# Case Studies on Technology Solutions for Temporary Traffic Control Operations

## Automated Flagger Assistance Devices and Portable Traffic Signal Applications

Image Courtesy Horizon Signal

November 2022

American Traffic Safety Services Association

ATSSA
SAFER ROADS SAVE LIVES

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# Introduction

Transportation agencies, contractors, traffic control services companies, and a broad range of other stakeholders desire efficiency and safety in implementing temporary traffic control (TTC) for a variety of situations. Vendors are continuously researching, prototyping, and engineering devices that can improve operations and safety. For devices to gain adequate use, they need to be simple, straightforward, easily moved to the site or remobilized to another location and be cost effective to use.

Temporary traffic control applies to work zones, planned special events, or traffic incident management. Each situation is different and requires planning to ensure adequate levels of safety. While incident management planning focuses on proactive verification and response, work zones and planned special events both benefit from the use of devices within the traffic control plan that can improve safety.

Fatalities and serious injuries at or near temporary traffic control setups remain problematic. In 2020, 38,824[1] fatalities occurred on highways in the United States. During the same year, 774 fatal crashes occurred in work zones, resulting in 857[2] work zone fatalities. In addition, nearly 38% of the 156 fatalities coded as pedestrians are individuals working at the project site. Regardless of the number of advanced warning signs installed, distracted drivers do not see them and do not lower their speeds accordingly when approaching typical temporary traffic control situations.

The American Traffic Safety Services Association (ATSSA) is committed to reducing work zone injuries and fatalities through promotion of safe work zone traffic control practices. ATSSA members research, develop, and manufacture devices and technologies that provide greater levels of efficiency and safety in and around work zones. Of particular focus is moderate- to high-speed two-lane rural work zones where traffic is controlled by stopping one lane at a time and alternating traffic through the work zone.

Depending on the conditions at project sites, there are several options for managing traffic flow through work zones on two-lane highways. These techniques are outlined in the Manual on Uniform Traffic Control Devices (MUTCD), in existing ATSSA publications, and in transportation agency standards and specifications. Two applications with significant mobility, efficiency, and safety benefits include the application of Automated Flagger Assistance Devices (AFAD) and Portable Traffic Signals (PTS).

Table 1 outlines some of the common types of TTC operations and their associated benefits, challenges, and requirements.

*Table 1. Types of Flagging Operations: Differences, Benefits, and Requirements*

[1] https://www.nhtsa.gov/press-releases/2020-traffic-crash-data-fatalities
[2] http://www.workzonesafety.org/work-zone-data/

| Example Strategy | Benefits, Uses, Challenges, and Requirements |
|---|---|
| Two flagger operation | • Allows monitoring of traffic delays and queues<br>• Requires two individuals with potential exposure to traffic |
| Single flagger operation | • Flagger stands across from the work space<br>• Appropriate in low volume, low speed situations with adequate sight distance |
| Pilot car operation | • A pilot car leads traffic through a more complex work zone<br>• Flaggers control both approaches to the work zone |
| Automated Flagger Assistance Device (AFAD) | • Designed for short- and intermediate-term activities<br>• Allows the flagger(s) to stand in a safer position off the shoulder (requires trained flaggers)<br>• May include a red/yellow lens or stop/slow indication<br>• Typically trailer mounted devices or portable units with gate arms and manual control<br>• Must be controlled remotely by an appropriately trained individual with unobstructed views of the AFAD and approaching traffic (in both directions for a single operator)<br>• May include one or two flaggers – AFAD must not be left unattended<br>• Require similar signing to traditional flagging operations and may be supplemented with additional traffic control devices |
| Portable Traffic Signal (PTS) | • Designed for short- to long-term work zones with one-lane two-way tapers that remain in place while no workers are present<br>• There is no need to position a flagger on the shoulder near the path of oncoming traffic<br>• Require similar signing to traditional flagging operations |

Practitioners have a need for information on proven, tested techniques that can improve work zone safety. This need includes examples of requirements and accepted practices for use of the AFAD and the PTS on two-lane roadways. This case study outlines some examples of proper application of the AFAD and the PTS, along with example agency requirements and traffic control plan standard drawings. These case study examples will benefit interested transportation agencies and private sector representatives.

## Differences and Similarities in the AFAD and PTS

Portable traffic signals are trailer or cart mounted devices that may include multiple signal heads that control traffic at the approach to the one-lane two-way taper or open lane. Portable traffic signals control each traffic approach to a project site on a two-lane road without the need for flaggers. These devices can use pre-determined and customized timing plans. PTS can also allow more efficient traffic flow compared with traditional flagging operations by utilizing detection system components that allow signal timings to be adjusted in real-time based on traffic conditions. PTS have a variety of applications depending on the durations of the project and can also be used on two-lane roadways and bridges where traffic must alternate over a long-term duration. Portable traffic signals can be mounted on a trailer or smaller pedestal for ease of maneuvering.

*Figure 1. Pedestal-mounted PTS (Image Courtesy Branz Technologies)*

Automated Flagger Assistance Devices provide enhanced safety for flaggers by allowing them to control the devices from a location off the shoulder of the roadway. AFADs can be cart or tripod mounted and are operated by a trained flagger to control traffic in one or both directions. Given that AFADs are controlled by one or more individuals from within the work zone, they are designed for use with short and intermediate term operations (typically one work shift). Some agencies limit AFAD use to 3 days. AFADs can be equipped with a red/flashing yellow indication or a stop/slow indication.

*Figure 2. Closed Lane AFAD Application in Michigan (Image Courtesy Michigan Department of Transportation)*

The MUTCD outlines several requirements and recommendations for application of PTS and AFADs, including the following condition information.

- AFADs shall be operated only by a flagger who has been trained in proper operation of the AFAD. The operator may be required to have manufacturer certification for operation.
- Traffic control shall either include an AFAD at each end of the zone, or an AFAD at one end and a flagger at the opposite end.
- AFADs may be operated by a single flagger if views are unobstructed to the AFADs and to traffic approaching in both directions.
- AFADs may include a stop/slow indication or a red/yellow lens device.

Some AFAD systems link portable camera technology to tablets in the field for closer monitoring of the approaches by appropriate personnel. Additional personnel may monitor the operation using a tablet device while the flagger controls the devices from a distance. This application has also been used with multiple flaggers and with pilot car operations, where the pilot vehicle leads traffic through more complicated routes. In addition, the AFAD supports traffic rerouting through third party app connectivity. It is important to note that the pilot car operator must not control the AFADs or be distracted by any devices.

*Figure 3. SmartFlagger with Connectivity and Video Surveillance (Image Courtesy SIte2020)*

The following figure outlines where AFADs and Portable Traffic Signals are used[3] in the United States.

[3] Usage statistics determined based on the presence of a standard drawing, specification, verbal or written agency confirmation, or the device is included on the agency's approved products list. In some cases, information may not have been readily available.

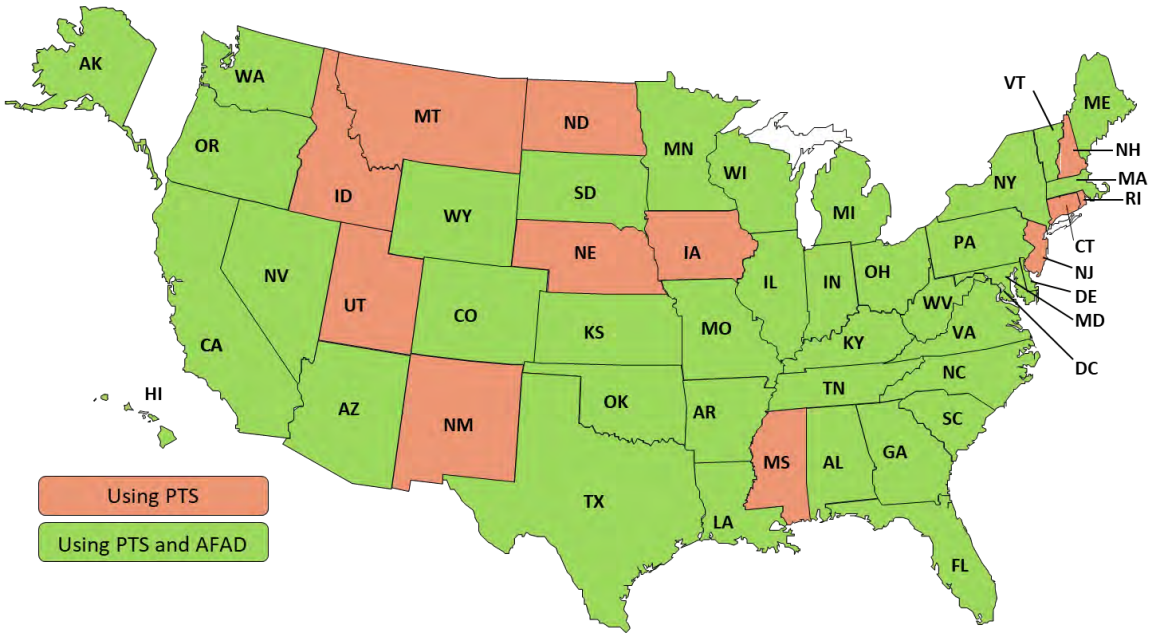



*Figure 4. AFAD/PTS Use by State (As of November 2022)*

## Case Study – Trailer-Mounted Portable Traffic Signals in Sturgis, South Dakota

The Sturgis Motorcycle Rally has an 83-year history of attracting nearly 600,000[4] people to the small northern Black Hills community of Sturgis, South Dakota (population approximately 7,000) for a ten-day event. Given the size of the local area and its population, adding the volume of motorcycles and vehicular traffic to the area required careful traffic planning, including the use of portable traffic signals to accommodate users while moving traffic safely and efficiently.

*Figure 5. Temporary Signalized Intersection in Sturgis, SD Using Portable Traffic Signals (Image Courtesy Street Smart)*

[4] https://americanrider.com/american-motorcycle-news/2022-sturgis-motorcycle-rally-stats-report/2022/08/19#:~:text=The%20most%20reputable%20number%20comes,reported%20attendance%20of%20555%2C000%20people.

During the nearly two-week period each year, motorcycles and large recreational vehicles use the roadways to access campground areas, hotels, concerts, and other attractions. Rapid City, South Dakota lies approximately 30 to 40 miles south of Sturgis and is also a primary destination for travelers in the area. The added traffic using the local area and primary highway routes required innovative intersection control to accommodate the additional users.

The South Dakota Department of Transportation (SDDOT) collects traffic data for analysis in planning for the annual event. Based on the expected traffic demand for recent years, SDDOT installed portable traffic signals at 11 locations including Interstate 90 access ramps, several South Dakota highway intersections, and an access point to a Veterans Health Administration hospital and South Dakota Army National Guard training facilities. The portable trailer-mounted signals provide protected left turns and optimal traffic flow based on the estimated mainline and side street demand. Cameras also allow for remote monitoring of the intersections thereby allowing operators to refine the signal timing for even greater efficiency.

Primary PTS Benefits:

Trailer-mounted PTS can temporarily signalize a stop-controlled intersection for improved safety and efficiency during planned special events.

When comparing statistics from the rally in 2021 to that of 2022, data showed fewer total citations, non-injury and injury crashes, and fatal crashes[5]. Further investigation and analysis would be needed to show specific safety improvements from the PTS use at the affected intersections; however, the PTS also contributed to greater compliance with reduced posted speed limits in the area.

## Case Study – Automated Flagger Assistance Devices in Michigan

The Michigan Department of Transportation (MDOT) has used AFADs on several projects to control traffic on two-lane highways during construction. MDOT initially piloted the technology on a 27-mile hot mix asphalt fine textured milling and resurfacing project on several sections of M-65 in the northeastern portion of the lower peninsula. The project included a 3-year materials and workmanship pavement warranty, and MDOT used two sets of AFADs during a one-lane two-way traffic closure for the milling and paving work. MDOT also used the AFADs on a 7-mile overband crack fill, chip seal, and fog seal on M-72, which also included a two-year pavement performance warranty. The challenge with these types of projects is allowing adequate access to the work space for the contractor to ensure quality while also managing traffic and ensuring motorist and worker safety approaching and within the work zone. The length of work space at any given time on the projects using the AFAD was approximately two miles.

*Figure 6. AFAD Use in Michigan (Image Courtesy MDOT)*

[5] https://southdakotarides.com/2022-rally-recap/

One event in the fall of 2021 precipitated the need for technologies to improve safety, where a commercial motor vehicle struck and killed a flagger working on a project. The AFAD provides an opportunity to separate the flagger (referred to as a traffic regulator in Michigan) from the approaching motorists. By using the AFAD, flaggers are able to stand in a nearby driveway or off the shoulder, as applicable. The AFAD can also be equipped with a horn that can be used to trigger a stop prior to a vehicle entering the work space.

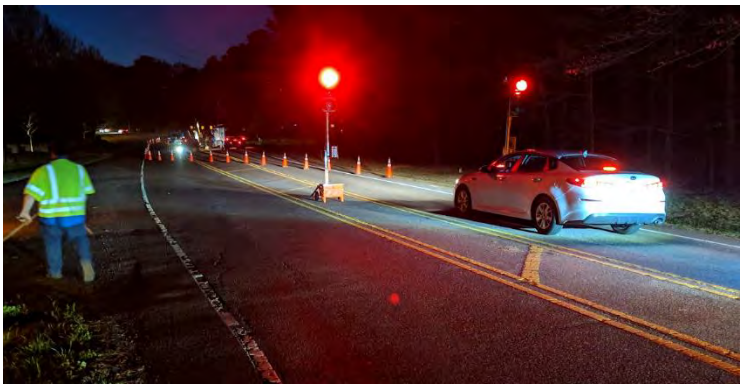
After two days of use and observations of traffic and AFAD operators, the benefits were very apparent. The contractor used a pilot car to guide traffic through the work zone on each project and deployed portable temporary rumble strips at the approaches to further enhance safety.

Primary AFAD Benefits:

Allows flaggers to relocate away from traffic. AFAD may garner greater respect from motorists than with traditional flaggers.

MDOT's special provision requires a maximum of 750 feet between the flagger and AFAD. In addition, a key consideration is traffic demand – in lower volume situations, the delay between activation and the lowering of the gate arm is less impacting. When considering AFADs for higher volume conditions, the delay time between button push and gate arm lowering may be dictated by local specifications to ensure safe stopping after the last vehicle passes the device. In these two cases, the use of the AFAD and flagger(s) was lower in cost than deploying portable signals.

## Case Study – Pedestal-Mounted Portable Traffic Signals in North Carolina



The North Carolina Department of Transportation (NCDOT) allows contractors to use pedestal-mounted Portable Traffic Signals on two-lane highway construction projects. NCDOT does not specify or require use of PTS (or AFADs) but rather allows flexibility with contractors to determine the type of control for two-lane two-way operations when a lane is closed. Instead of providing a pay item for a flagger or flaggers, NCDOT utilizes a flagger station pay item which provides flexibility for contractors to select the appropriate device for their application.

*Figure 7. Pedestal-Mounted Portable Traffic Signals (Image Courtesy Branz Technologies)*

As shown in Figure 7, these portable traffic signals provide red/yellow/green indications for approaching traffic based on pre-programmed signal timing patterns. The signals may also rest in red mode until a pilot car operator triggers the green phase or a detection system identifies approaching vehicles.

Primary Pedestal-Mounted PTS Benefits:

Allows safe traffic control on bridges or narrow shoulders where flaggers are exposed to dangerous conditions. Smaller footprint and ease of portability.

In North Carolina and other states, the PTS have alleviated labor shortage issues and are cost competitive devices for payment to the contractor. NCDOT limits use of pedestal mounted PTS to 72

hours, as the visibility of the larger trailer-mounted PTS is better for long-term projects. Four pedestal-mounted PTS can fit on one trailer and one person can set up each device. Deployment time is shorter versus trailer mounted because tandem trailering (connecting multiple PTS trailers to one truck) is against North Carolina state law. Pedestal-mounted PTS are almost exclusively used for short-term operations in North Carolina.

NCDOT also uses the AFAD and the larger trailer mounted PTS. On a recent project, NCDOT installed trailer-mounted PTS to create a temporary intersection to allow a building development occupancy permit to be issued prior to construction of the permanent signalized intersection. The pedestal-mounted devices use a smaller footprint and can also be used on narrow shoulders on bridges where a flagger would otherwise stop and release traffic in advance of the bridge (due to lack of an escape route on the bridge). Drivers can also see the PTS better and may be less inclined to perform unsafe maneuvers such as driving around a queue of traffic on a bridge.

*Figure 8. Pedestal-Mounted PTS on a Bridge (Image Courtesy Branz Technologies)*

## Case Study – Improving Pedestrian Safety at the World Trade Center

Portable traffic signals can also be used for temporary traffic control in urban settings to enhance pedestrian safety. For example, the Port Authority of New York/New Jersey recently deployed trailer mounted portable traffic signals on a roadway near the World Trade Center campus. While the area has limited access for traffic with only commercial vehicles allowed to enter the area, pedestrian traffic is heavy. In addition, a new train station created an influx of pedestrian traffic to the area. Approximately ten trucks access the site in an hour, while during peak hours nearly 4,000 pedestrians access the area and cross local roadways.

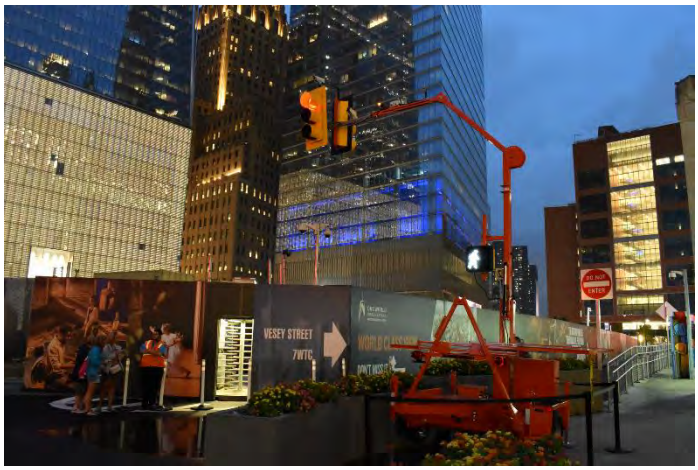



*Figure 9. Trailer Mounted PTS near the World Trade Center Site in New York (Image Courtesy Horizon Signal)*

The Port Authority deployed a customized PTS system that favored pedestrian traffic and allowed vehicle actuation using a video detection system. Pedestrian crosswalks rested in WALK mode as the priority. When the PTS detected a vehicle, crosswalk approaches changed to DON'T WALK to allow vehicles onto the site. The Port Authority met the challenge of safely controlling pedestrian traffic while allowing commercial and construction vehicles into the area.

## Case Study – Pedestal-Mounted Portable Traffic Signals in Virginia

In 2022, the Virginia Department of Transportation (VDOT) let a contract for bridge painting on a two-lane roadway (route 600) under Interstate 77 in Wythe County, Virginia. The contractor deployed

pedestal mounted PTS to accommodate temporary traffic control on a narrow roadway with limited shoulders. The PTS operated continuously for approximately one month as the work was completed. The contractor developed the traffic control plan and signal timing plan and obtained VDOT approval for the setup, with the primary focus of the most efficient all red time. The contractor installed and programmed the system in the field and monitored routinely to ensure safe operation.

The pedestal mounted PTS were initially set with yellow flash mode as personnel drove through the work zone at varying speeds from each approach to determine the best change interval. The devices also include pre-determined inputs including speed limit and the distance between signals to automatically establish a suggested timing pattern (the actual travel speed through the work zone may differ significantly from posted speed limit). The contractor rented the devices with little maintenance required due to the battery life and device power capacity. The contractor also added stop bars to the pavement given the duration of the project (no permanent markings existed on the roadway). VDOT requires temporary pavement markings for intermediate or long-term work (such as the addition of a stop bar for each approach).

The type of PTS used on this project have a variety of capabilities. Project personnel can switch to an all-red mode during a project phase change and then can be set back to a pre-timed plan. Common modes include all-red, flashing red, off, and flashing yellow. With adequate sunlight, three batteries and a solar panel provide for continuous operation with weekly inspection of voltages. For short-term projects, one battery will last several days, and a single battery allows for ease of moving each device. A pilot car can also change the pattern as need, and detection on the unit can call all-red or extend the green time depending on demand using doppler sensors.

## Additional Technologies Currently Being Tested

Another challenge in effectively managing traffic in and around two-lane highway work zones is traffic entering from driveways and side streets. For a long stretch of one-way flow on a two-lane road with one lane closed, driveway entry into the traffic space can be confusing for motorists unless they are able to follow a mainline vehicle or platoon of vehicles. State Departments of Transportation are experimenting with a different type of portable signal to alleviate this issue.

*Figure 10. DAD Controlling Traffic on a Side Road (Image Courtesy John Thomas, Inc.)*

The Driveway Assistance Device (DAD) is a portable trailer-mounted signal head with signing that is used to control driveway traffic entering a one-lane work zone. In periods of light traffic, turning into the traffic space can be a maneuver that is opposite the flow controlled by portable signals on the mainline. The DAD includes signal heads normally displaying either solid red, flashing red left arrow, or flashing red right arrow indications for motorists entering the mainline from a driveway.

The DAD is supplemental and used in conjunction with portable traffic signals on trailers at each end of the work zone that maintain bi-directional traffic. The device is experimental, has been tested in several states, and requires appropriate approvals for use. Recent evaluations have shown positive benefits from the application, including one statistic citing a safe side street traffic movement rate of 93 percent[6].

## Summary and Conclusions

The benefits to use of AFAD and PTS devices are readily apparent. These benefits and typical situations are summarized in Table 2 below.

| Type of Device | Typical Situations and Benefits |
|---|---|
| AFAD (Michigan Case Study) | Allows the flagger to stand in a safer position off the shoulder; Applicable to short-term work zones where a flagger or flaggers are present |
| Pedestal-Mounted PTS (North Carolina and Virginia Case Studies) | Smaller footprint where widths may be limited; Removes the need for the flagger(s); Allows flexibility in positioning devices in work zones on bridges or narrow shoulders where otherwise a flagger would not have a safe position on the bridge for an adequate escape route; Common applications include maintenance and utility work, parking garages, and side roads |
| Trailer-Mounted PTS (Sturgis, SD, and New York City Case Studies) | Applicable to long-term work zones with one-lane two-way tapers that remain in place while no workers are present; Removes the need for the flagger(s); Broad application including temporarily signalizing a two-or four-way stop-controlled intersection, use with bridge repair, emergency knockdowns, and haul roads |

*Table 2. Summary AFAD and PTS Benefits and Applications*

Temporary traffic control for work zones and planned special events requires careful planning and consideration of innovative approaches to minimize impacts. The temporary traffic control approaches highlighted in this document provide work zone safety and mobility benefits when implemented by agencies, contractors, and private sector representatives. The American Traffic Safety Services Association is committed to improving work zone safety and reducing injuries and fatalities through outreach on innovative practices. For more information see ATSSA's website (http://www.atssa.com) or call (540) 368-1701.

[6] https://intrans.iastate.edu/news/research-studies-driveway-assistance-devices-dads-as-potential-work-zone-option/

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Section 4H.02 Design of Traffic Control Signals for One-Lane, Two-Way Facilities
Section 4H.03 Operation of Traffic Control Signals for One-Lane, Two-Way Facilities
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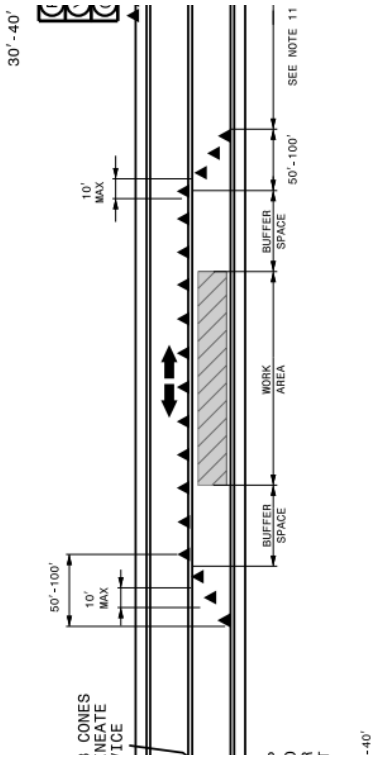
https://workzonesafety.org/work-zone-devices/

# Appendix – Example State Department of Transportation AFAD/PTS Standard Drawings and Special Provisions

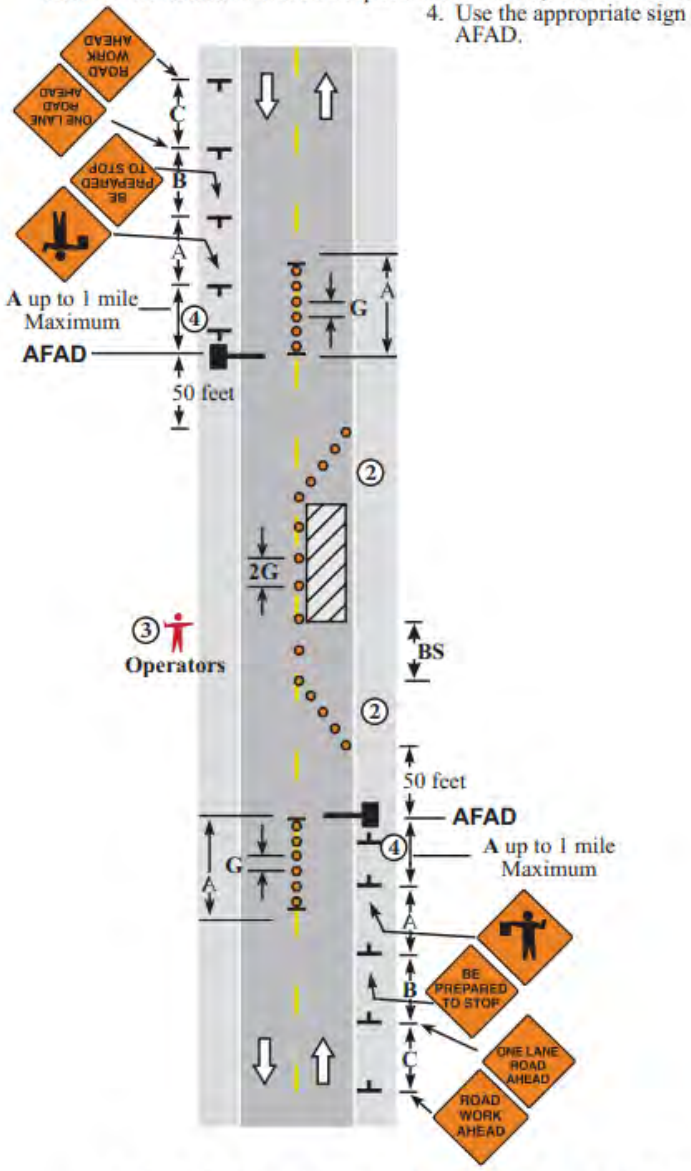
**North Carolina Department**



**Tennessee Department of Transportation Standard Drawing for AFAD Use**

NOTES:

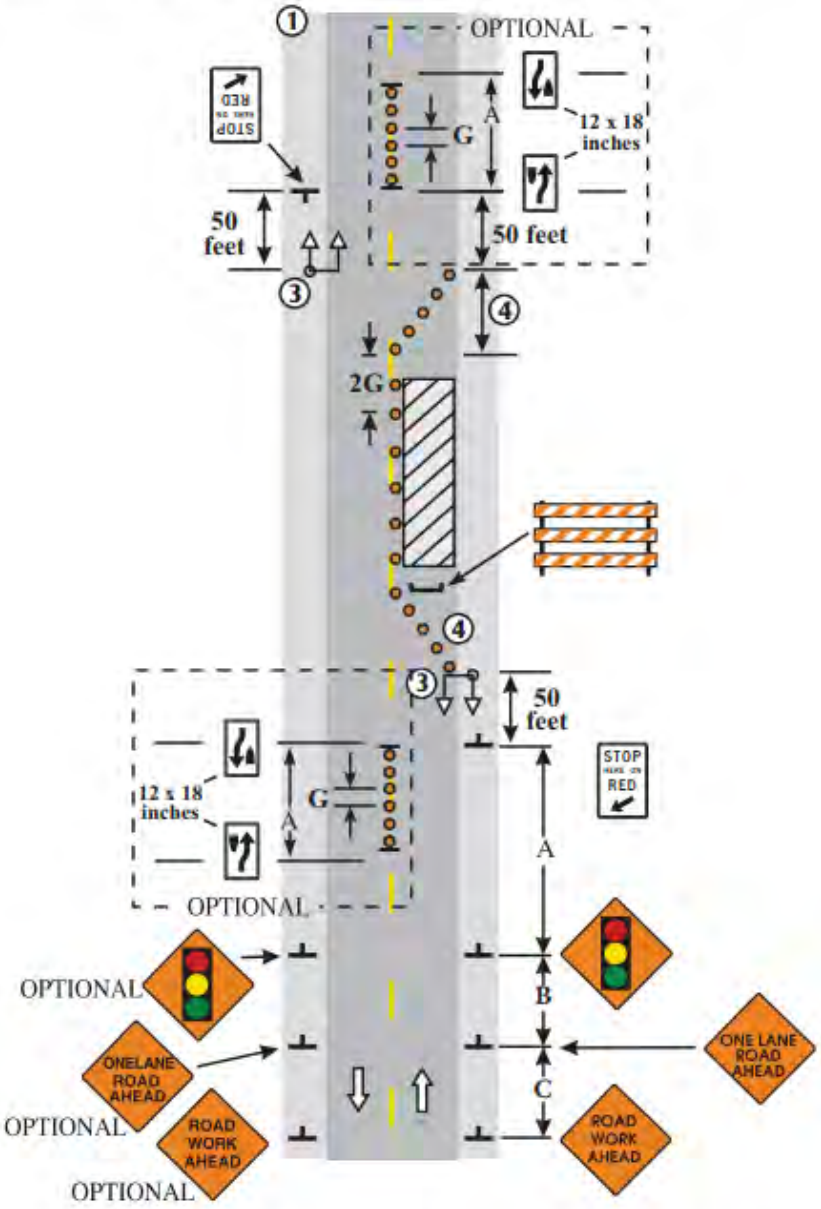
1. The approach sight distance to the Automated Flagging Assistance Device (AFAD) shall be at least the Decision Sight Distance (D).
2. The two-way taper should be 50 feet in length using 5 equally spaced channelizing devices.
3. When using a single operator, they shall be located so they can see traffic at both AFAD locations. If back of queue is not visible, consider two flaggers.
4. Use the appropriate sign on the AFAD.




**LANE CLOSURE, AUTOMATED FLAGGERS**
**TWO-LANE TWO-WAY ROAD**

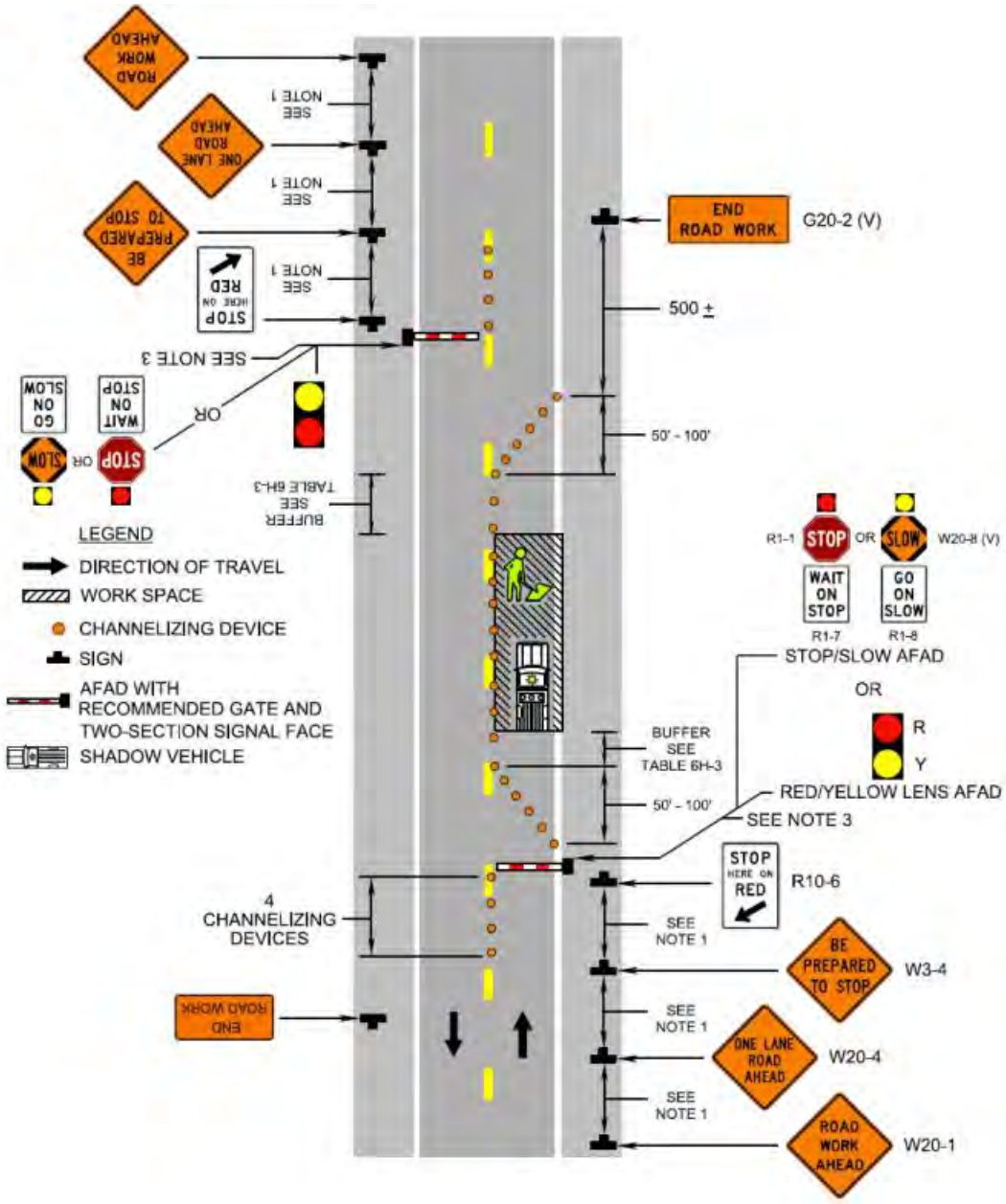
NOTES:

1. Approach signs are the same in both directions.
2. Signal timing and signal head locations shall be established by qualified personnel and approved by the local road authority.
3. Two signal heads shall be installed per approach. The first shall be installed on the right shoulder. The second signal head may be installed on either the left shoulder or mounted over head on the same structure as the first signal head.
4. The two-way taper should be 50 feet in length using five equally spaced channelizing devices.




**LANE CLOSURE WITH PORTABLE SIGNALS**
**TWO-LANE, TWO-WAY ROAD**

**Virginia Department of Transportation Standard Drawing for AFAD Use**



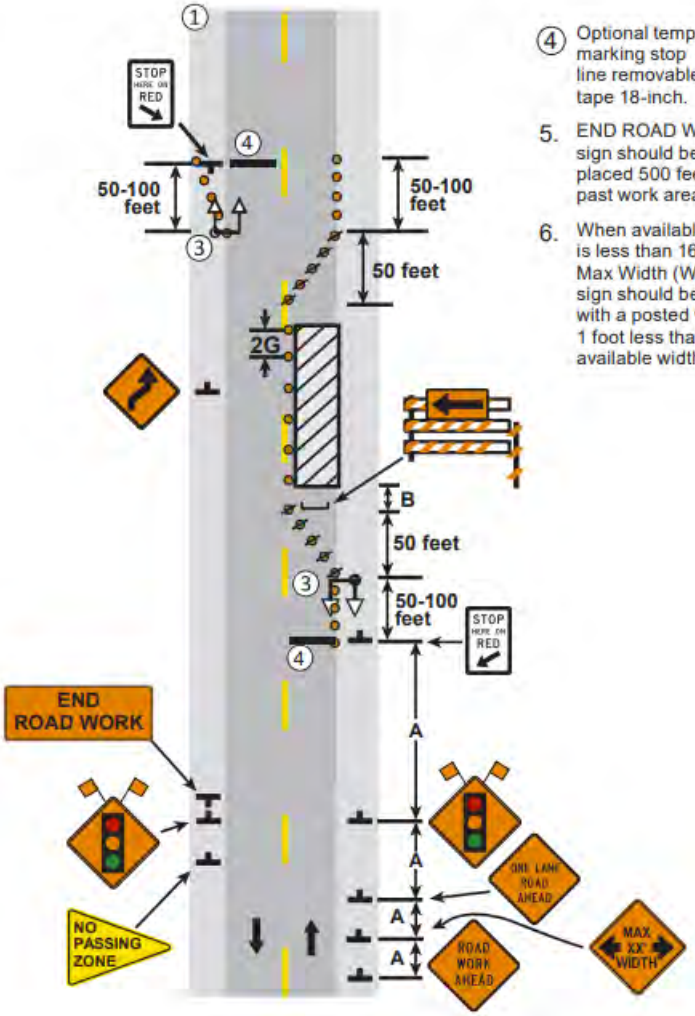
**Wisconsin Department of Transportation Standard Drawing for PTS Use**

## NOTES:

(1) Approach signs are the same in both directions.

2. Signal timing and signal head locations shall be established by qualified personnel and approved by the road authority.

(3) Two signal heads shall be installed per approach. The first shall be installed on the right shoulder. The second signal head may be installed on either the left shoulder or mounted overhead on the same structure as the first signal head.




(4) Optional temporary marking stop line removable tape 18-inch.

5. END ROAD WORK sign should be placed 500 feet past work area.

6. When available width is less than 16 feet a Max Width (W12-52) sign should be used with a posted width 1 foot less than available width.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
**AUTOMATED FLAGGER ASSISTANCE DEVICE**

COS:SAH 1 of 3 APPR:CRB:CT:07-25-22

**a. Description.** This work consists of furnishing, installing, operating, maintaining, relocating, and the removal of Automated Flagger Assistance Devices (AFAD) that allows the operator to fully control the device from a safe location, outside of the lane of traffic. Use automated flagger assistance devices to control traffic in one-lane, two-way work zones. Relocate the system as required by the location of work. This system will be used to control traffic during active work only when personnel are on-site.

The Contractor is responsible for coordinating with any work in adjacent work zone projects.

**b. Materials.** Ensure all hardware components of this system are crashworthy in accordance with the *NCHRP 350* or *MASH*, in addition to the following requirements:

1. Provide a qualified traffic regulator as described in subsection 812.03.G.8 of the Standard Specifications for Construction with the material listed in subsections 922.11.B, 922.11.C, and 922.11.D of the Standard Specifications for Construction and an AFAD system composed of one of the following two options and as noted below:

   A. Furnish an AFAD device meeting the requirements of *MMUTCD Section 6E.05 STOP/SLOW Automated Flagger Assistance Devices*.

   B. Furnish an AFAD device meeting the requirements of *MMUTCD Section 6E.06 Red/Yellow Lens Automated Flagger Assistance Devices*. Furnish the required Stop Here On Red sign (R10-6 or R10-6a) as part of the device or installed on the right-hand side of the approach at the point at which drivers are expected to stop.

2. Delineate the unit with a 2-inch by 36-inch strip, or an equivalent area, of reflectorized red and white conspicuity tape to increase nighttime visibility.

3. Furnish a unit with an intrusion alarm system to alert workers when traffic has improperly entered the work zone. The alarm will sound when the operator activates the intrusion alarm using a wireless controller or when the gate arm is detached from the AFAD.

4. Furnish the AFAD system equipped with a solar power supply and a battery backup with a built-in 110 VAC battery charger. When fully charged, ensure the AFAD and wireless controlled are capable of operating for 24 hours continuously.

5. Ensure the AFAD trailer is painted highway orange.

6. Furnish a gate arm meeting the requirements of the *MMUTCD Section 6E.06* which descends to a down position across the approach lane of traffic when the STOP face or Red Lens is displayed and then ascends to an upright position when the SLOW face or Yellow

Lens is displayed. Ensure both configurations employ visible methods of determining the status of each AFAD unit from the backside of the unit. Ensure the indication is legible for a minimum distance of 300 feet from the back of the unit in daylight hours and does not produce false indications to opposing traffic.

**c. Construction.** Install the AFAD in accordance with the manufacturer's recommendations, the plans, and the following requirements:

1. Furnish up to 1 hour of training for applicable representatives from contractors and MDOT if required by the Engineer. The training includes, at a minimum, installation, removal, and operation of the system and must take place prior to installation if required.

2. Use AFADs in accordance with the *MMUTCD Section 6E.04 Automated Flagger Assistance Devices*.

3. Delineate the AFAD with three channelizing devices. The use of cones is allowed for daytime use only.

4. It is acceptable for one traffic regulator to operate two AFADs from a central location when the distance between the regulator and each AFAD is a maximum of 750 feet with a clear line of sight from the regulator to both AFADs.

5. Furnish a two-way handheld radio system and standby traffic regulator equipment as a backup system for traffic regulators operating the AFAD.

6. Traffic regulators operating the AFADs should stand on or behind the shoulder of the roadway. Ensure positioning allows the regulators to remain safely out of traffic areas while remaining visible to motorists.

7. Furnish AFAD controllers to each traffic regulator located at the AFAD. Ensure the control is simple in nature and consist of buttons that can be pushed while wearing gloves. Controls with electronic screens are prohibited unless approved by the Engineer.

8. Use AFADs to control mainline traffic. Any side street or intersecting location will require an intermediate traffic regulator. Intermediate traffic regulators are required to follow the guidance in subsection 812.03.G.8 of the Standard Specifications for Construction. AFADs may be used at intermediate locations at the Contractor's expense.

9. Remove AFADs from the roadway completely at the end of each work day and store outside of the clear zone, as determined by the Engineer, or in the Contractor's yard.

**d. Measurement and Payment.** The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

| **Pay Item** | **Pay Unit** |
|---|---|
| Automated Flagger Assistance Device | Each |

**Automated Flagger Assistance Device** includes installing, operating and removing one automated flagger assistance device. No additional payment will be made for relocating the device on the project. The Department will pay for the maximum number of automated flagger

assistance devices in use at one time on the project. Additional payment will not be provided for AFADs installed at intermediate locations.