

# WORK ZONE SAFETY & MOBILITY GUIDANCE DOCUMENT APPENDIX A TEMPORARY TRAFFIC CONTROL DEVICES

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Prepared by:

Vermont Agency of Transportation



# Work Zone Safety and Mobility Guidance Document Appendix A Temporary Traffic Control Devices

## Overview –

The following Appendix was drafted in response to updates made to the work zone regulations in 23 CFR 630, Subpart K, published by the Federal Highway Administration. This document applies to all federal aid projects that have a pre-contract/step submittal date after July, 1, 2011.

The purpose of the Appendix is to provide guidance on the use of temporary traffic control devices, flaggers and uniformed traffic officers to control and minimize worker exposure to traffic hazards and to increase road user safety. Additional guidance for preparing site specific traffic control plans can be found in Chapter 6 of the Manual on Uniformed Traffic Control Devices (MUTCD).

The primary users of this Appendix will be project managers, project design engineers and technicians and construction resident engineers.

## Framework:

**Procedures** –procedures, and guidance established under the WZ Safety & Mobility Rule for the systematic consideration and management of WZ impacts **shall** include consideration and management of road user and worker safety by Exposure addressing:

- Use of positive protection devices to prevent intrusions;
- control measures to avoid or minimize exposure;
- Other traffic control measures to minimize crashes; and
- Safe entry/exit of work vehicles onto/from the travel lanes.

**Positive Protection Devices** – use **shall** be based on an engineering study.

An engineering study **may** be used to develop positive protection guidelines for the agency, or to determine the measures to be applied on an individual project; (See MUTCD Section 1A.13.65 FOR DEFINITION OF Engineering Study);

Use of positive protection **shall** be considered in work zone situations that place workers at increased risk from motorized traffic and where positive protection devices offer the highest potential for increased safety for workers and road users.

**Exposure Control Measures** – **should** be considered to avoid or minimize exposure for workers and road users.

**Other Traffic Control Measures** – **should** be considered to reduce work zone

crashes, and risks and consequences of intrusions into the work space.

**Uniformed Law Enforcement** – includes guidance for the use of uniformed law enforcement on Federal-aid highway projects.

**Work Vehicles and Equipment** – Safe means for work vehicles and equipment to enter and exit traffic lanes and for delivery of construction materials to the work space **should** be addressed at the project level.

**Payment for Traffic Control Features and Operations** – **shall** not be incidental to the contract, or included in payment for other items of work not related to traffic control and safety.

Separate pay items **shall** be provided for major categories of traffic control devices, safety features, and work zone safety activities. For minor projects, the major category may be 641.10 Traffic Control, Lump Sum.

**Quality Guidelines** – **shall** be implemented to help maintain the quality and adequacy of the temporary traffic control devices for the duration of the project.

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## 1.0 DESIGN GUIDELINES FOR POSITIVE PROTECTION IN WORK ZONES

Positive protection is an essential part of numerous works zones where workers are exposed to nearby traffic for an extended period of time or where errant vehicles would be in significant jeopardy by entering the work area. The proposed use of positive protection should be considered based on one or a combination of the following site characteristics.

### 1.1 Project Characteristics ( When to consider using positive protection)

**Site Operating Speed** – Work zones where the non-work zone posted speed limit or 85<sup>th</sup> percentile speed is equal to or greater than 45 mph.

**Volumes** – On roadways where the AADT is 15,000 or greater.

**Project Duration** - Projects greater than **two weeks** in length where workers are in close proximity to traffic thereby increasing the risk of a vehicle intrusion in the work area.

**Longitudinal Drop-offs** - Project construction characteristics and phasing should be evaluated on the basis of Standards T-35 and T-36 (E-108 and E-108A).

**Fixed Objects** - Equipment, materials or other fixed objects that remain in the work area overnight.

**Interstate or divided limited access facilities** - Bypasses for bridge construction or roadway reconstruction. Longer bypasses 1 mile or greater may use positive protection devices for shifts and approaches, and use surface mounted vertical delineation devices (tubular markers) on tangents based on an economic analysis

### 1.2 Positive Barrier Use guidelines

When positive barrier is utilized in projects, the following guidelines should be considered:

- Positive barrier should be installed tangentially with a desired minimum 2 ft offset from the traveled lane to the face of the barrier at its widest point. The lateral offset should not be less than 1 ft. On higher speed facilities, the lateral offsets should be maximized to the extent possible.
- If there is no tolerance for deflection within the work area, consider anchoring barrier to roadway surface or bridge deck.
- Tapers for positive barrier are based on operating or 85<sup>th</sup> percentile speed of the facility as seen in the chart on Standard T-22 (E- 106)
- Unprotected ends of the barrier on US and State Routes should be tapered at least 10 ft. outside the edge of the traveled lane. If the positive barrier cannot be tapered outside the minimum clear zone of 10ft, then an appropriate crash attenuator shall be provided to protect the end of the barrier. Truck mounted attenuators should

not protect the ends of barrier but may be used to close off or protect the work area if adequate roll distance is available.

- Unprotected ends of the barrier on interstates and other limited access multi-lane facilities should be tapered to the clear zone as defined in the latest edition of the AASHTO Roadside Design Guide. If the positive barrier cannot be tapered outside the minimum clear zone, then an appropriate crash attenuator shall be provided to protect the end of the barrier.
- Consider and plan for how construction materials will be delivered to the job site. Positive barrier may need to be opened temporarily.
- Access to businesses and residences must be delineated and proper treatment of the blunt ends of the barrier.

### 1.3 Exceptions

For moving operations such as paving projects where barrier is not practical but exposure is still long duration, other methods should be incorporated to protect workers and motorists, see “Exposure Control Measures” section for alternate methods of reducing worker exposure. Limited access facility projects employing long crossovers and two lane two way operations may use surface mounted vertical delineation devices (tubular markers) instead of concrete barrier on tangents based on an economic analysis and engineering judgment. Consider tubular markers when the risk to motorists and workers of placing a large length of temporary barrier along with the high overall cost of placing the barrier offsets the advantages of providing positive separation.

### 1.4 Truck Mounted Attenuators

Truck Mounted Attenuators (TMA's) have proven to be an effective piece of equipment for improving safety in work zone traffic control areas. This effectiveness is dependent on the proper use of the device.

When to use TMA's:

- At the leading end of the Work Activity Area (after the buffer space) where errant vehicles could enter the Work Activity Area causing a danger to the workers and/or the vehicle operators themselves. Be sure to add sufficient length to the work area to allow for TMA forward roll if struck. The chart below, taken from Michigan DOT's TMA guidelines, provides some guidance for designers to consider when employing TMA's in work zones.
- Where access is maintained for construction materials and equipment. The TMA's prevent errant vehicles from impacting construction equipment, workers or from areas of significant hazard to the motorists. (ie. Bridge out, deep excavation, etc.)
- On shadow vehicles for moving operations.

When to NOT use TMA's:

- For crash attenuation at the terminal ends of temporary traffic barrier
- Without a channelizing taper in a static work zone.

### **MDOT Chart Test Level 3 – Guidelines for Roll-ahead Distance for TMA Vehicles**

<b>Weight of TMA Vehicle</b>	<b>Prevailing Speed (mph) (Posted Speed Prior to Work Zone)</b>	<b>Roll-Ahead Distance* (Distance from front of TMA Vehicle to Work Area)</b>
5 Tons	60-70	175 ft
	50-55	150 ft
	45	100 ft
12 Tons	60-70	50 ft
	50-55	25 ft
	45	25 ft

\* Roll-ahead distances are calculated using a 10,000 pound impact vehicle weight.

## **2.0 EXPOSURE CONTROL MEASURES**

Exposure Control Measures should be considered where appropriate to avoid or minimize worker exposure to motorized traffic and exposure of road users to work activities, while also providing adequate consideration to the potential impacts on mobility. A wide range of measures may be appropriate for use on individual projects, such as:

### **2.1 Full road closures;**

When and What to consider:

- When viable alternate routes exist and full road closure will accelerate construction,
- When construction is only feasible with the roadway closed.
- When Emergency vehicle access can be accommodated in another manner.
- Public relations campaign is essential for off-site detours. See Section 2.4 for detour information.

## 2.2 Ramp closures;

When and What to consider:

- When construction on ramp will not allow adequate width (15 ft) to be maintained, (Temporary ramp widening may be a feasible alternative to ramp closure. For short durations, lesser widths may be acceptable; notice of the roadway restriction must be sent to DMV.)
- When mainline lane closures are close to ramps and adequate distances for safe merging cannot be obtained,
- Night work when ramp volumes are very low,
- Traffic impact to alternate routes must be considered. See Section 2.4,
- Public relations campaign is essential.

## 2.3 Median crossovers;

When and What to consider:

- When construction could adversely affect adjacent travel lane, such as ledge blasting, or slow heavy construction vehicle traffic moving in and out of work area.
- When construction can be accelerated or work quality can be improved by closing one barrel
- Capacity of remaining barrel must be considered. AADT should be less than 25,000 (DHV < 3000) unless an engineering study shows that capacity is sufficient.
- Crossovers should avoid interchange areas, to the extent possible
- Crossovers should be located so as to maximize sight distance for merging.
- Crossovers must be designed carefully to minimize rollover potential for large trucks. See Standard T-19 (E-104).

## 2.4 Full or partial detours or diversions;

Consider when traffic volumes exceed tables below:

For work zones on two lane highways with one lane open for traffic

Length of Closure	Max. DHV	Max. ADT
2500 ft	500	4000
1500 ft	1000	7500
1000 ft	1500	11500

The above values are based on:

Two phase operation (no intervening intersections)

50-50 directional split

25 mph avg. speed through work zone

$v/c \leq 1.0$

ADT's may be exceeded if flagging operations cease during peak hours of traffic (work during hours below DHV volumes)

Definitions:

Partial detour – one direction of traffic is maintained on alignment, but the other is detoured. Or, a particular type of traffic is detoured (i.e. trucks) while other traffic is maintained.

Full detour – full road closure with traffic maintained off-alignment. Detour may consist of temporary roadway or signed detour on existing highways.

Diversions – two way traffic is maintained on alignment but because of real or perceived capacity constraints, substantial numbers of drivers can be expected to seek alternate routes not officially signed as detours.

When and What to consider:

- Capacity, condition and safety of detours/alternate routes must be considered.
- Off-site improvements, especially at intersections, may be necessary to accommodate additional traffic. This may include temporary signalization, changes in signal timings, paving or temporary widening, signing/pavement markings improvements, brush cutting to improve sight distance at intersections.
- Truck traffic and truck turning characteristics must be considered.
- Legal load restrictions on town highways or bridges may be lower than state highway limits. Town highways may require upgrades to accommodate increased truck traffic if detour is allowed by town.
- Separate truck detours may be considered.



- Bicycle and pedestrian access must be considered.
  - Long detours are not acceptable for these modes of traffic.
  - Bicycles and pedestrians shall not be detoured onto limited access highways.
  - Detour route for these modes does not have to be the same as for vehicular traffic, if signed separately.
  - Road surface conditions may need to be upgraded.
- Access to businesses (including directional signing) and residences must be considered.
- Emergency vehicle access must be considered.
- Detour route shall be adequately signed
- For town highway bridge projects, town should designate detour route prior to ROW process commencing, and the designated detour route should be included in the project plans.

## 2.5 Road work during nighttime or off-peak periods when traffic volumes are lower;

When to consider:

- When capacity is constrained but detours are not a viable option.
- Consider night work for high volume non-residential roads, especially with substantial day-time business traffic.
- Consider imposing seasonal constraints near schools or high volume seasonal traffic generators such as fairgrounds or fall tourist destination areas.

Pros:

- May be able to avoid use of detours,
- May increase worker safety due to reduced exposure to high volume traffic,
- May be able to complete work faster by closing off more of the roadway,
- May reduce affect on adjacent traffic generators

Cons (Night Work):

- Reduced ability to get materials, inspectors, upper level decision making,
- Higher costs,
- Lower temperatures, especially at either end of construction season; may be difficult to meet materials specifications,
- Work quality may suffer due to lighting conditions and worker fatigue,
- Unexpected condition for drivers; higher speeds,
- Local ordinances may limit type of work (such as noise ordinances),

Cons (Daytime off-peak work):

- Additional time/cost of setting up/removing traffic control to avoid am/pm peak periods; increased worker exposure to adjust traffic control devices,
- Shortened work periods may increase duration of project

Cons (Seasonal off-peak work):

- May be difficult to predict/control when project will be constructed.

## 2.6 Rolling road blocks;

When to consider:

- Activities taking less than one hour affecting both lanes of an interstate barrel, such as ledge blasting, crossover bridge launching, utility line pulls, major material deliveries,
- Should be done at low volume daylight period,
- Should be warned at least one week in advance using PCMS,
- Requires UTO's.

## 2.7 Accelerated construction techniques;

- Consider cost/benefit of accelerated construction vs. normal construction practices; longer detours may be palatable for shorter construction periods.
- Accelerated construction may include full roadway closures, round the clock work, or off site prefabrication.
- Inconvenience to the travelling public and businesses should be balanced by shorter overall durations and reduced worker exposure to traffic.

### 3.0 TRAFFIC CONTROL MEASURES

Listed Below are Traffic Control Measures that may be used in the Temporary Traffic Control Plan (TCP). Designers, Resident Engineers and Contractors should consider these when developing, reviewing, proposing changes or implementing traffic control plans. These have been arranged starting with the most commonly used at the top of the list. The arrangement of this list should not stop the designer, resident engineer or contractor from considering any of these measures when preparing traffic control plans or resolving traffic control issues.

*From 23 CFR 630.1108 (c)* "Other Traffic Control Measures should be given appropriate consideration for use in work zones to reduce work zone crashes and risks and consequences of motorized traffic intrusion into the work space. These measures, which are not mutually exclusive and should be considered in

combination as appropriate, include a wide range of other traffic control measures such as:"

### 3.1 Effective, credible signing:

When to consider:

- This is used on every project. Guidance on work zone signing can be found in MUTCD (Manual on Uniform Traffic Control Devices) and the VTrans T – Standards. The MUTCD can be found online at <http://mutcd.fhwa.dot.gov/> and signing for work zones can be found in chapter 6.

What to consider:

- What is the message that needs to be provided to the driver?
- Are there any permanent traffic control devices that conflict with the work zone signing? (conflict can either be visual – blocking, screening etc or the conflict can be with message on the permanent sign.)

### 3.2 Changeable message signs:

When to consider PCMS / VMS:

- To give drivers notice of the date or time of upcoming construction activities or traffic pattern changes which might lead to seeking alternate routes or changing travel plans.
- When long term work zones change traffic control phases, and traffic pattern has changed (i.e., left lane was closed for a long period, now right lane is closed.)
- When additional directional guidance is required (i.e., use exit 10 for Montpelier)

What to consider:

- PCMS shall not take the place of static signs, and should not display the same message for more than 2 weeks. If message is required for longer than 2 weeks static signs should be used.
- Each message shall consist of no more than two phases. A phase shall consist of no more than three lines of text and eight characters per line. Each phase shall be understood by itself regardless of the sequence in which it is read. More detailed guidance for this can be found in the MUTCD. The provisions in Chapter 2L apply to both permanent and portable changeable message signs with electronic displays. Additional provisions that only apply to portable changeable message signs can be found in Section 6F.60.
- Consider pay item by day instead of each when traffic flow through project area will not change over time

### 3.3 Arrow panels:

Shall only be used for lane drops (merging conditions), and not for shifting traffic within a lane. Refer to Section 6F.61 of the 2009 MUTCD

### 3.4 Longitudinal and lateral buffer space:

When to consider:

- All projects.
- The buffer space is a lateral and/or longitudinal area that separates road user flow from the work space or roadside hazards, and might provide some recovery space for an errant vehicle.
- Neither work activity nor storage of equipment, vehicles, or material should occur within a buffer space. The width of a lateral buffer space should be determined by engineering judgment.

What to consider:

- Will the site allow for longitudinal buffer? (capacity needs on one lane/two way traffic space, driveways, side roads, curve/grade sight distance restrictions could lead to longer or shorter buffer spaces)
- What is the speed limit approaching the workzone ? (Stopping sight distance SSD is baseline for longitudinal buffer – see MUTCD Table 6C-2)
- What are the traffic volumes. (high volumes = increased worker exposure)
- Are there going to be drop offs (even if no devices required by Standard T-35/T-36 (E-108/E-108A), lateral buffer may increase safety)
- Curves and grades – longitudinal buffer may be increased to provide better sight distance to approach on curves (vertical/horizontal), longitudinal buffer may be increased for downhill grades especially with high truck volumes.
- Is there enough room for traffic to safely pass when the buffer space is provided? (i.e.. what are the lane widths for traffic through the work zone) For one lane – two way traffic, 15 feet of travel space is ideal, with 1-2 feet of lateral buffer space.
- Can I use a temporary lane closure to provide lateral buffer space? (lane closure next to shoulder work)
- Are pedestrian and bicycle accommodations needed ? (may require wider travel space, therefore reducing available space to use for lateral buffer.) Bicycle accommodation where cyclists cannot keep up with speed of traffic in longer work zones can be another issue to consider.
- Will the site allow for lateral buffer without barrier? (Refer to positive barrier Section 1.2)

- Will positive protection be used? If positive protection is used the longitudinal buffer area buffer may be shorter than what is shown in Table 6C-2 of 2009 MUTCD.

### 3.5 Trained flaggers and spotters:

For reference please refer to VTrans Standard Specifications for Construction (latest edition) Section 630 and Section 6E.01 of the 2009 MUTCD:

Flaggers are only allowed to stop and release traffic. A UTO is required for intersection traffic direction.

When to consider flaggers:

- When maintaining two way traffic in a single travel lane
- When side roads enter into a flagger controlled travel space
- When haul roads require stopping one direction of traffic to allow construction vehicles to enter and exit.

When to consider using flaggers as spotters:

- When high speed traffic near workers (slow paddle only) for example, long paving operations, spotter may be used next to paver where there is less lateral buffer space
- When the lane closure is long and the flaggers may not be visible to each other

### 3.6 Automated Flagger Assistance Devices

Automated Flagger Assistance Devices (AFADs) enable a flagger(s) to be positioned out of the lane of traffic and are used to control road users through temporary traffic control zones. These devices are designed to be remotely operated either by a single flagger at one end of the TTC zone or at a central location, or by separate flaggers near each device's location.

There are two types of AFADs:

- Remotely controlled STOP/SLOW sign on either a trailer or a movable cart system to alternately control right-of-way.
- Remotely controlled red and yellow lenses and a gate arm to alternately control right-of-way.

When to consider:

- Bridge maintenance;
- Haul road crossings; and
- Pavement patching.
- Night work, because AFAD using red and yellow lenses and gate may be more visible than flagger, and will lead to less worker exposure by moving flagger out of roadway.

What to consider:

- Must be operated manually so not for use on long term closures
- AFAD's take additional time to set up and remove, so not for very short or mobile operations.

### 3.7 High quality work zone pavement markings and removal of misleading markings;

When to consider:

- When new traffic pattern will be in place for greater than 3 days

What to consider when specifying materials to be used for pavement markings:

- Time of year for placement may affect type of marking suitable for application,
- If pavement markings to be in place for greater than 1-2 months, consider normal paint pay items rather than temporary paint,
- If temporary markings are on final pavement layer, removable tape should be considered rather than any type of paint, which will have to be ground off when no longer valid.

Line Striping Targets (LST) or Raised Pavement Markers (RPM) can also be used instead of temporary tape or paint.

- LST's should not be used for over 14 days, nor where heavy traffic is expected to drive over the line (such as passing maneuvers)
- See MUTCD for appropriate device spacing to mimic solid and dashed lines
- Adjacent to barriers, RPM's shall be used in addition to solid edgeline.

Refer to current edition of VTrans Standard Specifications for Construction section 646.08 for more guidance on Temporary Pavement Markings.

### 3.8 Channelizing device spacing reduction;

When to consider:

- when high volume traffic near workers,
- when cones are at risk of blowing over,
- on curves,
- where additional guidance is needed for drivers to safely negotiate work zone
- when using channelizing devices for pedestrian pathways

What to consider:

- Where multiple channelizing devices are aligned to form a continuous pedestrian channelizer, connection points should be smooth to optimize long-cane and hand railing.

- The maximum allowable spacing between cones, tubular markers, vertical panels, drums, and barricades is a distance in feet equal to 1.0 times the speed limit in mph when used for taper channelization, and a distance in feet equal to 2.0 times the speed limit in mph when used for tangent channelization. Spacing should be reduced as needed.
- When channelizing devices have the potential of leading vehicular traffic out of the intended vehicular traffic space the channelizing devices should be extended a distance in feet of 2.0 times the speed limit in mph beyond the downstream end of the transition area. *(At the end of a taper, it might be helpful to the driver to continue the line of cones/barrels on tangent to get them straightened out again.)*  
SEE Section 6F.63 of the 2009 MUTCD

3.9 Work zone speed management (including changes to the regulatory speed and/or variable speed limits); Speed reductions Taken from section 6C.01 of the 2009 MUTCD.

When to consider:

- Reduced speed limits should be used only in the specific portion of the (temporary traffic control) TTC zone where conditions or restrictive features are present. However, frequent changes in the speed limit should be avoided. A TTC plan should be designed so that vehicles can travel through the TTC zone with a speed limit reduction of no more than 10 mph.
- Reduced speed zoning (lowering the regulatory speed limit) should be avoided as much as practical because drivers will reduce their speeds only if they clearly perceive a need to do so.
- A reduction of more than 10 mph in the speed limit should be used only when required by restrictive features in the TTC zone. Where restrictive features justify a speed reduction of more than 10 mph, additional driver notification should be provided. The speed limit should be stepped down in advance of the location requiring the lowest speed, and additional TTC warning devices should be used.

3.10 Law enforcement; See Section 4.0 of this document

3.11 Worker and work vehicle/equipment visibility;

From the 2009 edition of the MUTCD.

“Standard: All workers, including emergency responders, within the right-of-way (ROW) who are exposed either to traffic (vehicles using the highway for purposes of travel) or to work vehicles and construction equipment within the TTC zone shall wear high-visibility safety apparel that meets the Performance Class 2 or 3 requirements of the ANSI/ISEA 107–2004 publication entitled “American National Standard for High-Visibility Safety Apparel and Headwear” (see Section 1A.11), or equivalent revisions, and labeled as meeting the ANSI 107-2004 standard performance for Class 2 or 3 risk exposure, except as provided in Paragraph 5. A person designated by the employer to be responsible for worker safety shall make the selection of the appropriate class of garment.”

What this means: Everyone in the ROW needs to have the appropriate vest.

In addition to high visibility garments for workers, an internal work zone traffic control plan should be developed for projects with traffic management plans. For short term projects all workers on site should have an understanding of how equipment will access and exit the work zone.

### 3.12 Temporary traffic signals.

When to consider:

- One lane – two way traffic is maintained 24 hours per day. (Otherwise flaggers or AFADs are typically used.)
- Often used on bridge projects that maintain traffic on a portion of the existing bridge. When significant traffic is diverted or detoured to an unsignalized intersection, creating capacity or safety issues.

### 3.13 Public relations and traveler information;

When to consider:

- All projects need some form of public outreach,
- The extent required should be determined based on the project category,
- A minor project may only need property owner visits during the design phase, and notification of local officials during construction,
- A significant project may have a Public Relations Officer (PRO), project website, weekly bulletins, etc.
- Designated Public Relations Officers are typically used for longer term projects affecting large volumes of traffic, especially projects with multiple phases where traffic patterns change and potential for significant congestion exists.



What to consider:

- The needs of all road users should be assessed such that appropriate advance notice is given and clearly defined alternative paths are provided,
- The cooperation of the various news media should be sought in publicizing the existence of and reasons for TTC zones because news releases can assist in keeping the road users well informed,
- The needs of abutting property owners, residents, and businesses should be assessed and appropriate accommodations made,
- The needs of emergency service providers (law enforcement, fire, and medical) should be assessed and appropriate coordination and accommodations made,
- Special provision are required when utilizing PROs,
- The needs of railroads and transit should be assessed and appropriate coordination and accommodations made,
- The needs of operators of commercial vehicles such as buses and large trucks should be assessed and appropriate accommodations made.

### 3.14 Warning flags and lights on signs;

When to consider:

- Where changes to the intersection or roadway may not be expected to driver and consequences of not obeying traffic control devices are severe,
- Converting an intersection to 4 way stop during construction,
- Adding a temporary signal during construction,
- Adding a permanent signal,
- Converting an intersection to a roundabout,
- Traffic is not responding to signs (stop, yield, speed limit),
- Traffic pattern/intersection control has been altered (new signal or stop sign).

What to consider:

- Will the flags block another traffic control device,
- Will the flags hang over the travel way and be hit by large trucks.

### 3.15 Pace or pilot vehicle:

When to consider:

- When traffic is routed through an extended work zone with multiple activity areas. These work zones many times have a serpentine travel path for motorists which is not intuitively obvious thus requiring a pilot car,

- When traffic may need to come to a stop on the interstate (rolling road block).

### 3.16 Longitudinal channelizing barricades

These are not barriers – this refers to lightweight barricades used for channelization only (plastic “jersey barrier”)

When to consider:

- Lower speed roadways (Speed limit 40 mph or less),
- Projects where there is no lighting provided during nighttime hours,
- Drivers need extra visual cues to get through work zone at night (more retroreflectivity than a barrel),
- Work zones with limited lateral buffer space. In such cases other channelizing devices would require constant resetting.

What to consider:

- Existing speed limit of the roadway prior to the work zone,
- Is there recovery area behind the barricade for an errant vehicle,
- Barricade should not replace barriers,
- Is worker protection needed behind the barricade. If impacted by a vehicle is there sufficient lateral deflection distance before entering the work area.

### 3.17 Worker training

When to consider:

- On all projects, all workers need to have sufficient training for their safety,
- Additional training may be required if project is unique and or has one unique element that is not normally seen in Vermont.

What to consider:

- What is unique about the project and what are the risks to workers
- Who needs to be trained, and at what level, based on their risk exposure.

### 3.18 Enhanced flagger station setups

When to consider:

- When flagger is in a less than ideal environment (such as shadow, low light, visually congested area with high driver attention load)

What to consider:

- Additional device(s), typically a flag tree, to enhance the visibility of the flagger.
- A high-level warning device shall consist of a minimum of two flags with or without a Type B high intensity flashing warning light.
- The distance from the roadway: to the bottom of the lens of the flashing light and/or to the lowest point of the flag material shall be not less than 8 feet.
- The flag shall be 16 inches square or larger and shall be orange or fluorescent orange in color.

### 3.19 Intrusion alarms

When to consider:

- Daily lane closures in high volume/high speed areas where positive barrier is not in use.

### 3.20 Transverse Rumble strips

When to consider:

- Where longitudinal and lateral buffer is limited and it is important that the driver see and understand the next traffic control device after rumble strips,
- In long lane closures, to reduce the speed of traffic (traffic calming),
- At the beginning of speed reduction zones,
- Not for use in mobile operations.

What to consider:

- If the color of a transverse rumble strip used within a travel lane is not the color of the pavement, the color of the rumble strip shall be white, black, or orange.
- Transverse rumble strips should be placed perpendicular to vehicular traffic movement. They should not adversely affect overall pavement skid resistance under wet or dry conditions.
- Transverse rumble strips should not be placed on sharp horizontal or vertical curves.
- Rumble strips should not be placed through pedestrian crossings or on bicycle routes.
- Transverse rumble strips should not be placed on roadways used by bicyclists unless a minimum clear path of 4 feet is provided at each edge of the roadway or on each paved shoulder
- These are placed 150 to 300' feet in advance (WZ speed dependent) of the next traffic control feature you want the driver to see (merge, speed limit etc)
- Proximity to residences and noise sensitive businesses
- No signing is required

### 3.21 Drone radar and Radar Speed Feedback Signs (RSFS);

When to consider:

- Work zone speeding is a problem
- Enforcement cannot be on the project everyday
- RSFS may be used instead of UTO presence

What to consider:

- Drone radar only affects drivers with radar detectors
- Use Drone Radar with spot enforcement so drivers do not ignore drone
- Typically use only when workers are present
- Some PCMSs have drone radar

### 3.22 Automated speed enforcement (where permitted by State/local laws);

Vermont State Statutes currently do not allow this

### 3.23 Consecutive Work Zone Spacing

For short term interstate lane closures, work zone length should be based on contractor's capacity to conduct work within the closure that day. Lanes should only be closed if work is imminent, so that drivers can perceive the need for the closure and obey temporary traffic control. In most cases, lane closures should not exceed 3 miles, and consecutive closures should be spaced at least 1 mile apart. This will allow queues to dissipate and traffic to develop appropriate gaps.

## 4.0 UNIFORMED TRAFFIC OFFICERS

### 4.1 General Guidance:

The goal of these guidelines is to reduce the likelihood of injuries and fatalities to workers and road users in Work Zones, while maintaining a fiscally responsible approach in the use of flaggers and uniformed traffic officers. These guidelines provide parameters to identify the appropriate need and consistent use of flaggers and uniformed traffic officers addressed by the following categories:

**Traffic control** (guiding and directing traffic in, through, and around a work zone).

**Presence** (deter speeding and aggressive driving, encourage drivers to cautiously proceed through the work zone)

**Enforcement** (actively enforce traffic laws within the work zone on an as needed basis to gain driver awareness rather than as a full-time operation).

**Emergency assistance** (assist and coordinate activities at accident sites within the work zone, report accidents)

### 4.2 Traffic Control Operations

Flaggers shall be used to the greatest extent possible for “dynamic” traffic control operations. However, the use of uniformed traffic officers may be necessary in some instances.

Examples of dynamic traffic control operations where **flaggers** should be used include:

- Alternating 1-way traffic (stop/slow paddles must be used).
- Controlling traffic at low volume intersections (one flagger per approach).
- Assisting trucks and equipment in and out of work areas.
- Controlling traffic at side roads and driveways during mobile operations (i.e. paving, striping, etc.).
- Directing pedestrians and bicyclists through the work zone.
- Providing detour guidance beyond work zone limits, if needed.

Examples of dynamic traffic control operations where **uniformed traffic officers** may be used include:

- Directing traffic through complex intersections, especially where signal indications are being countermanded (signal shall be placed in flashing mode).

- Assisting construction vehicles and equipment in and out of work areas on high speed, high volume facilities. Note: If an access area is anticipated to be in place for an extended period of time and it is determined that assistance is required for the safe exit and entry of construction vehicles, then a cost analysis should be completed to determine if stationary measures (i.e. signals) would be more cost effective than officers or flaggers.
- Rolling roadblock operations on interstates and other multi-lane limited access highways.
- If a uniformed officer is already on site for other needs (**enforcement or presence**), then the officer may be asked to supplement these duties by providing limited duration traffic control that would otherwise be covered by a flagger. However, the officer must be adequately trained for the flagger operation to be performed and must use appropriate equipment and techniques (which may include the use of stop/slow paddles).

#### 4.3 Presence

The use of flaggers or uniformed traffic officers for **presence** should only be used when there is an added safety risk to the workers and road users due to speeding, other aggressive driving behaviors, and/or high traffic crash/incident rates attributed to other features such as poor highway geometrics.

**Flaggers** may be used for **presence** to alert and slow traffic with the use of hand signals and “slow” face of stop/slow paddles as described in Part 6 of the MUTCD.

**Uniformed traffic officers** should be used for **presence** on high-speed facilities when workers are not behind barrier and are in close proximity to high volume traffic for extended periods of time (long term or intermediate term stationary projects lasting more than one daylight period, or at night) or where unique work zone conditions require a higher level of driver awareness to ensure safety. Facilities where this application may be appropriate include, but are not necessarily limited to:

##### Interstate facilities

Roads with a posted speed of 45 mph or higher **and** an average daily traffic (ADT) volume of 10,000 vpd or greater.

If all work is behind positive barrier, neither officers nor flaggers are typically necessary.

The use of police vehicles should be considered for nighttime operations in most instances, as the use of flashing blue lights, visible from 360

degrees, has been proven to deter aggressive driving behavior. However, the manner of their use during nighttime operations should be carefully considered as police vehicle lights provide no positive direction to motorists traveling through the work zone and are often overpowering and distracting. Excessive use of police vehicles with lights at night, or the inappropriate positioning of these vehicles, may actually detract from the positive guidance the work zone traffic control devices (TCDs) provide. When used for nighttime work, flashing blue lights shall be dimmed if capable.

Though typically not necessary, **uniformed traffic officers** may also be used for **presence** on roads with posted speeds of less than 45 mph or ADT volumes less than 10,000 vpd if the resident engineer determines that a **police presence** is needed to address a specific safety issue.

Examples of traffic control safety issues where a uniformed officer may be needed include:

- A work zone with a high rate of crashes.
- A work zone with vehicles traveling at excessive speeds.
- A work zone with poor highway geometrics.
- A work zone with excessive East-West sun glare.

NOTE: Using the flashing blue lights from a police vehicle to slow traffic approaching a work zone with poor visibility (i.e. East-West sun glare) or poor sight distance due to geometric features should be considered only after other measures have been determined to be ineffective.

#### 4.4 Enforcement

The following guidelines are recommended to reduce the likelihood of injuries and fatalities to workers and road users by enforcing traffic laws within work zones. **Enforcement** can only be performed by uniformed traffic officers.

Enforcement may be used during work zone operations where excessive speed and/or other aggressive driving behaviors are likely to jeopardize the safety of the workers and other road users.

Enforcement may be used on an as needed basis within a work zone either by itself or where another officer is being used for **presence** to improve that officer's effectiveness.

Uniformed traffic officers being used for **presence** should typically not be used for **enforcement** except for flagrant violations of traffic law.

If an arrest is necessary, the work-zone detail uniformed officer shall either:

- call in, and turn the arrest over to, an on-duty officer,
- call in a replacement UTO to cover work zone duties.

#### 4.5 Emergency Assistance

While on site, work-zone detail uniformed traffic officers may offer immediate assistance in emergency situations, such as a motor vehicle crash within the limits of the work-zone. The detail officer may investigate minor property damage crashes that occur within the work-zone if the time required to complete the investigation is minimal and the detail officer is not actively engaged in directing traffic. The detail officer should limit investigation of minor property damage crashes to assurance that no injuries are involved. Crashes involving injury should be investigated by the appropriate personnel once other emergency personnel arrive at the scene, not the detail officer.

## 5.0 WORK VEHICLES AND EQUIPMENT

FROM 23 CFR 630.1108 (e) *Work Vehicles and Equipment*. In addition to addressing risks to workers and road users from motorized traffic, the agency processes, procedures, and/or guidance established in accordance with 23 CFR 630.1006 should also address safe means for work vehicles and equipment to enter and exit traffic lanes and for delivery of construction materials to the work space, based on individual project characteristics and factors.

### 5.1 Introduction

Wherever possible, construction, maintenance and utility work zones shall be designed to allow for safe access from or entrance to travel lanes by work vehicles or equipment and for delivery of construction materials.

The project designer should address the access of work vehicles and equipment in the traffic control plans for significant projects. The contractor has the option of proposing alternative traffic control plans and entry and exit of work and delivery vehicles should be addressed. Anything below a significant project shall be addressed by the contractor prior to starting construction even if the contractor is using standard plans for TTC.



When to consider:

- Significant projects in the design phase
- All other projects need to be developed by the contractor and reviewed by the RE before construction starts

What to consider:

- What is the classification and speed limit of the roadway? (limited access vs a local road. i.e. traffic would expect to be stopped on a local road but not on a limited access facility)
- How will the work be phased?
- What type of work is being performed? Will work vehicles be exiting/entering the project once a day or many times through out the day? (i.e. a concrete pour versus a steel beam delivery)
- Will the project have many visitors or does the project have environmental concerns that may require monitoring from other agencies besides Vtrans?

## 5.2 Strategies for Enhancing Safety at Work Zone Access Points

Strategies which may aid in this objective include, but are not limited to:

- flaggers stationed and signed appropriately,
- advance warning signs for driveway locations,
- advance warning using “TRUCKS ENTERING” signs,
- advance warning using portable changeable message signs,
- temporary turn lanes or shoulder lanes approaching access points.

Used to slow approaching traffic:

- temporary transverse rumble strips,
- radar feedback signs,
- uniformed law enforcement officers in marked vehicles.

## 6.0 MAINTENANCE OF TEMPORARY TRAFFIC CONTROL DEVICES

When project construction begins all TTC devices should be new or like new. In the course of the project, TTC devices should be maintained to meet the ATSSA “acceptable” level

<sup>1</sup> The American Traffic Safety Services Association's (ATSSA) Quality Guidelines for Work Zone Traffic Control Devices uses photos and written descriptions to help judge when a traffic control device has outlived its usefulness. These guidelines are available for purchase from ATSSA through the following URL:

[http://www.atssa.com/store/bc\\_item\\_detail.jsp?productId=1](http://www.atssa.com/store/bc_item_detail.jsp?productId=1).

## 7.0 PAYMENT GUIDELINES FOR WORK ZONE TRAFFIC CONTROL

Another critical piece of the traffic control puzzle is specifying the proper pay items to include in the traffic control plan. The contract documents must provide sufficient detail and information to give contractors the ability to develop reasonable bids for the work required. In addition to the contractor's requirements, items must be specific enough to develop useable bid histories with time. These allow the contracting agency to determine reasonable estimates for budgeting purposes.

### 7.1 Item Categories

#### *Traffic Control Devices*

608.45	Truck Mounted Attenuator	Hour
621.56-59	Energy Absorption Attenuator	Each
621.90	Temporary Traffic Barrier	Linear Foot
621.95	Remove and Reset Temporary Traffic Barrier	Linear Foot
641.10	Traffic Control	Lump Sum
641.12	Public Relations Officer	Lump Sum
641.15	Portable Changeable Message Sign	Each
641.16	Portable Arrow Board	Each
641.17	Portable Changeable Message Sign	Day
641.18	Portable Arrow Board	Day
646.600 to 646.715	Temporary Pavement Marking Items	Linear Foot
646.75	Temporary Raised Pavement Markers, Type II	Each
646.76	Line Striping Targets	Each
646.85	Removal of Existing Pavement Markings	Square Foot
646.86	Pavement Marking Mask	Square Foot
678.40	Temporary Signal Item	Each
678.41	Temporary Flashing Beacon	Each
678.42	Temporary Detector	Each

#### *Safety Features*

900.XX	Various traffic control Specialty items	Each
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For items not currently listed, such as PIO, AFAD, Smart Work Zone, I-Cones, etc

#### *Work Zone Activities*

630.10	Uniformed Traffic Officers *	Hour
630.15	Flaggers	Hour



blunt barrier end, use the plastic barrel type of attenuation. If adequate space is not available, specify a temporary attenuator similar to the Quad-guard.

One spare attenuator should be included in the quantities in order to have a spare on site in case of a vehicle impact.

621.90 Temporary Traffic Barrier Lineal Foot

Estimate the total length of barrier needed to be brought to the construction site for any work zone traffic control phase necessary during construction of the project. This item also pays for the final removal of barrier from the site.

621.95 Remove and Reset Temporary Traffic Barrier Lineal Foot

Add this item if more than one traffic control phase is needed which requires moving temporary traffic barrier to different locations on the construction site. This item pays the contractor only for moving barrier a few feet on site and excludes trucking costs. Estimate the lineal feet of barrier needed for all traffic control phases beyond the initial traffic control phase.

630.10 Uniformed Traffic Officers Hour  
630.15 Flaggers Hour

See Section 4 for guidance on the use of flaggers and UTOs.

641.10 Traffic Control Lump Sum

Add this item to all projects to cover the site specific traffic control plan for the project. The item covers all items needed for the successful implementation for the plan other than those items which have their own separate pay items, such as signs, barricades, cones and barrels.

This item will include all necessary traffic control phases during construction.

641.15/641.17 Portable Changeable Message Sign(PCMS) Each/Day

PCMS should be used to inform motorist of changing conditions in the work zone when temporary static signs do not convey the same message. In most cases they should be paid for by the unit day item. This item pays for the signs and only for the days that they are in use.

641.16/641. 18      Portable Arrow Board      Each/Day

Arrow boards are to be used only when vehicles are to merge from one lane into another. Arrow boards are not to be used when vehicles are being redirected to follow a detour or a bypass.

Similar to the PCMS signs in most situations, the unit day item should be used. Using the unit day item helps the Agency build a bid history for this item and also only pays for the item when it is in use.

646.6-646.715      Temporary markings      Lineal foot

These items should be used only for projects or traffic control phases which are proposed to last one to two months. If traffic control phases are estimated to last more than two months, then the regular paint items should be used.

646.75      Raised Pavement Markers, Type II      Each

Raised Pavement markers, Type II should be used where the temporary pavement markings need to be supplemented, such as next to barrier, or may be used in lieu of temporary paint or LST's where temporary markings are required for more than two weeks

RPMs should be placed at maximum 20 ft spacing to mimic solid lines. Double lines (centerlines) should have side by side RPMs. Dashes consist of 3 RPMs per dash at 5 ft spacing.

646.76      Line Striping Targets      Each

On projects where temporary or permanent markings cannot be placed for up to 14 days. They should not be used if permanent markings are not expected to be installed within two weeks due to their lack of long term durability. LST's should be placed at maximum 20 ft spacing to mimic solid lines. Double lines (centerlines) should have side by side LSTs. Dashes consist of 3 LSTs per dash at 5 ft spacing.

646.85      Removal of Existing Pavement Markings      Square Foot

This item should be used when existing pavement markings may confuse motorists as to the proper travel path through a work zone. This removal is usually accomplished via a mechanical means. Consideration should be given to whether the permanent pavement will be scarred by the pavement marking removal process. Sometimes scarred pavement can confuse motorists.

646.86	Pavement Marking Mask	Square Foot
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This item should be used if scarring the pavement surface is not desirable. In some areas the existing pavement marking material can remain by just covering the lines however, the MUTCD does not allow markings to be covered over with a black paint.

678.40	Temporary Traffic Signal	Lump Sum
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For temporary bridge or roadway projects that can only maintain one direction of traffic at a time and for projects where rerouted traffic causes unacceptable congestion at existing non-signalized intersections, this item can be used. If it is used for intersections the traffic signal warrants should be met. This item includes all signal equipment, signs, markings and various accessories to create an operating temporary signal per plan (see Section 678.12 Standard Specifications for Construction, 2011 ed.)

678.41	Temporary Flashing Beacons	Each
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Temporary flashing beacons should be used when motorists have limited sight distance in advance of the upcoming traffic control. Also flashing beacons can be incorporated into a traffic control scheme when additional emphasis is needed.

900.xxx	Specialty Items	Varies
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Specialty items are those items that are infrequently used on projects or are items that have just been developed and have not made it into the Vermont Standard Specifications for Construction. These items include: Public Relations Officers (PRO), Smart work zones, I-cones, AFADs, etc. Check with Contract Administration to ensure that the proper item descriptions are called for in the special provisions.

## 8.0 TRAFFIC MANAGEMENT PLAN CHECKLIST

### Project Design – Traffic Management Plan Checklist

Project Name and Number: \_\_\_\_\_

Project Manager: \_\_\_\_\_

#### Conceptual Design Phase

##### 1. Classify Project:

\_\_\_ Significant (Major reconstruction; high impacts on traffic both inside and outside project limits. Projects that on their own might be moderate could be significant in combination with concurrent projects in the vicinity.)

\_\_\_ Moderate (most projects; most traffic impact is localized within project limits)

\_\_\_ Minor (mobile and short term operations; minimal impact to the traveling public)

##### 2. Identify necessary Traffic Management Plan Components:

\_\_\_ Temporary Traffic Control Plan (required for all projects)

\_\_\_ Transportation Operations Component (strategies to mitigate off-site impacts; required for significant projects, may be needed for moderate projects)

\_\_\_ Public Information Component (communications with public and property owners before and during construction; required for significant projects, may be beneficial for any project.)

#### Preliminary Design Phase:

##### 1. Temporary Traffic Control Plan:

\_\_\_ Identify features which will require adjustments to E-standards or MUTCD Typical Applications (curves and other geometric constraints, commercial and residential driveways, intersecting roads, adjacent/concurrent projects, special road users)

\_\_\_ Determine feasible phasing for construction with regard to where and how traffic will be maintained.

\_\_\_ Identify potential ROW or Environmental permitting needs associated with maintenance of traffic. (Specific limits will be needed for ROW plans)

##### 2. Transportation Operations Component:

\_\_\_ Identify off-project impacts and determine whether off-project improvements are required to maintain traffic mobility. (This may include signalization improvements, pedestrian upgrades, paving, widening. Improvements may be needed on official detour routes and also on major expected diversion routes if project is open to traffic but cannot handle ADT.)

\_\_\_ Can impacts be mitigated by adjusting timing of project? (This could include night work, avoiding school terms, opening project to traffic during known high traffic events, or full road closure to expedite work.)

\_\_\_ Consider whether special accommodations need to be made for emergency service access (Ambulance, Fire, Police)

### 3. Public Information Component

\_\_\_ Identify stakeholders (emergency responders, municipalities, businesses, schools, property owners, etc.)

\_\_\_ Can stakeholders be kept informed by Resident Engineer and Project Manager, or will there be enough information flow required to justify a public relations officer?

### **Final Design Phase:**

#### 1. Temporary Traffic Control Plan:

\_\_\_ Can all anticipated users safely get from one side of the project to the other in a reasonable amount of time? (Bike/Ped, Cars, Trucks, emergency vehicles)

\_\_\_ Is access to side roads, commercial drives, and residences accounted for?

\_\_\_ Are workers adequately protected from traffic?

\_\_\_ All projects: include traffic control notes specific to project needs, and applicable T-Standards (E-standards). (For example, paving projects usually include a list of side roads requiring road work ahead/end road work signs)

\_\_\_ Project where T-Standards (E-Standards) or MUTCD typical applications do not account for site specific conditions: include TCP layout sheets detailing sign placement and placement of other traffic control devices.

\_\_\_ Project requiring phased construction: provide enough detail in TCP layout sheets to demonstrate constructability, that sufficient space exists to maintain traffic, and to develop quantities. (As defined at the Preliminary Plans Stage) Provide traffic control notes specifying time/space constraints and other project specific requirements.

\_\_\_ Project requiring detour: provide detailed detour sign locations, including affected existing signs that need to be covered or removed; consider whether different detours are applicable to trucks, cars, and bike/peds. Cars may be able to use local routes not legal for trucks, bike/peds can't be sent on miles of detour or on limited access roadways. (If ROW is required, these details should be addressed at Preliminary Plans stage)

\_\_\_ Project requiring night work: require contractor to submit site specific lighting plan.

\_\_\_ Include necessary pay items in quantity sheet (temporary markings, pavement marking removal/replacement, RPMs and/or LST's, barriers and attenuators, TMA's, arrow boards, PCMS, flaggers, UTO's, etc.)

#### 2. Transportation Operations Component:

\_\_\_ Include plan sheets detailing off-site improvements.



\_\_\_ Document other mitigation strategies as appropriate (as traffic control plan notes, special provisions, agreements with municipalities, etc.)

3. Public Relations Component:

\_\_\_ include PRO in Quantities if needed. Document expectations in special provisions.

## 9.0 SITE SPECIFIC TRAFFIC CONTROL PLAN GUIDANCE

**Purpose:** To ensure that all roadway users can get through the project area safely without undue delay.

Site specific traffic control plans are needed when project conditions do not closely resemble E-standards or MUTCD Typical applications, or there are project specific issues that must be addressed.

If needed, site specific control plans may be included in the project plans, or may be required of the contractor, or both. In some cases, project plans may contain phased construction traffic control plans in order to demonstrate constructability and determine ROW requirements, but still require additional information from the contractor based on methods and means.

Site specific traffic control plans should include:

- Layouts showing existing site conditions (may be based on CADD layouts, aerial photo, map, or hand drawn)
  - Location of pertinent features such as sidewalks, utility poles, ramps, drives, and side roads
  - Lane configurations
  - Existing traffic control devices such as signs, signals, and pavement markings
  - Location of pertinent traffic generators, such as shopping centers, schools, large businesses
  - Pertinent dimensions should be labeled
  - Layout may need to include features which are outside the project limits if they affect traffic control considerations, such as nearby intersections or ramps
- Proposed Temporary Traffic Control on layouts
  - Location of devices such as cones, temporary signals, barriers, temporary markings
  - Location of flagger stations if used
  - Taper lengths and device spacing
  - Pedestrian accommodations where appropriate
  - Pertinent dimensions should be labeled
- Narrative describing work activities and how materials and equipment will be transported to and from the work area and stored, as they relate to temporary traffic control. Narrative may also address emergency vehicle accommodations.