enews.ntta.org/DrivingForward/June2011/mobile_barriers_DF0611

Washington State Department of Transportation Work Zone Traffic Control Guidelines Book M54-44

<http://www.wsdot.wa.gov/Publications/Manuals/M54-44.htm>

National Work Zone Safety Clearinghouse.

<http://www.workzonesafety.org>







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