

# **Intermediate Maintenance of Traffic Refresher**

## **Participant Workbook**





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# Intermediate Maintenance of Traffic Refresher

FY 2021-22

## Participant Workbook

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Section 102 Maintenance of Traffic

Section 990 Temporary Traffic Control Device Materials

#### ***Supplemental Resources***

Guide to Current FDOT Publications

TTC Definitions

Quick Reference 102 Sheet Tables





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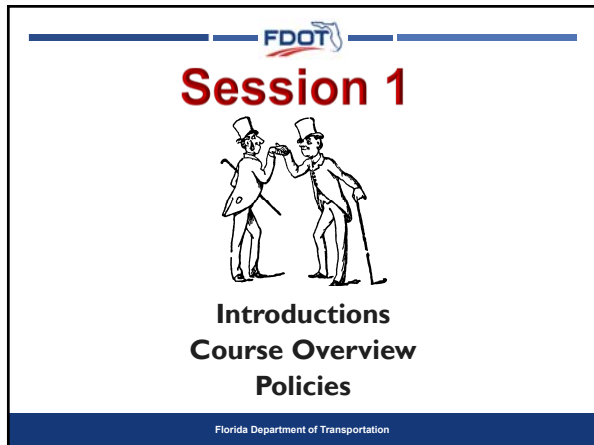
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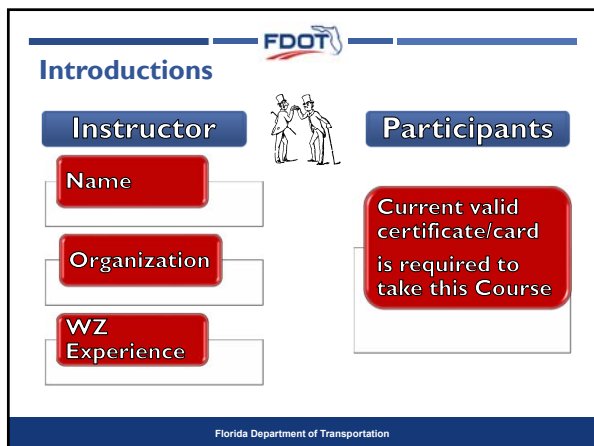
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## Course Goal

Upon completion of this Course, you will be able to:

- Select appropriate Standard Plans Index
- Correctly place, maintain and remove temporary traffic control devices
- Inspect placement and operational functions of traffic control devices
- Instruct individuals in Flagger training administration

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## Participant Responsibilities

Maintain a valid Maintenance of Traffic qualification

Keep updated on all changes to standards and related documents

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## National Manuals

- Manual on Uniform Traffic Control Devices (MUTCD)
- Roadside Design Guide (RDG)
- Policy on Geometric Design of Highways and Streets (AASHTO Green Book)

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```
graph TD; A[State of Florida Manuals] --> B[Standard Plans]; A --> C[FDOT Design Manual]; B --> D[Standard Plans Revision]; B --> E[Standard Specifications]; C --> F[Design Bulletins]; C --> E;
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**State of Florida Manuals**

- Standard Plans**
  - Standard Plans Revision
  - Standard Specifications
- FDOT Design Manual**
  - Design Bulletins
  - Standard Specifications

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# End of Session 1



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The image is a presentation slide for 'Session 2' of a course on 'Fundamental Principles of Temporary Traffic Control Zones'. At the top, the Florida Department of Transportation (FDOT) logo is displayed. Below the logo, the text 'Session 2' is written in a large, bold, red serif font. Underneath the session title is a photograph of a road construction zone. In the foreground, a large orange diamond-shaped sign with black text reads 'ROAD CLOSED'. Behind the sign, a line of orange traffic cones is visible, and a 'No Left Turn' sign is partially seen. The background shows a road with lane markings and a clear sky.

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Principles of Traffic Control  
Design Considerations

Guide Traffic and Maintain Work Zone

Provide adequate warning, delineation, and channelization to assist in guiding road users

Remove or cover inappropriate devices or markings

Monitor work zones under varying conditions

Keep clear zone free of equipment and materials

Maintain good communication with public and agencies

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End of Session 2



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Session 3

Temporary Traffic Control  
Devices and Index 102-600

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**INSTRUCTOR - Click Book to Launch  
Standard Plans Index 102-600  
PowerPoint Presentation**



**Students - Open your copy of the  
Standard Plans to Index 102-600**

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**Temporary Traffic Control Devices**

**All temporary traffic control  
devices shall be on the  
Department's Approved  
Products List (APL)**



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**Approved Products List (APL)**

**Products approved for use in  
Florida based on:**

 <b>Specifications</b>	 <b>Standard Plans</b>	 <b>Vendor Drawing</b>
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FDOT

## Channelizing Devices

- Cones, Drums
- Temporary Tubular Markers
- Longitudinal Channelizing Devices (LCD's)
- Vertical Panels
- Barricades ,Types 1 & 2
- Barricades, Direction Indicator
- Barricades, Type 3

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## Function of Channelizing Devices

- Warn road users of conditions created by work activities in or near the roadway.
- Guide and direct drivers, bicyclist and pedestrians safely through the work zone.

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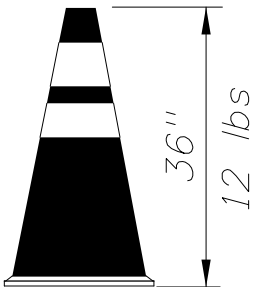
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## Cones



CONE SIZE:  
Florida requires  
36-inch, 12-lb  
cones on state  
roads

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FDOT

Temporary Tubular Marker

4" Diameter

Temporary tubular markers must be a minimum of 36" high and 4" in diameter.

36" Min.

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Drums

18" Diameter

36" Min.

Drums are highly visible devices, have good target value and give the appearance of being formidable obstacles; therefore they command the respect of motorist.

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Vertical Panel

12" Max.

36" Min.

12" Max.

A-FRAME

POST MOUNT

Vertical panels may be used for channelization and are particularly appropriate for traffic separation or in other locations where lateral space is restricted.

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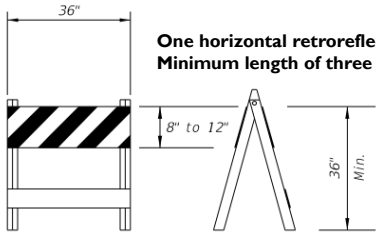
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### Type I Barricade



**One horizontal retroreflective rail**  
**Minimum length of three feet**

General: Markings shall slope downward at a 45° angle toward the direction to which traffic is to pass.

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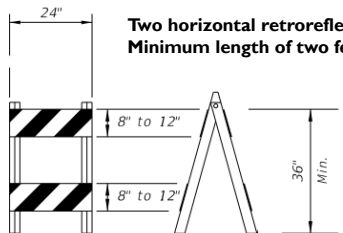
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### Type II Barricade



**Two horizontal retroreflective rails**  
**Minimum length of two feet**

General: Ballast shall not be placed on top rails or any striped rails or higher than 13 inches above the driving surface.

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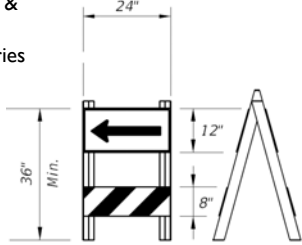
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### Direction Indicator Barricade

May be used in tapers & transitions  
 If used, shall be in a series



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## Type III Barricade

If road closure signs are mounted on a Type III Barricade they shall be installed in accordance with manufacturer's vendor drawing shown on the APL.

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## Pedestrian Longitudinal Channelizing Devices (LCD's)

- Minimum 8" continuous detectable edging above walkway
- Minimum 32" height and minimum footprint of 2' OR
- Minimum 42" height and be anchored or ballasted to withstand a 200lb point load

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## Arrow Boards

- Supplement other warning devices
- Provide additional advance warning
- Used for lane closures on multi-lane roadways

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## Arrow Boards

- Multiple lane closures use multiple arrow boards
- Reduce intensity of flashers during darkness
- Delineate with temporary traffic control devices




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# Portable Changeable Message Signs (PCMS)

- Programmable messages that advise the road user of unexpected situations
- Provide additional advance warning
- Used for night time work within 4' of edge travelway



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## Portable Changeable Message Signs (PCMS)

### Typical Uses:

- Speed is expected to drop substantially
- Queuing and delays expected
- Changes in alignment or surface condition
- Advance notice of closures (ramp, lane..)
- Changes in road user pattern

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Portable Changeable Message Signs (PCMS)

Message Design

- Message Panel

  - 8 characters per line
  - 3 lines per phase
- Each message shall consist of either 1 or 2 phases
- Each phase conveys a single thought
- Phase Layout

  - Top line - Present the problem
  - Center Line - Present the location of distance ahead
  - Bottom line - Present recommended driver action

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Radar Speed Display Unit

Used as part of the Motorist Awareness System

Driver Speed Display

Regulatory Speed Limit Sign

'Your Speed' Sign

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Portable Regulatory Sign

Used as part of the Motorist Awareness System

Flashing Lights

Regulatory Speed Limit Sign

When Flashing Sign

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### Truck/Trailer Mounted Attenuators (TMA'S)



- Truck or Trailer Mounted
  - Listed on APL
- Index 102-607
- Mounted by Manufacturer's Recommendations

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### Temporary Lane Separator



Temporary  
Tubular  
Marker



Vertical  
Panel



Opposing  
Traffic

←
3 Approved Fixed Channelizing Devices
→

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### Painted Pavement Markings



Centerlines, lane lines, edge lines, stop bars and turn arrows will be required in work zones prior to opening the road to traffic.

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## Pavement Markings - Conflicting Markings

Remove all pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) that conflict with the adjusted vehicle or pedestrian paths.



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## Temporary Signals

Traffic Signals

Temporary

Existing




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## Work Zone Signs

Warning

Regulatory

Guide






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Warning Signs

- Diamond is basic shape
- Temporary warning signs black legend and border on fluorescent orange background
- Must be at least 48 inches X 48 inches
- Permanent warning signs yellow background with black legend may remain in work zone if still applicable

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Regulatory Signs

- Generally rectangular with longer vertical dimension black legend and border on white background
- Impose legal obligations and/or restrictions on all traffic
- STOP, YIELD, DO NOT ENTER, and WRONG WAY signs have white legend on red background




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Guide Signs

- Rectangular shape with long horizontal dimension
- Basic color white on green
- At work zones may be black on orange to indicate routing changes due to maintenance activity

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## Sign Placement

Sign supports must not be located on sidewalks, bicycle facilities, or areas designated for pedestrian or bicycle traffic.

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## Work Zone Sign Supports

### Temporary Post-Mounted

Work operations exceed 1 day

### Temporary Portable

Work operations less than 1 day

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## End of Session 3

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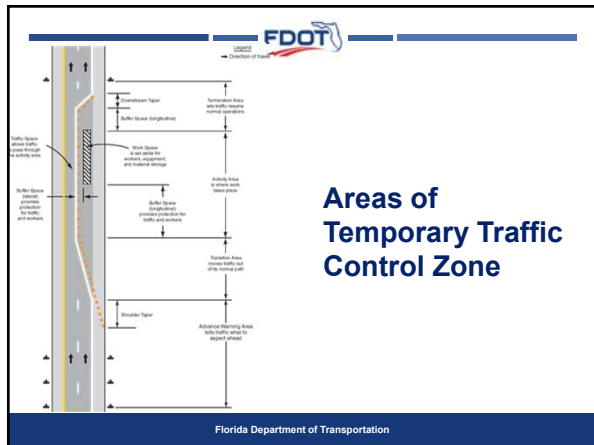
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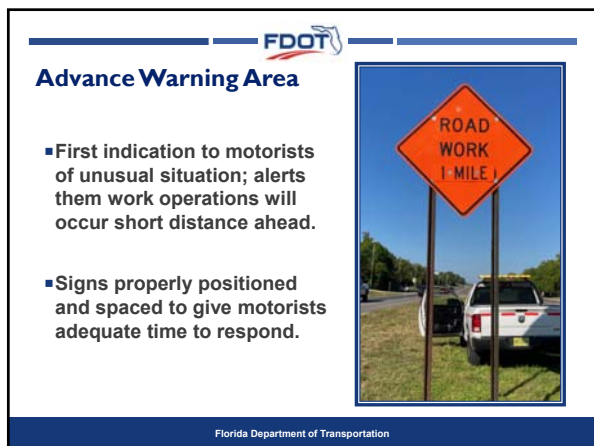
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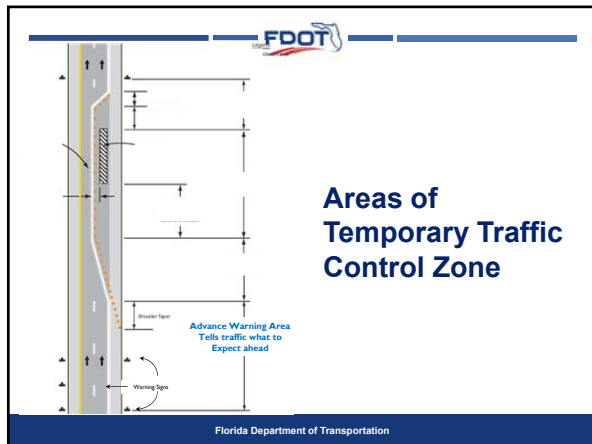
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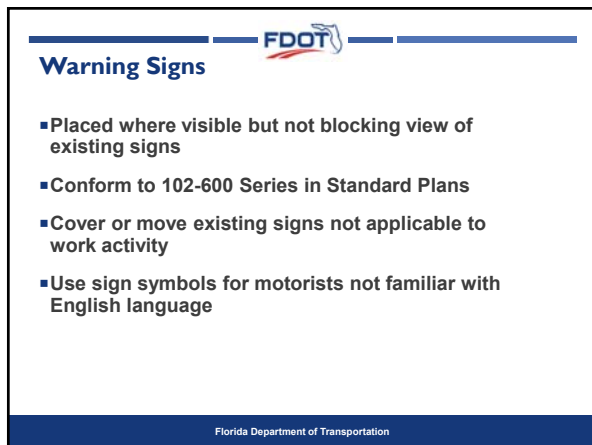
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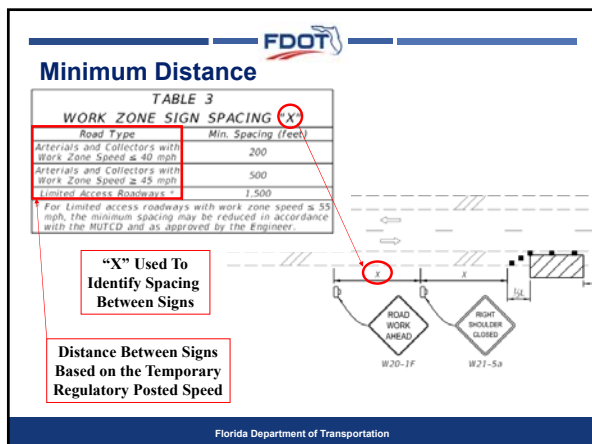
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### Transition Area

Direct motorist from one lane to another in a smooth and gradual transition with channelizing device

Use shadow vehicle during moving operations to warn and guide traffic in proper lane



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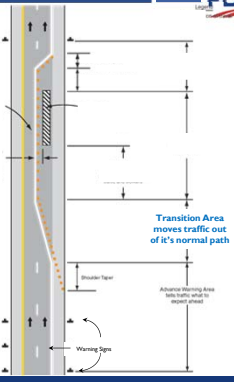
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### Areas of Temporary Traffic Control Zone

Transition Area moves traffic out of its normal path

Advance Warning Area

Work Zone

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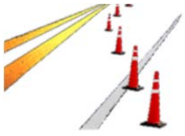
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### Taper

- Series of channelizing devices and/or pavement markings placed on angle to move traffic out of or into normal path.



Work Zone Speed (mph)	Min. Length (feet)
≤ 40	$L = WS$
≥ 45	$L = WS$

Where:  $W$  = width of offset in feet  
 $S$  = speed in mph

- Formula to calculate taper length found in Table 2 of Index 102-600.

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**Calculating Taper Length**

Taper Length Based on Speed "S" and Offset "W"

**TABLE 2**  
**TAPER LENGTH "L"**

**FORMULAS**

$S \leq 40$	$L = (WS^2)/60$
$S \geq 45$	$L = WS$

Where:  
 $L$  = Taper Length in feet  
 $W$  = Width of Offset in feet  
 $S$  = Work Zone Speed in mph

**EXAMPLE "L" VALUES**

S	W		
	5	10	12
25	52	104	125
35	102	204	245
45	225	450	540
55	275	550	660
65	325	650	780

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**5 Types of Tapers**

Two-lane two-way taper

Downstream taper

Merging taper

Shifting taper

Shoulder closure taper

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**Two-Lane Two-Way / Down Stream Taper**

Two-Lane Two-way Taper - Used for flagging operations

Down Stream Taper – used at the downstream end of work area to direct drivers to move back into lane that was closed

50'-100'

50'-100'

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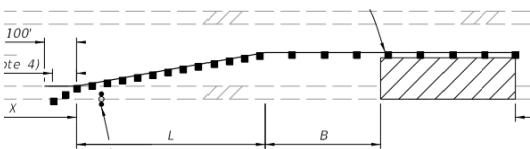
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### Merging Taper



A merging taper is used to close a lane on a multilane roadway and to direct traffic in the closed lane to merge into the adjacent lane.

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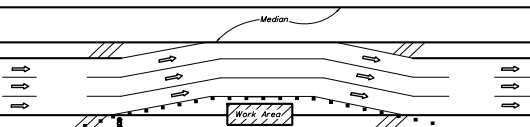
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### Shifting Taper



A shifting taper is used to move traffic into a different travel path when a merge is not required.

**Shifting Taper Length =  $.5L$**

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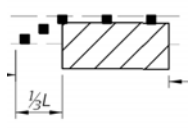
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### Shoulder Closure Taper



A shoulder taper is used to close a shoulder.

**Shoulder Taper =  $L/3$**

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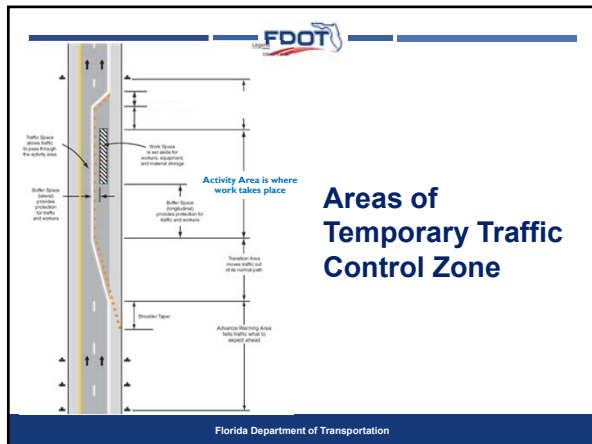
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**Activity Area**

Section of highway where work activity takes place consists of:

- **Buffer Space**
  - Longitudinal
  - Lateral
- **Work Space**
- **Traffic Space**

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**Buffer Space**

- **Longitudinal Buffer Space**
  - Allow motorists extra space to regain control if they missed warning signs
  - Provides room for motorist to stop before reaching work area
- **Lateral Buffer Space**
  - Used to separate traffic space from the workspace and provides protection for traffic and workers
- **Keep buffer space free of equipment, workers, materials, and workers' vehicles**

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# Buffer Space

6" White  
(See General Note 7)

Buffer Space is based on speed

Refer to Table 4 in Index 102-600

**TABLE 4**  
**BUFFER LENGTH "B"**

Work Zone Speed (mph)	Min. Length (feet)
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730

Note: When Buffer Length "B" cannot be attained due to geometric constraints, use the greatest length possible, but not less than 155 feet.

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# Work and Traffic Space

- Work Space/Work Area
  - Portion of roadway closed to traffic where work takes place
  - May be stationary or moving
  - May be several work spaces within the project limits
  - Size of work area largely determined by available right-of-way
  - Avoid gaps in work area
- Traffic Space
  - Portion of the highway where road users are routed through the activity area

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# Termination Area

Provides short distance for traffic to clear work area and return to normal traffic lanes

Legend  
→ Direction of travel

Downstream Taper

Buffer Space (longitudinal)

Termination Area lets traffic resume normal operations

Work Space is set aside for workers, equipment, and material storage

Activity Area is where work

Traffic Space allows traffic to pass through the activity area

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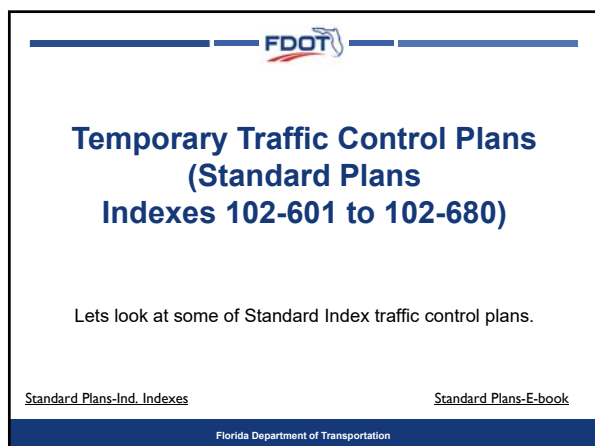
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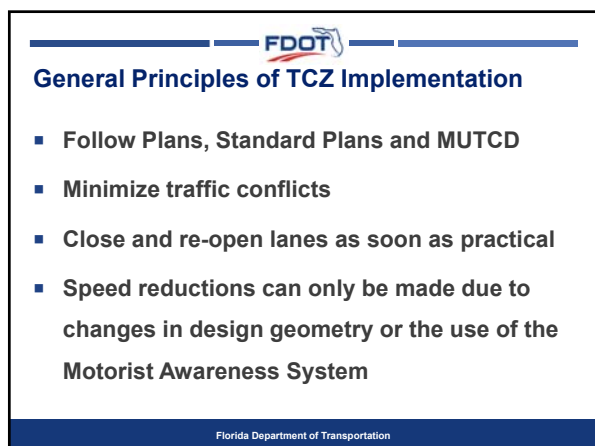
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### General Principles of TCZ Implementation

- Avoid traffic delays that could cause backups
- Avoid scheduling work during peak hours, weekends, and holidays
- Give high priority passage to emergency vehicles



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### Safety Principles of TCZ Implementation

- Maintain access to emergency services, such as police, fire stations, fire hydrants, and hospitals
- Equip work vehicles with flashing lights
- Keep equipment in good condition, replacing or repairing as needed



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### Safety Tips for TCZ Implementation

- Stay alert.
- Do not turn your back on traffic.
  - Use a spotter, if needed.
- Have a bail-out plan in case of an errant vehicle.
- Always wear High Visibility Safety Apparel when working with the right of way.
- Install the traffic control devices from the shoulder, if possible.
- Ensure that proper lighting is used during nighttime operations.

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Clothing Requirements

- ANSI/ISEA 107-2004/107-2010 High-Visibility Safety Apparel:
  - Standard Class 2 for Day
  - Standard Class 3 for Night
- Required within Right-of Way
- Hard hat (recommended)



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TCZ Set-up Procedure



- Phase I - Preparation
  - Prior to beginning work
- Phase II - Implementation
  - Basic steps for set-up and removal of work zone
- Phase III- Maintenance

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TCZ Set-up Procedure

- PHASE I - Preparation
  - Visit the location to survey geometric conditions and identify potential issues
  - Review the traffic control plans or the appropriate 102 Series Index
  - Inventory the devices you plan to use
  - Verify that the crew has the proper training and brief them on their responsibilities

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- **PHASE II - Implementation**

- If possible, pull all vehicles and equipment at least 15 feet off the roadway while preparing for the set-up operation
- Set up the work zone using the traffic control plans or the proper 102 Series Index
- Review the installation and make any adjustments needed

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## TCZ Set-up Procedure

## ■ PHASE II – Basic Lane Closure Set Up

- Locate and mark the beginning of work area, buffer space, and taper
- Beginning from the taper, measure and mark sign spacing distances
- Install advance warning signs
- Install traffic control devices with the flow of traffic

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## TCZ Set-up Procedure

## ■ PHASE II – Basic Lane Closure Take Down

- Remove traffic control devices starting with the termination area first
- Remove advance warning signs
- Remove first advance warning sign last
- Store removed devices outside the clear zone

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## TCZ Set-up Procedure

- **PHASE II – Basic Detour Setup/Take Down**
  - Set-Up
    - Install last sign first
    - Work backwards toward the beginning of the detour
  - Take Down
    - Remove first sign at the beginning of the detour
    - Remove remaining signs with flow of traffic

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## TCZ Set-up Procedure

- **PHASE III – Maintenance**
  - Inspect the work zone
    - Document observations and any deficiencies
    - Correct deficiencies
  - Ensure devices are always in the correct position, properly oriented, clearly visible, and clean
  - Maintain devices to meet the classification of "Acceptable" in the appropriate quality guidelines
  - Immediately repair, replace or clean damaged, defaced or dirty devices.

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## TCZ Set-up Procedure

- **PHASE III – Maintenance (Quality Guidelines)**
  - Devices to meet the classification of "Acceptable"
    - ATSSA Quality Guidelines
    - FDOT Pedestrian LCD Evaluation Guide
    - FDOT Temporary Concrete Barrier Evaluation Guide

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FDOT

# End of Session 6



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FDOT

# Session 7

## FLAGGER OPERATIONS

### (Flagger Training)



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## Objectives

- 1 Perform as Flagger
- 2 Implement Emergency Procedures
- 3 Plan Flagging Operations
- 4 Select potential Flaggers
- 5 Train Flaggers

7/27/2015

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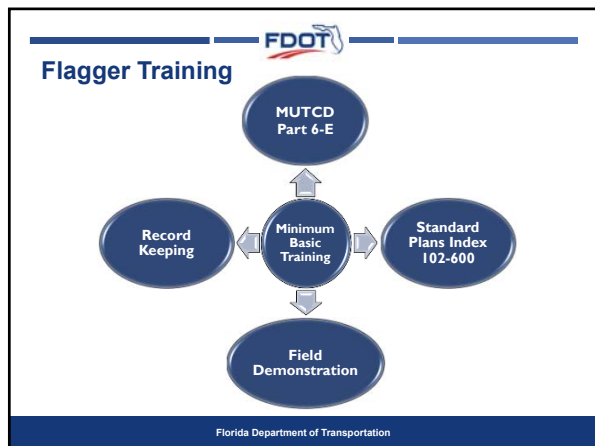
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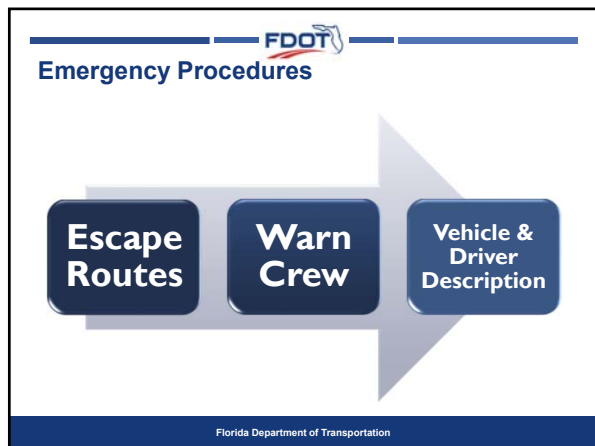
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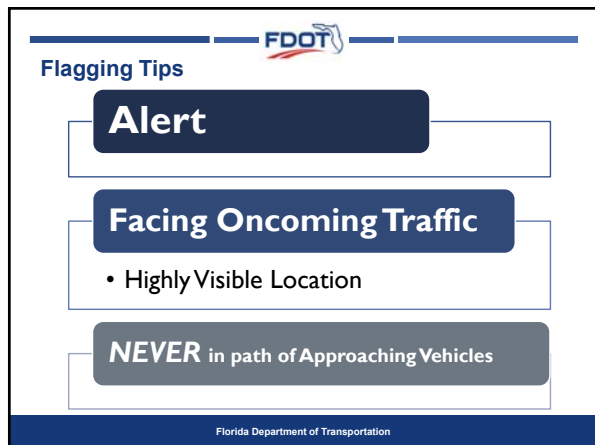
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Two Flaggers – Accommodations for Bicyclists

After bicyclists have crossed, release opposing traffic.

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Flagger Clothing

- ANSI/ISEA 107-2004/107-2010 High-Visibility Safety Apparel:
  - Standard Class 2 for Day
  - Standard Class 3 for Night
- Required within Right-of Way
- Hard hat (recommended)

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FDOT

Flagger Equipment

24" Stop Slow Paddle

Night Well-lighted

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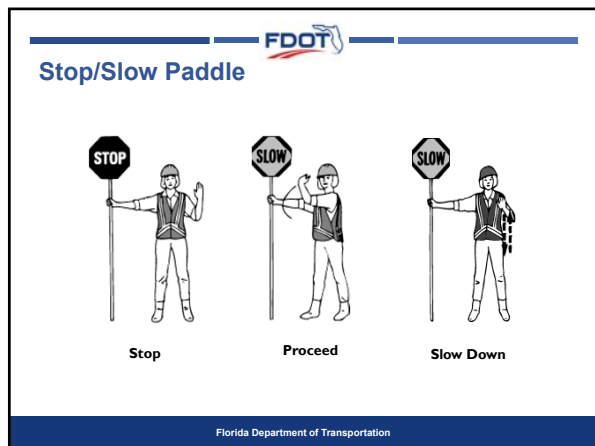
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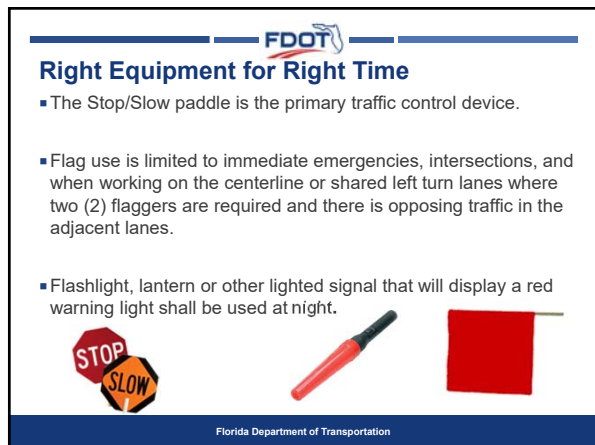
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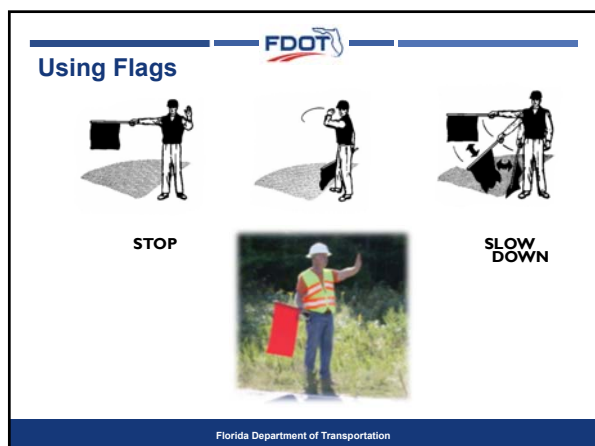
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## Flagging Administration

Administration file includes:

- Qualification of instructor
- Copy of course material
- Keep record of:
  - Date of training
  - Individuals trained

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FDOT

## End of Session 7

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FDOT

## Session 8

### Questions, Review and Qualification Exam

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Maintenance of Traffic Related Webpage Links	
Description	Web page link
MUTCD	<a href="http://mutcd.fhwa.dot.gov/">http://mutcd.fhwa.dot.gov/</a>
Florida Department of Transportation	<a href="http://www.fdot.gov/">http://www.fdot.gov/</a>
Standard Plans	<a href="http://www.fdot.gov/design/StandardPlans/SPS.htm">http://www.fdot.gov/design/StandardPlans/SPS.htm</a>
ATSSA Quality Guidelines	<a href="http://www.atssa.com/ATSSA-Shops/ProductDetail.c?P7795b-beed-e811-a863-00001a140bb5">http://www.atssa.com/ATSSA-Shops/ProductDetail.c?P7795b-beed-e811-a863-00001a140bb5</a> <a href="http://blobwww.blob.core.windows.net/infiniti/docs/default-source/programmanagement/implemented/urinspecs/flow/docs/default-source/content-docs/programmanagement/implemented/urinspecs/files/TemporaryConcreteBarrierGuide.pdf?svrm=343b4c97_10">http://blobwww.blob.core.windows.net/infiniti/docs/default-source/programmanagement/implemented/urinspecs/flow/docs/default-source/content-docs/programmanagement/implemented/urinspecs/files/TemporaryConcreteBarrierGuide.pdf?svrm=343b4c97_10</a>
FDOT Quality Guidelines	<a href="http://blobwww.blob.core.windows.net/infiniti/docs/default-source/programmanagement/implemented/urinspecs/files/evaluationguide.pdf?svrm=166e0f16_2">http://blobwww.blob.core.windows.net/infiniti/docs/default-source/programmanagement/implemented/urinspecs/files/evaluationguide.pdf?svrm=166e0f16_2</a>
FDOT Design Manual	<a href="http://www.fdot.gov/roadway/FDPM/">http://www.fdot.gov/roadway/FDPM/</a>
Specification Book	<a href="http://www.fdot.gov/programmanagement/Specs.htm">http://www.fdot.gov/programmanagement/Specs.htm</a>
APL (Approved Products List)	<a href="http://fdoweb1.dot.state.fl.us/ApprovedProducts/Specifications">http://fdoweb1.dot.state.fl.us/ApprovedProducts/Specifications</a>
Survey Safety Handbook	<a href="http://www.fdot.gov/geospatial/documentsandpubs/surveysafetyhandbook.pdf">http://www.fdot.gov/geospatial/documentsandpubs/surveysafetyhandbook.pdf</a>
TTC Training Procedure	<a href="http://fdoweb1.dot.state.fl.us/ProceduresInformationManagementSystemInternet/FormsAndProcedures/ViewDocument?picNum=625-010-010">http://fdoweb1.dot.state.fl.us/ProceduresInformationManagementSystemInternet/FormsAndProcedures/ViewDocument?picNum=625-010-010</a>
MOT Administration Website	<a href="http://www.motadmin.com/home.aspx">http://www.motadmin.com/home.aspx</a>


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### FORM INSTRUCTIONS

- Student ID is the first 9 numbers of a State Drivers License or Passport. No letters, dashes or spaces. Add zeros at the end to complete 9 numbers.
- Your email address is mandatory. Email will be used for login instructions to obtain exam results, and receive expiration reminders.
- Fill in bubbles completely.
- If you erase, make sure it is erased completely.
- Review your score sheet at the end of the exam and make sure you have not filled in 2 bubbles for the same question.

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### Any questions **BEFORE** we start the Exam?



- Open Book and Notes
- 2 hours
- Instructor is not allowed to discuss or answer ANY type of question
- 70% score to pass

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# FDOT Specifications



## **SECTION 102 MAINTENANCE OF TRAFFIC**

### **102-1 Description.**

Maintain traffic within the limits of the project for the duration of the construction period, including any temporary suspensions of the work. Construct and maintain detours. Provide facilities for access to residences, businesses, etc., along the project. Furnish, install and maintain traffic control and safety devices during construction. Furnish and install work zone pavement markings for maintenance of traffic (MOT) in construction areas. Provide any other special requirements for safe and expeditious movement of traffic specified in the Plans. MOT includes all facilities, devices and operations as required for safety and convenience of the public within the work zone.

Do not maintain traffic over those portions of the project where no work is to be accomplished or where construction operations will not affect existing roads. Do not obstruct or create a hazard to any traffic during the performance of the work, and repair any damage to existing pavement open to traffic.

### **102-2 Materials.**

Meet the following requirements:

Bituminous Adhesive.....	Section 970
Temporary Raised Pavement Markers.....	Section 990
Paint .....	Section 971
Removable Tape .....	Section 990
Glass Spheres .....	Section 971
Temporary Traffic Control Device Materials .....	Section 990
Retroreflective and Nonreflective Sheeting for Temporary Traffic Control Devices .....	Section 994

**102-2.1 Temporary Traffic Control Devices:** Use only the materials meeting the requirements of Section 990, Section 994, Standard Plans and the Manual on Uniform Traffic Control Devices (MUTCD).

**102-2.2 Detour:** Provide all materials for the construction and maintenance of all detours.

**102-2.3 Commercial Materials for Driveway Maintenance:** Provide materials of the type typically used for base, including reclaimed asphalt pavement (RAP) material, and having stability and drainage properties that will provide a firm surface under wet conditions.

### **102-3 Specific Requirements.**

**102-3.1 Beginning Date of Contractor's Responsibility:** Maintain traffic starting the day work begins on the project or on the first day Contract Time is charged, whichever is earlier.

**102-3.2 Worksite Traffic Supervisor:** Provide a Worksite Traffic Supervisor who is responsible for initiating, installing, and maintaining all temporary traffic control devices as described in this Section and the Contract Documents. Provide all equipment and materials needed to set up, take down, maintain traffic control, and handle traffic-related situations. Use approved alternate Worksite Traffic Supervisors when necessary.



The Worksite Traffic Supervisor must meet the personnel qualifications specified in Section 105.

The Worksite Traffic Supervisor is to perform the following duties:

1. On site direction of all temporary traffic control on the project.
2. Is on site during all set up and take down, and performs a drive through inspection immediately after set up.
3. Is on site during all nighttime operations ensuring proper temporary traffic control.
4. Immediately corrects all safety deficiencies and corrects minor deficiencies that are not immediate safety hazards within 24 hours.
5. Is available on a 24 hour per day basis and present at the site within 45 minutes after notification of an emergency situation and is prepared to respond to maintain temporary traffic control or to provide alternate traffic arrangements.
6. Conducts daily daytime and weekly nighttime inspections of projects with predominately daytime work activities, and daily nighttime and weekly daytime inspections of projects with predominantly nighttime work activities of all traffic control devices, traffic flow, pedestrian, bicyclist, and business accommodations.

Advise the project personnel of the schedule of these inspections and give them the opportunity to join in the inspection as deemed necessary.

The Department may disqualify and remove from the project a Worksite Traffic Supervisor who fails to comply with the provisions of this Section. The Department may temporarily suspend all activities, except traffic, erosion control and such other activities that are necessary for project maintenance and safety, for failure to comply with these provisions.

**102-3.3 Lane Closures:** Approval for all lane closures, mobile operations, and traffic pacing operations is required. Submit routine requests to the Engineer fourteen calendar days in advance of planned lane closures, mobile operations, and traffic pacing operations. For unforeseen events that require cancelling or rescheduling lane closures, mobile operations, and traffic pacing operations, revise the lane closure request as soon as possible.

**102-3.3.1 Traffic Pacing:** In addition to dates and locations, include a pacing plan outlining the expected equipment and number of traffic control officers required, the proposed traffic pacing lengths and durations, the available existing egresses in the event of an emergency, and a contingency plan in the event of an equipment failure.

**102-3.4 Pedestrian and Bicycle Accommodations:** When an existing pedestrian or bicycle way is located within a traffic control work zone, accommodation must be maintained and provision for the disabled must be provided. Pedestrians are to be accommodated with a safe, accessible travel path around work sites separated from mainline traffic in compliance with the Americans with Disabilities Act (ADA) Standards for Transportation Facilities. Maintain existing or detour bicycle facilities satisfactorily throughout the project limits. Advanced notification of sidewalk closures and marked detours shall be provided by appropriate signs. Only approved pedestrian longitudinal channelizing devices may be used to delineate temporary traffic control zone pedestrian walkway. Existing businesses in work areas are to be provided with adequate entrances for vehicular and pedestrian traffic during business hours.

#### **102-4 Alternative Traffic Control Plan.**

The Contractor may propose an alternative traffic control plan (TCP) to the plan



presented in the Contract Documents. The Contractor's Engineer of Record must sign and seal the alternative plan and submit to the Engineer. Prepare the TCP in conformance with and in the form outlined in the current version of the FDOT Design Manual. Indicate in the plan a TCP for each phase of activities. Take responsibility for identifying and assessing any potential impacts to a utility that may be caused by the alternate TCP proposed by the Contractor, and notify the Department in writing of any such potential impacts to utilities.

For projects with nighttime lane closure restrictions where paving is expected to extend into the winter months, the Contractor may propose an alternative TCP allowing for daytime lane closures for friction course paving. The alternative TCP must be a lane closure analysis based on actual traffic counts and prepared in accordance with the FDOT Design Manual.

Engineer's approval of the alternate TCP does not relieve the Contractor of sole responsibility for all utility impacts, costs, delays or damages, whether direct or indirect, resulting from Contractor initiated changes in the design or construction activities from those in the original Contract Specifications, Design Plans (including TCPs) or other Contract Documents and which effect a change in utility work different from that shown in the Utility Plans, joint project agreements or utility relocation schedules.

The Department reserves the right to reject any alternative TCP. Obtain the Engineer's written approval before beginning work using an alternate TCP. The Engineer's written approval is required for all modifications to the TCP. The Engineer will only allow changes to the TCP in an emergency without the proper documentation.

The Contractor may propose to extend lane closure times up to one hour in advance of the lane closure start times shown in the Plans for the following conditions:

1. Limited Access roadways with a traffic count of less than 1,300 vehicles per hour per lane
2. Arterials and Collector roadways with a traffic count of less than 1,550 vehicles per hour per lane.

To determine traffic count, record the number of vehicles in the direction of the closure during a 15-minute period. Multiply the number of vehicles by four and divide by the number of lanes in the direction of the closure.

## **102-5 Traffic Control.**

**102-5.1 Standards:** FDOT Standard Plans are the minimum standards for the use in the development of all TCPs. The MUTCD, Part VI is the minimum national standard for traffic control for highway construction, maintenance, and utility operations. Follow the basic principles and minimum standards contained in these documents for the design, application, installation, maintenance, and removal of all traffic control devices, warning devices and barriers which are necessary to protect the public and workers from hazards within the project limits.

**102-5.2 Maintenance of Roadway Surfaces:** Maintain all lanes that are being used for the MOT, including those on detours and temporary facilities, under all weather conditions. Keep the lanes reasonably free of dust, potholes and rutting. Provide the lanes with the drainage facilities necessary to maintain a smooth riding surface under all weather conditions.

**102-5.3 Number of Traffic Lanes:** Maintain one lane of traffic in each direction. Maintain two lanes of traffic in each direction at existing four (or more) lane cross roads, where necessary to avoid undue traffic congestion. Do not allow traffic control and warning devices to encroach on lanes used for MOT.



The Engineer may allow the Contractor to restrict traffic to one-way operation for short periods of time provided that the Contractor employs adequate means of traffic control and does not unreasonably delay traffic. When a construction activity requires restricting traffic to one-way operations, locate the flaggers within view of each other when possible. When visual contact between flaggers is not possible, equip them with 2-way radios, official, or pilot vehicles, or use traffic signals.

**102-5.4 Crossings and Intersections:** Provide and maintain adequate accommodations for intersecting and crossing traffic. Provide signing for the control of traffic entering and leaving work zones by way of intersecting cross roads to make drivers aware of work zone conditions. Do not block or unduly restrict any median opening, road or street crossing the project unless approved by the Engineer. Before beginning any construction, submit to the Engineer the names and phone numbers of persons that can be contacted when signal operation malfunctions.

**102-5.5 Access for Residences and Businesses:** Provide continuous access to all residences and all places of business.

**102-5.6 Protection of the Work from Injury by Traffic:** Where traffic would be injurious to a base, surface course, or structure constructed as a part of the work, maintain all traffic outside the limits of such areas until the potential for injury no longer exists.

**102-5.7 Flagger:** Provide flaggers to control traffic when traffic in both directions must use a single lane and in other situations as required. All flaggers must meet the personnel qualifications specified in Section 105.

**102-5.8 Conflicting Pavement Markings:** Remove all existing pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) that conflict with temporary paths of vehicles, bicycles or pedestrians when the conflict will exceed 24 hours. Use any method, other than paint or sprayed asphalt, approved by the Engineer to remove existing pavement markings. Remove conflicting pavement markings using a method that will not damage the surface texture of the pavement and which will eliminate the previous marking pattern regardless of weather and light conditions.

Remove all pavement markings that will conflict with “the next phase of operation” for vehicle, bicycle, and pedestrian paths as described above, before opening to vehicle or bicycle traffic or use by pedestrians.

Cost for removing conflicting pavement markings (paint, tape, thermoplastic, raised pavement markers, etc.) to be included in Maintenance of Traffic, lump sum.

**102-5.9 Vehicle and Equipment Visibility:** Equip all pickups and automobiles used on the project with a minimum of one Class 2 warning light that meets the Society of Automotive Engineers Recommended Practice SAE J595, dated November 1, 2008, or SAE J845, dated December 1, 2007, and incorporated herein by reference. Existing lights that meet SAE J845, dated March, 1992, or SAE J1318, dated April, 1986, may be used to their end of service life. The warning lights must be a high intensity amber or white rotating, flashing, oscillating or strobe light. Lights must be unobstructed by ancillary vehicle equipment such as ladders, racks or booms and be visible 360 degrees around the vehicle. If the light is obstructed, additional lights will be required. The lights must be operating when the vehicle is in a work area where a potential hazard exists, when operating at less than the average speed for the facility while performing work activities, making frequent stops or called for in the Plans or Standard Plans.

Equip all other vehicles and equipment with a minimum of 4 square feet of retroreflective sheeting or warning lights.



**102-5.10 No Waiver of Liability:** Conduct operations in such a manner that no undue hazard results due to the requirements of this Article. The procedures and policies described herein in no way acts as a waiver of any terms of the liability of the Contractor or his surety.

**102-5.11 Work Zone Speed:** Use the work zone speed in the TTCP. When field conditions warrant work zone speeds different from those in the TTCP, submit signed and sealed documentation to justify reducing the work zone speed limit to the Engineer for approval, or the Engineer may request the District Traffic Operation Engineer to investigate the need.

Sign work zone speed reductions in accordance with Standard Plans, Index 102-600 and the TTCP.

**102-5.12 Limited Access Temporary Openings: When required by the Contract Documents,** construct temporary openings in accordance with the Standard Plans. Submit a written request identifying the specific locations within the project limits to the Engineer.

Locate temporary openings in areas with adequate sight distance. Do not locate temporary openings with 1.5 miles of interchanges or within 2000 feet of the acceleration-deceleration lanes at rest areas, median openings, other access openings, or other highway service areas. Do not remove existing guardrail or barrier for temporary openings.

Use temporary pavement for the acceleration-deceleration lane surface of the temporary opening. Commercial material may be used for the driveway surface of the temporary opening. Install a gate at the limited access fence and keep the gate locked when the temporary opening is not in use.

Do not use temporary openings to transport materials to or from any other project.

Failure to comply with this Section and the Standard Plans, 102 Series shall be cause for the Engineer to terminate usage of the temporary opening. When the temporary opening is no longer needed, remove immediately and restore the area to pre-construction condition.

## **102-6 Detours.**

**102-6.1 General:** Construct and maintain detour facilities wherever it becomes necessary to divert traffic, including pedestrians and bicyclists, from any existing facility, or wherever construction operations block the flow of traffic.

**102-6.2 Construction:** Plan, construct, and maintain detours for the safe passage of traffic in all conditions of weather. Provide the detour with all facilities necessary to meet this requirement.

Where pedestrian facilities are detoured, blocked or closed during the work, provide safe alternate accessible routes through or around the work zone meeting the requirements of the ADA Standards for Transportation Facilities. When temporary walkway surfaces and ramps are required to be constructed, ensure surfaces are stable, firm, slip resistant, and kept free of any obstructions and hazards such as holes, debris, mud, construction equipment and stored materials. Install detectable warnings on temporary ramps in accordance with Section 522.

When the Plans call for the Department to furnish detour bridge components, construct the pile bents in accordance with the Plans, unless otherwise authorized by the Engineer.

Provide two Contractor representatives, who will be directly involved in the erection of Department-owned temporary bridging, to attend a mandatory one-day training session to be conducted at the Department's storage facility. No bridging will be released to the Contractor prior to the completion of this training.



Submit the following: company name, phone number, office address, project contact person, names of the representatives who will attend the training described above, project number, detour bridge type, bridge length, span length, location and usage time frames, to the Engineer at least 30 calendar days before the intended pick-up date, to obtain the storage facility location and list of components for the project. Upon receipt, the Engineer will, within 10 calendar days submit an approved material list to the Contractor and the appropriate Department storage yard.

Submit the name of the representative with authority to pick up components, to the Engineer at least 10 calendar days before the proposed pick-up date. The Department is not obligated to load the bridge components without this notice. Take responsibility and sign for each item loaded at the time of issuance.

Provide timber dunnage, and transport the bridge components from the designated storage facility to the job site. Unload, erect, and maintain the bridge, then dismantle the bridge and load and return the components to the designated storage facility.

Notify the Engineer in writing at least 10 calendar days before returning the components. Include in this notice the name of the Contractor's representative authorized to sign for return of the bridge components. The yard supervisor is not obligated to unload the bridge components without this notice.

The Department will provide equipment and an operator at the Department's storage facility to assist in loading and unloading the bridge components. Furnish all other labor and equipment required for loading and unloading the components.

The Department's representative will record all bridge components issued or returned on the Detour Bridge Issue and Credit Ticket. The tickets must be signed by a Department and a Contractor representative, after loading or unloading each truck to document the quantity and type of bridging issued or returned.

Bind together all bridge components to be returned in accordance with the instructions given by the storage facility. The yard supervisor will repack components that are not packed in compliance with these instructions. Upon request, written packing instructions will be made available to the Contractor, before dismantling of the bridge for return to the Department's storage facility.

Assume responsibility for any shortage or damage to the bridge components. Monies due the Contractor will be reduced at the rate of \$35.00 per hour plus materials for repacking, repairs or replacement of bridge components.

The skid resistance of open steel grid decking on the detour bridge may decrease gradually after opening the bridge to traffic. The Department will furnish a pneumatic floor scabbler machine for roughening the roadway surface of the detour bridge decking. Provide an air compressor at the job site with 200 cubic feet per minute capacity, 90 psi air pressure for the power supply of the machine, and an operator. Transport the scabbler machine to and from the Department's structures shop. Repair any damage to the scabbler machine caused by operations at no expense to the Department. Perform scabbling when determined necessary by the Engineer. The Department will pay for the cost of scabbling as Unforeseeable Work in accordance with 4-4.

Return the bridge components to the designated storage facility beginning no later than 10 calendar days after the date the detour bridge is no longer needed, the date the new bridge is placed in service, or the date Contract Time expires, whichever is earliest. Return the detour bridging at an average of not less than 200 feet per week. Upon failure to return the bridge



components to the Department within the time specified, compensate the Department for the bridge components not returned at the rate of \$5.00 per 10 feet, per day, per bridge, for single lane; and \$10.00 per 10 feet, per day, per bridge, for dual lane until the bridge components are returned to the Department.

**102-6.3 Construction Methods:** Select and use construction methods and materials that provide a stable and safe detour facility. Construct the detour facility to have sufficient durability to remain in good condition, supplemented by maintenance, for the entire period that the detour is required.

**102-6.4 Removal of Detours:** Remove detours when they are no longer needed and before the Contract is completed. Take ownership of all materials from the detour and dispose of them, except for the materials on loan from the Department with the stipulation that they are returned.

**102-6.5 Detours Over Existing Roads and Streets:** When the Department specifies that traffic be detoured over roads or streets outside the project area, do not maintain such roads or streets. However, maintain all signs and other devices placed for the purpose of the detour.

**102-6.6 Operation of Existing Movable Bridges:** The Department will maintain and operate existing moveable bridges that are to be removed by the Contractor until such time as they are closed to traffic. During this period, make immediate repairs of any damage to such structures caused by use or operations related to the work at no expense to the Department, but do not provide routine repairs or maintenance. In the event that use or operations result in damage to a bridge requiring repairs, give such repairs top priority to any equipment, material, or labor available.

**102-6.7 Special Detour:** A special detour is defined as a diversion or lane shift for vehicular traffic that requires temporary pavement.

**102-6.8 Pedestrian or Bicycle Special Detour:** A pedestrian or bicycle special detour is defined as a temporary pedestrian or bicycle way that requires temporary pavement or other stable, firm, slip-resistant surface.

## **102-7 Traffic Control Officer.**

Provide uniformed law enforcement officers, including marked law enforcement vehicles, to assist in controlling and directing traffic in the work zone when the following types of work is necessary on projects:

1. When directing traffic/overriding the signal in a signalized intersection.
2. When Standard Plans, Index 102-607 is used on freeway facilities (interstates, toll roads, and expressways) at nighttime for work within the travel lane.
3. When Standard Plans, Index 102-655 Traffic Pacing is called for in the Plans or approved by the Engineer.
4. When pulling conductor/cable above an open traffic lane on limited access facilities, when called for in the Plans or approved by the Engineer.
5. When Standard Plans, Index 102-625 Temporary Road Closure 5 Minutes or Less is used.
6. When performing lane closures during nighttime operations on roadways with posted speed limits 55 mph or greater.

At no additional cost to the Department, traffic control officers may be used for operations other than those listed above.

The Department will not consider any claim arising from the failure of a traffic control officer to be present or available on the project. A noncompensable time extension may be



granted when a state or local emergency requires all area law enforcement officers to be on-duty and not available for hire.

## **102-8 Driveway Maintenance.**

**102-8.1 General:** Ensure that each residence and business has safe, stable, and reasonable access.

**102-8.2 Construction Methods:** Place, level, manipulate, compact, and maintain the material, to the extent appropriate for the intended use.

As permanent driveway construction is accomplished at a particular location, the Contractor may salvage and reuse previously placed materials that are suitable for reuse on other driveways.

## **102-9 Temporary Traffic Control Devices.**

**102-9.1 General:** Use only devices that are listed on the APL. Immediately remove or cover, using any method of covering approved by the Engineer, any existing or temporary devices that do not apply to current conditions.

The use of NCHRP Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features devices purchased prior to January 1, 2020 is permitted on projects let prior to January 1, 2030. All devices manufactured or purchased on or after January 1, 2020 must be MASH compliant in accordance with Section 990.

The APL number is to be permanently marked on the device at a readily visible location. Sheeting used on devices and pavement markings are exempt from this requirement.

Notify the Engineer in writing of any scheduled operation that will affect traffic patterns or safety sufficiently in advance of commencing such operation to permit review of the plan for the proposed installation of temporary traffic control devices.

Assign an employee the responsibility of maintaining the position and condition of all temporary traffic control devices throughout the duration of the Contract. Keep the Engineer advised at all times of the identification and means of contacting this employee on a 24 hour basis.

Maintain temporary traffic control devices in the correct position, properly oriented, clearly visible and clean, at all times. All applicable temporary traffic control devices must meet the classification category of Acceptable as defined in the American Traffic Safety Services Association (ATSSA) Quality Guidelines for Temporary Traffic Control Devices and Features. Temporary concrete barriers must meet the classification category of Acceptable defined in the Department's Temporary Concrete Barrier Evaluation Guide, which may be viewed at the following URL:

[https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/urlinspecs/files/docs/default-source/content-docs/programmanagement/implemented/urlinspecs/files/temporaryconcretebarrierguide.pdf.pdf?sfvrsn=343b4c97\\_10](https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/urlinspecs/files/docs/default-source/content-docs/programmanagement/implemented/urlinspecs/files/temporaryconcretebarrierguide.pdf.pdf?sfvrsn=343b4c97_10). Pedestrian longitudinal channelizing devices (LCDs) must meet the classification category of Acceptable as defined in the Pedestrian LCD Evaluation Guide, which may be viewed at the following URL:

[https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/urlinspecs/files/lcdevaluationguide.pdf?sfvrsn=166e0f16\\_2](https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/programmanagement/implemented/urlinspecs/files/lcdevaluationguide.pdf?sfvrsn=166e0f16_2). Immediately repair, replace or clean damaged, defaced or dirty devices. Traffic control devices must not be cleaned while installed/used. Use of warning lights on any temporary traffic control device is prohibited, with the exception of the trailer mounted portable regulatory signs.



Employ an approved independent Channelizing Device Supplier (CDS) to provide and maintain the condition of the following non-fixed channelizing devices: drums, cones, vertical panels, barricades, temporary tubular markers, and pedestrian longitudinal channelizing devices. Cones may be provided and maintained by the Contractor.

The CDS shall not be affiliated with the Contractor and must be approved by the Department. Department approved CDSs are listed on the State Construction Office website. CDSs seeking inclusion on the list must meet the requirements of 102-9.1.1. The CDS shall submit a monthly certification on letterhead that the channelizing devices mentioned above installed/used within the work zone meet classification category of Acceptable as defined in the Pedestrian LCD Evaluation Guide and the ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features. The CDS shall submit the monthly certification on letterhead for channelizing devices installed/used within the work zone. The CDS certification shall include the following statement, "I certify that I have provided and maintained the following devices <list devices covered under the certification> in accordance with Pedestrian LCD Evaluation Guide and the ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features." If the Contractor chooses to provide and maintain cones, the Contractor must submit a monthly Contractor certification on letterhead that all cones installed/used within the work zone meet acceptable standards as outlined in the ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features. The Contractor certification shall include the following statement, "I certify that I have provided and maintained cones in accordance with the ATSSA Quality Guidelines for Temporary Traffic Control Devices and Features."

#### **102-9.1.1 Approved Independent Channelizing Device Supplier (CDS)**

**Requirements:** Submit the following documents to the State Construction Office for review and approval

1. A letter on company letterhead signed and dated by the owner of the company or company officer with the following information and statements:
  - a. The company's owners, stockholders, and officers.
  - b. A statement declaring that the company will not perform as a CDS on any project where there is common ownership, directly or indirectly, between the company and the Contractor.
  - c. A statement declaring that the company will furnish and maintain the condition of all channelizing devices with the exception of cones as required in 102-9.1 with its own forces.
  - d. A statement declaring at least five years of experience in providing channelizing device supplier services, with its own inventory of channelizing devices.
  - e. On a separate sheet, list a sample project history of the company's experience as a channelizing device supplier for the five years declared in item 1(d) above including the following information:
    1. Project name and number and a brief description of CDS work performed,
    2. Beginning and ending date of CDS project activities,
    3. Location of project (city, state),
    4. Monetary amount of CDS work on project,
    5. Owner of project, contact person and phone number with area code,



6. Name of Contractor (client) that the work was performed for and phone number with area code.

2. A maintenance plan for approval by the Department that outlines the frequency and methods for maintaining the condition of all channelizing devices, except cones owned and maintained by the Contractor, installed/used in the work zone.

**102-9.2 Work Zone Signs:** Furnish, install, maintain, remove and relocate signs in accordance with the Plans and Standard Plans, Index 102-600.

**102-9.2.1 Post Mounted Signs:** Meet the requirements of 990-8.

**102-9.2.2 Portable Signs:** Use only approved systems, which includes sign stands and attachment hardware (nuts, bolts, clamps, brackets, braces, etc.), meeting the vendor requirements specified on the APL drawings.

**102-9.2.3 Barrier Mounted Signs:** If post mounting criteria cannot be achieved in accordance with Standard Plans, Index 102-600 and a barrier or traffic railing exists, use temporary sign criteria provided in Standard Plans, Index 700-012 or Index 700-013. Use Standard Plans, Index 700-012 only when mounting the sign to the top of the barrier or traffic railing places the sign panel closer than two feet from the traveled way.

**102-9.3 Business Signs:** Provide and place signs in accordance with the Plans and Standard Plans, Index 102 series. Furnish signs having retroreflective sheeting meeting the requirements of Section 990.

**102-9.4 Project Information Signs:** Provide and place signs in accordance with the Plans and Standard Plans, Index 102 series. Furnish signs having retroreflective sheeting meeting the requirements of Section 990.

**102-9.5 Channelizing Devices:** Furnish, install, maintain, remove and relocate channelizing devices in accordance with the Plans and Standard Plans.

**102-9.5.1 Retroreflective Collars for Traffic Cones:** Use collars for traffic cones listed on the APL that meet the requirements of Section 990. Use cone collars at night designed to properly fit the taper of the cone when installed. Place the upper 6 inch collar a uniform 3-1/2 inches distance from the top of the cone and the lower 4 inch collar a uniform 2 inches distance below the bottom of the upper 6 inch collar.

Collars must be capable of being removed for temporary use or attached permanently to the cone in accordance with the manufacturer's recommendations. Provide a white sheeting having a smooth outer surface and that has the property of a retroreflector over its entire surface.

**102-9.5.2 Pedestrian Longitudinal Channelizing Devices (LCDs):** Use LCDs listed on the APL for pedestrian use and meeting the requirements of Section 990 and the Standard Plans. Pedestrian LCDs must be interlocked except for the stand-alone unit placed perpendicular to a sidewalk. For pedestrian LCDs requiring internal ballasting, an indicator that clearly identifies the proper ballast level will be required. For pedestrian LCDs requiring external ballasting, the ballasting methods must be detailed in the APL drawings including ballasting type and minimum weight.

Ensure that joints on the pedestrian LCDs are free of sharp edges and have a maximum offset of 1/2 inch in any plane.

**102-9.6 Temporary Barrier:** Furnish, install, maintain, remove and relocate temporary barrier in accordance with the Plans and Standard Plans. Obtain and use precast temporary concrete barrier from a manufacturing plant that is on the Department's Production Facility Listing. Temporary concrete barrier must meet the material and construction requirements of



Section 521 unless noted otherwise in the Standard Plans. Proprietary temporary concrete, steel, or water filled barrier used must be listed on the APL.

The maximum allowable height increase between consecutive temporary barrier units in the direction of traffic is 1 inch.

Temporary barrier must comply with Standard Plans, Index 102-100 or 102-120. Install temporary barriers as either anchored or freestanding as shown in the Plans or the Standard Plans. An anchored unit is defined as having at least one stake or bolt into the underlying pavement or bridge deck. All other units, including those with keeper pins, are considered freestanding.

Remove temporary asphalt pads and repair all attachment scars to permanent structures and pavements after barrier removal. Make necessary repairs due to defective material, work, or Contractor operations at no cost to the Department. Restore barrier damaged by the traveling public within 24 hours after notification as authorized by the Engineer.

Trailer mounted barriers listed on the APL may be used at the option of the Contractor. Trailer mounted barriers listed on the APL must have an FHWA eligibility letter and be successfully crash tested in accordance with MASH TL-3 criteria. All trailer mounted barriers must be equipped with an APL listed truck mounted attenuator, an APL listed vehicle mounted arrow board and vehicle warning lights in accordance with this Section.

**102-9.6.2.1 Temporary Barrier Meeting the Requirements of Standard Plans, Index 102-120 and 102-110:** Ensure the marking requirements of the respective Index are met.

**102-9.6.2.2: Proprietary Precast Temporary Concrete Barrier Fabricated prior to 2005:** Submit a certification stating that all unmarked barrier units meet the requirements of the Specifications and the Standard Plans. Certifications will be project specific and non-transferable.

**102-9.6.2.3 Proprietary Precast Temporary Concrete Barrier Fabricated in 2005 or later:** Ensure each barrier unit has permanent clear markings, showing the manufacture date, serial number, manufacturer's name or symbol, and the APL number. Label the markings on a plate, plaque, or cast in the unit. Proprietary barrier fabricated prior to 2016 and marked with the "INDX 521" in lieu of the APL number will be permitted.

**102-9.6.2.4 Temporary Concrete Barrier Repair:** Before beginning the repair, remove all laitance, loose material, and any other deleterious matter to sound concrete or a minimum depth of one inch. Additionally, when reinforcing bars, inserts or weldments are exposed, remove the concrete to provide a minimum one inch clearance all around. Fill the repair area with an approved high performance concrete repair material in accordance with 930-5 and the manufacturer's recommendations. Restore surfaces and edges to the original dimensions and shape of the barrier.

Repairs are not allowed on barrier units that have one or more of the following deficiencies: structural cracking or cracks that exist through the entire cross-section; unit-to-unit connection assemblies or anchor slots are broken or no longer in a fixed position.

Do not paint repaired barriers.

**102-9.7 Barrier Delineators:** Install barrier delineators on top of temporary barrier and vehicular LCDs meeting the requirements of Section 705.

**102-9.8 Temporary Glare Screen:** Use temporary glare screens listed on the APL that meet the requirements of Section 990. Furnish, install, maintain, remove and relocate glare screen systems in conjunction with temporary barrier at locations identified in the Plans.



The anchorage of the glare screen to the barrier must be capable of safely resisting an equivalent tensile load of 600 pounds per foot of glare screen, with a requirement to use a minimum of three fasteners per barrier section.

When glare screen is utilized on temporary barrier, barrier delineators will not be required.

**102-9.9 Temporary Crash Cushion (Redirective or Gating):** Furnish, install, maintain and subsequently remove temporary crash cushions in accordance with the details and notes shown in the Plans, Standard Plans, and requirements of the pre-approved alternatives listed on the APL.

Temporary crash cushions can be either new or used functionally sound refurbished devices. Performance of intended function is the only condition for acceptance. All metallic components must be galvanized in accordance with Section 967.

Anchor abutting temporary barrier in accordance the Standard Plans or APL drawings, as required. Bidirectional installations must have a transition panel installed between the crash cushion and the abutting barrier. Delineate the crash cushion in accordance with Section 544. Maintain the crash cushions until their authorized removal. Do not place any materials or equipment within the length of the crash cushion.

Remove temporary asphalt or concrete pads and repair all attachment scars to permanent structures and pavements after crash cushion removal. Make necessary repairs due to defective material, work, or Contractor operations at no cost to the Department. Restore crash cushions damaged by the traveling public within 24 hours after notification as authorized by the Engineer.

**102-9.10 Temporary Guardrail:** Furnish temporary guardrail in accordance with the Plans and Standard Plans. Meet the requirements of Section 536.

**102-9.11 Arrow Board:** Furnish arrow boards that meet the requirements of Section 990 as required by the Plans and Standard Plans to advise approaching traffic of lane closures or shoulder work. Ensure that the arrow board display panel is raised to a fully upright position and is fully visible to motorists. Type B arrow boards may be used on low to intermediate speed (0 mph to 50 mph) facilities or for maintenance or moving operations on any speed facility. Type C arrow boards must be used for all other operations on high-speed (50 mph and greater) facilities and may be substituted for Type B arrow boards on any speed facility.

**102-9.12 Portable Changeable Message Sign (PCMS):** Use PCMSs or truck mounted changeable message signs that meet the requirements of Section 990 as required by the Plans and Standard Plans to supplement other temporary traffic control devices used in work zones. Ensure that the PCMS display panel is raised to a fully upright position and is fully visible to motorists. Reduce the intensity of the flashers when using PCMS at night. Use PCMS with a minimum letter height of 18 inches. For facilities with posted speed limits of 45 mph or less, PCMS with a minimum letter height of 12 inches may be used.

Messages must have no more than two phases. The display time for each phase must be at least two seconds but no more than three seconds. The sum of the display time must be a maximum of six seconds.

**102-9.13 Portable Regulatory Signs (PRS):** Furnish PRSs that meet the requirements of Section 990 as required by the Plans and Standard Plans. Ensure that the PRS sign panel is raised to a fully upright position and is fully visible to motorists.

Activate portable regulatory signs only during active work activities and deactivate when no work is being performed.



**102-9.14 Radar Speed Display Unit (RSDU):** Furnish RSDUs that meet the requirements of Section 990 as required by the Plans and Standard Plans to inform motorists of the posted speed and their actual speed. Ensure that the RSDU display panel is mounted in accordance with the manufacturer's recommendations.

Activate the radar speed display unit only during active work activities and deactivate when no work is being performed.

**102-9.15 Temporary Signalization and Maintenance:** Provide temporary signals and maintain signalization at existing, temporary, and new intersections including, but not limited to, the following:

1. Installation of temporary poles and span wire assemblies as shown in the Plans,

2. Temporary portable traffic signals as shown in the Plans,

3. Adding or shifting signal heads,

4. Trouble calls,

5. Maintaining intersection and coordination timing and preemption devices. Coordination timing will require maintaining functionality of system communications.

Restore any loss of operation within 12 hours after notification. Provide alternate temporary traffic control until the signalization is restored.

Provide temporary pedestrian signalization in accordance with the TTCP, and maintain pedestrian signalization at existing, temporary, and new intersections.

Provide traffic signal equipment that meets the requirements of the Standard Plans and 603-2. The Engineer may approve used signal equipment if it is in acceptable condition. Replacement components for traffic signal cabinet assemblies will be provided by the maintaining agency. For temporary signals used for lane closure operations on two-lane, two-way roadways meet the requirements in 102-9.21.

**102-9.16 Temporary Traffic Detection and Maintenance:** Provide temporary traffic detection and maintenance at existing, temporary, and new signalized intersections. Provide temporary traffic detection equipment listed on the APL. Restore any loss of detection within 12 hours. Ensure 90% accuracy per signal phase, measured at the initial installation and after any lane shifts, by comparing sample data collected from the detection system with ground truth data collected by human observation. Collect the sample and ground truth data for a minimum of five minutes during a peak and five minutes during an off-peak period with a minimum three detections for each signal phase. Perform the test in the presence of the Engineer.

**102-9.17 Truck Mounted Attenuators and Trailer Mounted Attenuators:** Furnish, operate and maintain APL listed truck mounted and trailer mounted attenuators in accordance with the manufacturer's recommendations.

For posted speeds of 50 mph or greater, use either truck mounted attenuators or trailer mounted attenuators that meet TL-3 criteria. For posted speeds of 45 mph or less, use either truck mounted attenuators or trailer mounted attenuators that meet TL-2 or TL-3 criteria.

Attenuators will not be paid for separately. Include the cost of the truck with either a truck mounted attenuator or a trailer mounted attenuator in Maintenance of Traffic, lump sum. Payment includes all costs, including furnishing, operating maintaining and removal when no longer required, and all materials, labor, tools, equipment and incidentals required for attenuator maintenance.

**102-9.18 Temporary Raised Rumble Strip Set:** Use temporary raised rumble strips per the manufacturer's recommendations and in accordance with Standard Plans, Index 102-603.



The temporary raised rumble strip may be either a removable striping type or a portable type. Use a consistent type and color throughout the work zone.

**102-9.19 Automated Flagger Assistance Devices (AFAD):** Furnish, install, maintain, remove, and relocate AFADs in accordance with the Plans, Standard Plans, Index 102-603, and APL vendor drawings.

Position AFADs where they are clearly visible to oncoming traffic. AFADs may be placed on the centerline if they have been successfully crash tested in accordance with MASH TL-3 criteria. A gate arm is required in accordance with Section 990 if a single AFAD is used on the shoulder to control one direction of traffic.

The devices may be operated either by a single flagger at one end of the traffic control zone, from a central location, or by a separate flagger near each device location. Use only flaggers trained in accordance with Section 105 and in the operation of the AFAD. When in use, each AFAD must be in view of, and attended at all times by, the flagger operating the device.

Provide two flaggers on-site and use one of the following methods in the deployment of AFADs:

1. Place an AFAD at each end of the temporary traffic control zone, or
2. Place an AFAD at one end of the temporary traffic control zone and a flagger at the opposite end.

A single flagger may simultaneously operate two AFADs as described in (1) or a single AFAD as described in (2) if all of the following conditions are met:

1. The flagger has an unobstructed view of the AFAD(s),
2. The flagger has an unobstructed view of approaching traffic in both directions,

3. In the event of an AFAD malfunction, restore normal flagging operations with flaggers or immediately cease the flagging operation and reopen the roadway.

AFADs may be either a remotely controlled Stop/Slow AFAD mounted on either a trailer or a movable cart system, or a remotely controlled Red/Yellow Lens AFAD.

Illuminate the flagging station when the AFAD is used at night. When the AFAD is not in use, remove or cover signs and move the AFAD device outside the clear zone or shield it with a barrier.

AFADs will not be paid for separately. AFADs may be used as a supplement or an alternate to flaggers in accordance with the Plans, Standard Plans, Index 102-603, and the APL vendor drawings. Include the cost for AFADs in Maintenance of Traffic, Lump Sum.

**102-9.20 Temporary Lane Separator:** Furnish, install, maintain, remove and relocate temporary lane separator in accordance with the Plans and Standard Plans, Index 102-600. Anchor the portable temporary lane separator with a removable anchor bolt. Use epoxy on bridge decks where anchoring is not allowed. Remove the epoxy from the bridge deck by hydroblasting or other method approved by the Engineer. Repair any damage to the existing pavement caused by the removal of temporary lane separator.

**102-9.21 Temporary Signals for Lane Closures on Two-Lane, Two-Way Roadways:** Furnish, install, maintain, remove, and relocate temporary signals for lane closure operations on two-lane, two-way roadways at the locations shown in the Plans. Temporary signals may be used, at the Contractor's option, as an alternate to flaggers for lane closure operations on two-lane, two-way roadways in accordance with Standard Plans, Index 102-606. Temporary signals can either be portable signals or span wire signals and must be listed on the APL. Provide two signal faces for each approach.



**102-9.22 Type III Barricades:** Use type III barricades in accordance with the TTCP and Standard Plans. Ensure stripes are sloping downward in the direction road users are to pass. Mount sign panels in accordance with the manufacturer's instructions. Do not place ballast on any rails, or higher than 13 inches above the driving surface. Do not splice the retroreflective sheeting.

## **102-10 Work Zone Pavement Marking.**

**102-10.1 Description:** Furnish and install work zone pavement markings for MOT in construction areas and in close conformity with the lines and details shown in the Plans and Standard Plans.

Centerlines, lane lines, edge lines, stop bars, standard crosswalks, and turn arrows will be required in work zones prior to opening the road to traffic.

### **102-10.2 Painted Pavement Markings:**

**102-10.2.1 General:** Use painted pavement markings meeting the requirements of Section 710. Use standard paint unless otherwise identified in the Plans or approved by the Engineer.

### **102-10.3 Removable Tape:**

**102-10.3.1 General:** Use removable tape listed on the APL as shown in the Plans and meeting the requirements of 990-4.

**102-10.3.2 Application:** Apply removable tape with a mechanical applicator to provide pavement lines that are neat, accurate and uniform. Equip the mechanical applicator with a film cut-off device and with measuring devices that automatically and accumulatively measure the length of each line placed within an accuracy tolerance of plus or minus 2%. Ensure removable tape adheres to the road surface. Removable tape may be placed by hand on short sections, 500 feet or less, if it is done in a neat accurate manner.

**102-10.3.3 Retroreflectivity:** Apply white and yellow pavement markings that will attain an initial retroreflectivity of not less than 300 mcd/lx·m<sup>2</sup> for white and contrast markings and not less than 250 mcd/lx·m<sup>2</sup> for yellow markings. Black portions of contrast tapes and black masking tapes must be non-reflective and have a reflectance of less than 5 mcd/lx m<sup>2</sup>. At the end of the six month service life, the retro reflectance of white and yellow removable tape shall not be less than 150 mcd/lx·m<sup>2</sup>.

**102-10.3.4 Removability:** Provide removable tape capable of being removed from bituminous concrete and portland cement concrete pavement intact or in substantially large strips, either manually or by a mechanical roll-up device, at temperatures above 40°F, without the use of heat, solvents, grinding or blasting.

**102-10.4 Temporary Raised Pavement Markers (RPMs):** Use Class B RPMs except for work that consists of ground-in rumble strips at centerline locations. For ground-in rumble strips at centerline locations, use temporary RPMs in accordance with Section 710. Provide only temporary RPMs listed on the APL. Install all markers in accordance with the manufacturer's recommendations, the Standard Plans, and Section 706. After initial installation, replace broken or missing temporary RPMs in locations where more than three consecutive temporary RPMs are broken or missing at no expense to the Department.

## **102-11 Method of Measurement.**

**102-11.1 General:** Devices installed/used on the project on any calendar day or portion thereof, within the Contract Time, including time extensions which may be granted, will be paid for at the Contract unit price for the applicable pay item. Include the cost of any work that is



necessary to meet the requirements of the Contract Documents for MOT under Maintenance of Traffic, lump sum when separate payment is not provided.

**102-11.2 Traffic Control Officers:** The quantity to be paid for traffic control officers will be at the Contract unit price per hour (4 hour minimum) for the actual number of officers certified to be on the project site, including any law enforcement vehicles and all other direct and indirect costs. Payment will be made only for those traffic control officers specified in the Plans and authorized by the Engineer.

**102-11.3 Special Detours:** When a special detour is shown in the Plans, the work of constructing, maintaining, and subsequently removing such detour facilities will be paid for under Special Detour, lump sum. However, traffic control devices, warning devices, barriers, signing, pavement markings, and restoration to final configuration will be paid for under their respective pay items.

**102-11.4 Commercial Material for Driveway Maintenance:** The quantity to be paid for will be the certified volume, in cubic yards, of all materials authorized by the Engineer, acceptably placed and maintained for driveway maintenance. The volume, which is authorized to be reused, and which is acceptably salvaged, placed, and maintained in other designated driveways will be included again for payment. Commercial Material used for Temporary Openings will not be included for separate payment.

**102-11.5 Work Zone Signs:** The number of temporary post-mounted signs (temporary regulatory, warning and guide) certified as installed/used on the project will be paid for at the Contract unit price for work zone signs. When multiple signs are located on single or multiple posts, each sign panel will be paid individually. Signs greater than 20 square feet and detailed in the Plans will be paid for under Maintenance of Traffic, lump sum.

Temporary portable signs (excluding mesh signs) and vehicular mounted signs will be included for payment under work zone signs, only if used in accordance with the Standard Plans.

The number of temporary barrier mounted signs (temporary regulatory, warning and guide) certified as installed/used on the project will be paid for at the Contract unit price for barrier mounted work zone signs.

Work zone signs may be installed fourteen days prior to the start of Contract Time with the approval of the Engineer and at no additional cost to the Department.

**102-11.6. Business Signs:** The number of business signs certified as installed/used on the project will be paid for at the Contract unit price for business signs.

**102-11.7 Project Information Signs:** No separate payment will be made for project information signs. Payment will be included under Maintenance of Traffic, lump sum.

**102-11.8 Channelizing Devices:** The number of drums, vertical panels, and Type I, Type II, or direction indicator barricades, certified as installed/used on the project meeting the requirements of Standard Plans, Index 102-600 and have been properly maintained will be paid for at the Contract unit prices for channelizing device.

Payment for drums, vertical panels, and Type I, Type II, and direction indicator barricades will be paid per each per day.

Payment for vehicular LCDs will be paid as the length in feet installed divided by the device spacing for barricades, vertical panels, and drums and certified as installed/used on the project meeting the requirements of Standard Plans, Index 102-600 and have been properly maintained will be paid for at the Contract unit price for channelizing device.



Payment for pedestrian LCDs, certified as installed/used on the project and properly maintained, will be paid per linear foot per day. Placement of pedestrian LCDs at locations not shown in the Plans, or not authorized by the Engineer, will be at the Contractor's expense. Payment for pedestrian LCD mounted signs will be made under Work Zone Signs, per each per day.

Payment will not be made for channelizing devices unsatisfactorily maintained, as determined by the Engineer. Payment will be made for each channelizing device that is used to delineate trailer mounted devices. Payment will be made for channelizing devices delineating portable changeable message signs during the period beginning 14 working days before Contract Time begins as authorized by the Engineer.

**102-11.9 Temporary Barrier:** The quantity to be paid for will be the length, in feet, of freestanding units or anchored units certified as installed/used on the project. The quantity to be paid for relocating barrier will be based on the relocated installation type. No separate payment will be made for the asphalt pad. For freestanding units transitioned to a crash cushion, the cost of anchoring the transition units will be included in the cost of the temporary crash cushion in accordance with 102-11.12.

**102-11.10 Barrier Delineators:** No separate payment will be made for barrier delineators installed on top of temporary barrier and vehicular LCDs. Include the cost for barrier delineators in the cost of the barrier or vehicular LCD.

**102-11.11 Temporary Glare Screen:** The certified quantity to be paid for will be determined by the number of sections times the nominal length of each section.

**102-11.12 Temporary Crash Cushions:** No separate payment will be made for the concrete or asphalt pad.

**102-11.12.1 Redirective:** The quantity to be paid for will be the number of temporary crash cushions (redirective) certified as installed/used and maintained on the project, including anchoring of temporary barrier necessary for transition to the crash cushion and delineation.

**102-11.12.2 Gating:** The quantity to be paid for will be the number of temporary crash cushions (gating) certified as installed/used and maintained on the project, including anchoring of temporary barrier necessary for transition to the crash cushion and delineation.

**102-11.13 Temporary Guardrail:** The quantity to be paid for will be the length, in feet, of temporary guardrail constructed and certified as installed/used on the project. The length of a run of guardrail will be determined as a multiple of the nominal panel lengths.

**102-11.14 Arrow Board:** The quantity to be paid at the contract unit price will be for the number of arrow boards certified as installed/used on the project on any calendar day or portion thereof within the Contract Time.

**102-11.15 Portable Changeable Message Sign:** The quantity to be paid at the Contract unit price will be for the number of PCMSs or truck mounted changeable message signs certified as installed/used on the project on any calendar day or portion thereof within the Contract Time. Payment will be made for each portable changeable message sign that is used during the period beginning fourteen working days before Contract Time begins as authorized by the Engineer.

**102-11.16 Portable Regulatory Signs:** The quantity to be paid for will be the number of portable regulatory signs certified as installed/used on the project on any calendar day or portion thereof within the Contract Time, will be paid for the Contract unit price for portable regulatory sign.



**102-11.17 Radar Speed Display Unit:** The quantity to be paid for will be the number of radar speed display units certified as installed/used on the project on any calendar day or portion thereof within the Contract Time, will be paid for the Contract unit price for radar speed display unit.

**102-11.18 Temporary Signalization and Maintenance:** For existing intersections, the certified quantity to be paid for will be the number of signalized intersections per day for the full duration of the Contract. For temporary intersections, the certified quantity to be paid for will be the number of signalized intersections per day for the duration of the temporary intersection. No separate payment will be made for temporary signalization and maintenance at new intersections.

**102-11.19 Temporary Traffic Detection and Maintenance:** For existing intersections, the certified quantity to be paid for will be the number of signalized intersections per day beginning the day Contract Time begins and ending the day the permanent detection is operational and the final lane configuration is in place. For temporary and new intersections, the certified quantity to be paid for will be the number of signalized intersections per day beginning the day the temporary detection is functional and ending the day the permanent detection is operational and the final lane configuration is in place for a new intersection; or, when the detection is removed for a temporary intersection.

**102-11.20 Work Zone Pavement Markings:** Painted pavement markings will be paid as specified in 710-10. The quantity of removable tape to be paid for solid, 10'-30' skip, 3'-9' dotted, 6'-10' dotted, and 2'-4' dotted lines will be the length, in gross miles, authorized and acceptably applied under this Section and certified as installed/used on the project. The quantity of removable tape to be paid for transverse lines will be the length, in linear feet, authorized and acceptably applied under this Section and certified as installed/used on the project. The quantity of removable tape to be paid for pavement messages, symbols, and arrows will be per each, authorized and acceptably applied under this Section and certified as installed/used on the project. The quantity of temporary RPMs to be paid will be the number of RPMs authorized and acceptably applied.

**102-11.21 Temporary Raised Rumble Strips:** The quantity to be paid for will be the number of calendar days, or portions thereof, that temporary raised rumble strips are certified as installed/used on the project within the Contract Time. The number of strips used must meet the requirements of Standard Plans, Index 102-603. No adjustment will be made to the per day measurement for the number of strips or sets used, or for the number of times the sets are relocated.

**102-11.22 Temporary Lane Separator:** The quantity to be paid for will be the field measure, in feet, of temporary lane separator certified as installed/used on the project, including drainage gaps, completed and accepted. The cost of any pavement repairs due to removal is included in the cost of Maintenance of Traffic, lump sum.

**102-11.23 Temporary Signals for Lane Closures on Two-Lane, Two-Way Roadways:** The quantity to be paid for will be the number of temporary signals per day installed/used at the locations shown in the Plans. Temporary signals installed/used at the Contractor's option as an alternative to flaggers will be included in Maintenance of Traffic, lump sum.

**102-11.24 Temporary Highway Lighting:** When temporary highway lighting is required by the Plans, the work of constructing, maintaining, and removing the temporary highway lighting, including all materials and any necessary design work, will be paid for under temporary highway lighting, lump sum.



**102-11.25 Pedestrian or Bicycle Special Detours:** When a pedestrian or bicycle special detour is shown in the Plans, the work of constructing, maintaining, and subsequently removing such detour facilities will be paid for under pedestrian or bicycle special detour, lump sum. However, traffic control devices, warning devices, barriers, signing, pavement markings, and restoration to final configuration will be paid for under their respective pay items.

**102-11.26 Type III Barricades:** The number of type III barricades certified as installed/used on the project will be paid for at the Contract unit price for type III barricades.

**102-11.27 Limited Access Temporary Openings:** Include all construction, maintenance, removal, and restoration costs of temporary openings in Maintenance of Traffic, lump sum. No separate payment will be made for commercial material, gates, or fence.

## **102-12 Submittals.**

**102-12.1 Submittal Instructions:** Prepare a certification of quantities, using the Department's current approved form, for certified MOT payment items for each project in the Contract. Submit the certification of quantities to the Engineer. The Department will not pay for any disputed items until the Engineer approves the certification of quantities.

**102-12.2 Contractor's Certification of Quantities:** Request payment by submitting a certification of quantities no later than Twelve O'clock noon Monday after the estimate cut-off date or as directed by the Engineer, based on the amount of work done or completed. Ensure the certification consists of the following:

1. Contract Number, FPID Number, Certification Number, Certification Date and the period that the certification represents.

2. The basis for arriving at the amount of the progress certification, less payments previously made and less an amount previously retained or withheld. The basis will include a detail breakdown provided on the certification of items of payment in accordance with 102-13. After the initial setup of the MOT items and counts, the interval for recording the counts will be made weekly on the certification sheet unless there is a change. This change will be documented on the day of occurrence. Some items may necessitate a daily interval of recording the counts.

## **102-13 Basis of Payment.**

**102-13.1 Maintenance of Traffic (General Work):** When an item of work is included in the proposal, price and payment will be full compensation for all work and costs specified under this Section except as may be specifically covered for payment under other items.

**102-13.2 Traffic Control Officers:** Price and payment will be full compensation for the services of the traffic control officers.

**102-13.3 Special Detours:** Price and payment will be full compensation for providing all detour facilities shown in the Plans and all costs incurred in carrying out all requirements of this Section for general MOT within the limits of the detour, as shown in the Plans.

**102-13.4 Commercial Materials for Driveway Maintenance:** Price and payment will be full compensation for all work and materials specified for this item, including specifically all required shaping and maintaining of driveways.

**102-13.5 Work Zone Signs:** Price and payment will be full compensation for all work and materials for furnishing signs, supports and necessary hardware, installation, relocating, maintaining and removing signs.

**102-13.6. Business Signs:** Price and payment will be full compensation for all materials and labor required for furnishing, installing, relocating, maintaining, and removing the signs as well as the cost of installing any logos provided by business owners.



**102-13.7 Project Information Signs:** Price and payment will be full compensation for all materials and labor for furnishing, installing, relocating, maintaining and removing signs.

**102-13.8 Channelizing Devices:** Prices and payment will be full compensation for furnishing, installing, relocating, maintaining and removing the channelizing devices.

**102-13.9 Temporary Barrier:** Price and payment will be full compensation for furnishing, installing, maintaining, and removing the barrier and asphalt pad. When called for, temporary barrier (relocate) will be full compensation for relocating the barrier.

**102-13.10 Temporary Glare Screen:** Price and payment will be full compensation for furnishing, installing, maintaining, and removing the glare screen certified as installed/used on the project. When called for, glare screen (relocate) will be full compensation for relocating the glare screen.

**102-13.11 Temporary Crash Cushion (Redirective or Gating):** Price and payment will be full compensation for furnishing, installing, maintaining, and removing crash cushions and concrete or asphalt pads.

**102-13.12 Temporary Guardrail:** Price and payment will be full compensation for furnishing all materials required for a complete installation, including end anchorage assemblies and any end connections to other structures and for installing, maintaining and removing guardrail.

**102-13.13 Arrow Board:** Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing arrow boards.

**102-13.14 Portable Changeable Message Sign:** Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing portable changeable message signs.

**102-13.15 Portable Regulatory Signs:** Price and payment will be full compensation for furnishing, installing, relocating, operating, maintaining and removing a completely functioning system as described in these Specifications.

Payment will include all labor, materials, incidentals, repairs and any actions necessary to operate and maintain the unit at all times that work is being performed or traffic is being affected by construction and/or MOT operations.

**102-13.16 Radar Speed Display Unit:** Price and payment will be made only for a completely functioning system as described in these Specifications. Payment will include all labor, hardware, accessories, signs, and incidental items necessary for a complete system. Payment will include any measurements needed to ensure that the unit conforms to all Specification requirements.

Payment will include all labor, materials, incidentals, repairs and any actions necessary to operate and maintain the unit at all times that work is being performed or traffic is being affected by construction and MOT operations. Price and payment will be full compensation for furnishing, installing, operating, relocating, maintaining and removing radar speed display unit.

**102-13.17 Temporary Signalization and Maintenance:** Price and payment will constitute full compensation for furnishing, installing, operating, maintaining and removing temporary traffic control signals including all equipment and components necessary to provide an operable traffic signal. Payment will be withheld for each day at each intersection where the temporary signalization is not operational within 12 hours after notification.

**102-13.18 Temporary Traffic Detection and Maintenance:** Price and payment will constitute full compensation for furnishing, installing, operating, maintaining and removing



temporary traffic detection including all equipment and components necessary to provide an acceptable signalized intersection. Take ownership of all equipment and components. Payment will be withheld for each day at each intersection where the temporary detection is not operational within 12 hours after notification.

**102-13.19 Work Zone Pavement Markings:** Price and payment will be full compensation for all work specified including, all cleaning and preparing of surfaces, furnishing of all materials, application, curing and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work. Final payment will be withheld until all deficiencies are corrected.

Removable tape or durable paint may be substituted for standard paint at no additional cost to the Department.

Payment for temporary RPMs used to supplement line markings will be paid for under temporary raised pavement markers. Install these RPMs as detailed in the Standard Plans.

**102-13.20 Temporary Raised Rumble Strips:** Price and payment will be full compensation for all work and materials described in this Section, including all cleaning and preparing of surfaces, disposal of all debris, furnishing of all materials, application, curing, removal, reinstalling and protection of all items, protection of traffic, furnishing of all tools, machines and equipment, and all incidentals necessary to complete the work.

**102-13.21 Temporary Lane Separator:** Price and payment will be full compensation for all work specified in this Section.

**102-13.22 Temporary Signals for Lane Closures on Two-Lane, Two-Way Roadways:** Price and payment will be full compensation for furnishing, installing, operating, maintaining and removing temporary traffic signal including all equipment and components necessary to provide an operable portable traffic signal.

**102-13.23 Temporary Highway Lighting:** Price and payment will be full compensation for providing all temporary highway lighting shown in the Plans.

**102-13.24 Pedestrian or Bicycle Special Detours:** Price and payment will be full compensation for providing all pedestrian or bicycle special detours shown in the Plans.

**102-13.25 Type III Barricades:** Prices and payment will be full compensation for furnishing, installing, relocating, maintaining and removing the type III barricades.

**102-13.26 Payment Items:** Payment will be made under:

Item No. 102- 1-	Maintenance of Traffic - lump sum.
Item No. 102- 2-	Special Detour - lump sum.
Item No. 102- 3-	Commercial Material for Driveway Maintenance - per cubic yard.
Item No. 102- 4-	Pedestrian or Bicycle Special Detour - lump sum.
Item No. 102- 14-	Traffic Control Officer - per hour.
Item No. 102- 30-	Temporary Highway Lighting - lump sum.
Item No. 102- 60-	Work Zone Sign - per each per day.
Item No. 102- 61-	Business Sign - each.
Item No. 102- 62-	Barrier Mounted Work Zone Sign – per each per day
Item No. 102- 71-	Temporary Barrier - per foot.
Item No. 102- 75-	Temporary Lane Separator - per foot
Item No. 102- 73-	Temporary Guardrail - per foot.
Item No. 102- 74-	Channelizing Devices
Item No. 102- 76-	Arrow Board - per each per day.



Item No. 102- 78-	Temporary Raised Pavement Markers - each.
Item No. 102- 81-	Temporary Crash Cushion, Gating - per location.
Item No. 102- 89-	Temporary Crash Cushion, Redirective - per location.
Item No. 102- 94-	Glare Screen - per foot.
Item No. 102- 99-	Portable Changeable Message Sign - per each per day.
Item No. 102-104-	Temporary Signalization and Maintenance - per intersection per day.
Item No. 102-107-	Temporary Traffic Detection and Maintenance - per intersection per day.
Item No. 102-115-	Type III Barricade - per each per day.
Item No. 102-120-	Temporary Signal for Lane Closures on Two-Lane, Two-Way Roadways – per each per day.
Item No. 102-150-	Portable Regulatory Sign - per each per day.
Item No. 102-150-	Radar Speed Display Unit - per each per day.
Item No. 102-909-	Temporary Raised Rumble Strips - per day.
Item No. 102-913-	Removable Tape.
Item No. 710-	Painted Pavement Markings.
Item No. 711-	Thermoplastic Pavement Markings.



# TRAFFIC CONTROL MATERIALS

## SECTION 990 TEMPORARY TRAFFIC CONTROL DEVICE MATERIALS

### 990-1 General.

This Section specifies the material requirements for temporary traffic control devices.

### 990-2 Retroreflective Sheeting for Temporary Traffic Control Devices.

**990-2.1 Approved Product List (APL):** Sheeting for use on Temporary Traffic Control Devices shall be one of the products listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

**990-2.1.1 Bands for Temporary Tubular Markers, Vertical Panels, Barricades, and other Devices:** Bands for temporary tubular markers, vertical panels, barricades, and other devices shall meet the requirements of ASTM D4956 for Type III or higher retroreflective sheeting materials identified in Section 994.

**990-2.1.2 Collars for Traffic Cones:** Collars for traffic cones shall meet the requirements of ASTM D4956 Type III or higher retroreflective prismatic sheeting materials identified in Section 994 including supplementary requirements for reboundable sheeting. The outdoor weathering shall be for 6 months for all sheeting types.

**990-2.1.3 Drums:** Drums shall meet the requirements of ASTM D4956 for Type III or higher retroreflective sheeting materials identified in Section 994 including supplementary requirements for reboundable sheeting.

**990-2.1.4 Sign Panels:** Meet the requirements of 990-8.

### 990-3 Portable Devices (Arrow Boards, Changeable Message Signs, Regulatory Signs, Radar Speed Display Units and Truck Mounted Changeable Message Signs), Automated Flagger Assistance Devices).

**990-3.1 General:** All portable devices shall meet the physical display and operational requirements of the Manual on Uniform Traffic Control Devices (MUTCD) and be listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6 and include the following:

1. Certification showing that the product meets the requirements of this Section.

2. Drawings of the device along with technical information necessary for proper application, field assembly, and installation.

Portable devices shall meet the following requirements:

3. Ensure that all assembly hardware less than 5/8 inch in diameter, including nuts, bolts, external screws and locking washers are Type 304 or 316 passivated stainless steel. Stainless steel bolts, screws and studs shall meet ASTM F593. Nuts shall meet ASTM F594. All assembly hardware greater than or equal to 5/8 inch in diameter shall be galvanized. Bolts, studs, and threaded rod shall meet ASTM A307. Structural bolts shall meet ASTM F3125, Grade A325.

4. The controllers and associated on-board circuitry shall meet the requirements of the Federal Communications Commission (FCC) Title 47, Subpart B, Section 15



regulations concerning the emission of electronic noise by Class A digital devices. All electronic assemblies shall meet the requirements of NEMA TS-4-2016 Section 2.

5. The controller and associated on-board circuitry shall not be affected by mobile radio, or any other radio transmissions.

6. An operator's manual shall be furnished with each unit.

7. All portable devices shall be permanently marked with, manufacturer's name or trademark, model/part number, and date of manufacture or serial number.

8. Portable devices and trailers shall be delineated on a permanent basis by affixing retroreflective sheeting in a continuous line on the face of the trailer as seen by oncoming road users.

#### **990-3.1.1 Electrical Systems:**

**990-3.1.1.1 Solar Powered Unit:** The solar powered unit shall meet the following:

1. The unit shall provide automatic recharging of power supply batteries to normal operating levels with meters showing charge.

2. Solar array recovery time for arrow boards and regulatory signs shall be accomplished in a maximum of three hours.

3. Arrow boards and changeable message signs shall be designed to provide 180 days of continuous operation with minimum onsite maintenance.

#### **990-3.1.1.2 Battery Life Test:** Meet the following:

1. The photovoltaic unit shall be designed to provide 21 days of continuous operation without sunlight with a minimum of onsite maintenance for arrow boards and changeable message signs, or 10 days of continuous operation without sunlight with a minimum of onsite maintenance for regulatory signs and radar speed display units, or 2 days of continuous operation without sunlight with a minimum of onsite maintenance for Automated Flagging Assistance Devices signs.

2. The battery shall be equipped with a battery controller to prevent overcharging and over-discharging. An external battery level indicator shall be provided.

3. The battery, controller, and power panel shall be designed to be protected from the elements and vandalism.

4. Automatic recharging of power supply batteries shall be provided with charge indicator meter.

5. An AC/DC battery charger unit shall be provided.

#### **990-3.1.2 Display Panel and Housing:**

1. The display housing assembly shall be weather-tight.

2. Except for Automated Flagging Assistance Devices, the display assembly shall be equipped with an automatic dimming operational mode capable of a minimum of 50% dimming and a separate manual dimmer switch

3. The display panel background and frame for the display assembly shall be painted flat black and shall meet Federal Specification TT-E-489.

4. The display panel for arrow boards and changeable message signs, when raised in the upright position, shall have a minimum height of 7 feet from the bottom of the panel to the ground, in accordance with the MUTCD. The display panel for radar speed display units, when raised in the upright position, will have a minimum height of 5 feet from the bottom of the panel to the ground.



5. The regulatory speed sign panel for regulatory signs and radar speed display units, when raised in the upright position, shall have a minimum height of 7 feet from the bottom of the regulatory sign panel to the ground.

6. The unit shall have an accessible mechanism to easily raise and lower the display assembly. A locking device shall also be provided to ensure the display panel will remain in the raised or lowered position.

7. The display panel for changeable message signs shall have a safety system to protect against the panel falling from the trailer to the roadway should the panel separate from the lift system.

**990-3.1.3 Controller:** The Controller shall meet the following:

1. Controller and control panel shall be housed in a weather, dust, and vandal resistant lockable cabinet.

2. Controller and associated on-board circuitry shall meet the requirements of the FCC Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise by Class A digital devices.

3. For changeable message signs and arrow boards ensure that the sign control software provides an on-site graphical representation that visibly depicts the message displayed on the sign face.

4. For changeable message signs, if remote communication is included, ensure that the sign controller is addressable through the Ethernet communications network using software that complies with the National Transportation Communications for ITS Protocol (NTCIP) 1101 base standard, including all amendments as published at the time of contract letting, the NTCIP Simple Transportation Management Framework, and conforms to Compliance Level 1. Ensure that the software implements all mandatory objects in the supplemental requirement SR-700-4.1.1-01, FDOT Dynamic Message Sign NTCIP Requirements, as published on the FDOT State Traffic Engineering and Operations Office web site at the time of contract letting. Ensure that the sign complies with the NTCIP 1102v01.15, 2101 v01.19, 2103v02.07, 2201v01.15, 2202 v01.05, and 2301v02.19 standards. Ensure that the sign complies with NTCIP 1103v02.17, section 3. Ensure that additional objects implemented by the software do not interfere with the standard operation of mandatory objects.

**990-3.1.4 Support Chassis:** The support chassis shall meet the following:

1. The support chassis shall be self-contained and self-supporting without the use of additional equipment or tools.

2. Both trailer and truck-mounted units are allowed for arrow boards and changeable message signs. Trailer mounted units are required for regulatory signs and radar speed display units. Automated Flagging Assistance Devices may be trailer or non-trailer units.

a. Trailer mounted unit:

1. The sign, power supply unit and all support systems shall be mounted on a wheeled trailer.

2. The trailer shall be equipped with Class A lights, using a plug adaptor.

3. The trailer shall be equipped with adjustable outrigger leveling pads, one on each of the four frame corners.

4. The trailer shall be designed to be set up at the site with its own chassis and outriggers, without being hitched to a vehicle.



5. The trailer shall be equipped with fenders over the tires and shall be made from heavy-duty material sufficient to allow a person to stand and operate or perform maintenance on the unit.

6. The trailer shall meet all equipment specifications set forth in Chapter 316 of the Florida Statutes, and by such rule, regulation or code that may be adopted by the Department of Highway Safety and Motor Vehicles.

### **990-3.2 Portable Arrow Board:**

#### **990-3.2.1 Arrow Board Matrix:**

1. The minimum legibility distance for various traffic conditions are based on the decision-sight distance concept. The minimum legibility distance is the distance at which a driver can comprehend the arrow board message on a sunny day or a clear night. The arrow board size that is needed to meet the legibility distance is listed as follows:

Table 990-1			
Type	Minimum Size	Minimum Number of Elements	Minimum Legibility Distance
B	30 by 60 inches	13	3/4 mile
C	48 by 96 inches	15	1 mile

Type B arrow boards may be used on low to intermediate speed (0 mph to 50 mph) facilities or for maintenance or moving operations on any speed facility. Type C arrow boards shall be used for all other operations on high-speed (50 mph and greater) facilities and may be substituted for Type B arrow boards on any speed facility.

2. Devices shall meet all arrow board displays identified in the MUTCD.

3. The element lens should be 5-3/4 inches in diameter. Smaller element lens diameters are permissible only if they provide an equivalent or greater brightness indication and meet the legibility criteria in 990-3.2.1(a).

4. The color of the light emitted shall be in accordance with the MUTCD.

5. There shall be a 360 degree hood for close-up glare reduction.

6. For solar powered arrow boards the bulbs shall provide a 350 candle power intensity for day use and an automatic reduction or dimming capacity for night use. The dimmed night operation shall provide adequate indication without excessive glare.

7. The flashing rate of the element shall not be less than 25 flashes or more than 40 flashes per minute as required in the MUTCD.

8. The minimum element "on time" shall be 50% for the flashing arrow and 25% for the sequential chevron.

### **990-3.3 Portable Changeable Message Sign:**

#### **990-3.3.1 Message Matrix:**

1. Message matrix panel shall be a maximum height of 7 feet by a maximum width of 146 inches.

2. The matrix must be capable of displaying three lines of 8 characters using an 18 inch or 12 inch font. PCMS with a minimum font size of 18 inches shall be used on any speed facility. PCMS with a minimum font size of 12 inches may be used on facilities with speed limits of 45 mph or less.

3. The matrix must display characters that meet or exceed the numeral and letter sizes prescribed in the MUTCD and SHS (Standard Highway Signs) companion document.



Fonts and graphics must mimic the characteristics of fonts and graphics defined in NEMA TS4, the MUTCD, and SHS.

4. Similar components shall be interchangeable.

#### **990-3.3.2 Operation and Performance:**

1. The message shall be displayed in upper case except when lower case is project specific and is allowed by the MUTCD.

2. The message matrix panel shall be visible from one-half mile.

3. The 18 inch letter height message shall be legible from 650 feet for nighttime conditions and 800 feet for normal daylight conditions.

4. The 12 inch letter height message shall be legible from 650 feet for nighttime conditions and 650 feet for normal daylight conditions.

5. Under variable light level conditions the sign shall automatically adjust its light source to maintain legibility.

6. The message panel shall have adjustable display rates, so that the entire message can be read at least twice at the posted speed.

7. The control panel shall have the capability to store a minimum 50 pre-programmed messages.

8. The controller in the control panel shall be able to remember messages during non-powered conditions.

9. The controller shall allow the operator to generate additional messages on site via the keyboard.

10. All messages shall be flashed or sequenced. In the sequence mode, the controller shall have the capability to sequence three line messages during one cycle.

#### **990-3.4 Portable Regulatory Signs:**

**990-3.4.1 Sign Panel Assembly:** The sign panel assembly shall consist of a 24 inches by 30 inches “SPEED LIMIT XX” sign panel and a “WHEN FLASHING” sign panel, intended to notify oncoming traffic the speed limit where workers are present. The sign panel assembly shall meet the following minimum physical requirements:

1. The sign panel shall fold down and be pinned in place for towing. Maximum travel height shall be 80 inches.

2. Construct the sign panel and light housing to allow the unit to be operated in the displayed position at speeds of 30 mph. Design the sign panel assembly to withstand transport speeds of 65 mph.

3. Construct the sign panel such that, when in the raised position, the sign panel will have a height of 7 feet from the bottom of the lowest panel to the ground, in accordance with the MUTCD.

4. Provide the unit with a mechanism to raise and lower the sign panel. Provide the unit with a device to lock the sign panel in the raised and lowered position.

**990-3.4.2 Flashing Lights:** Provide a pair of hooded PAR 46 LED advance warning flashing lamps on each side of the top of the sign panel. These lamps shall be visible day or night at a distance of one mile with a flash rate of approximately 55 flashes per minute.

The lamp lens should be at least 5-3/4 inches in diameter. Smaller diameter lens are permissible if they provide an equivalent or greater brightness indication and meet the legibility criteria above.

The color of the light emitted shall be in accordance with the MUTCD. For solar powered units, the bulbs shall provide a 350 candlepower intensity for day use and an



automatic reduction or dimming capacity for night use. The dimmed night operation shall provide adequate indication without excessive glare.

**990-3.5 Portable Radar Speed Display Unit:**

**990-3.5.1 Display Unit Panel and Housing:** Meet the requirements of 990-3.1.2 and the following physical requirements as a minimum:

1. Provide capability to mount a 24 inches by 30 inches regulatory sign with interchangeable numbers showing the posted speed limit above the message display.
2. Provide legend "YOUR SPEED" either above or below the message display.

**990-3.5.2 Message Display:** The message display shall meet the following physical requirements as a minimum:

1. Provide a bright LED, two-digit speed display on a flat black background with bright yellow LEDs.
2. Each digit shall contain either a seven-segment layout or matrix-style design. Each digit shall measure a minimum 18 inches in height.
3. Speed display shall be visible from a distance of at least one-half mile and legible from a distance of at least 650 feet under both day and night conditions.
4. Display shall adjust for day and night operation automatically with a photocell.

**990-3.5.3 Radar:** The radar unit shall not be affected by normal radio transmissions and meet the following physical requirements as a minimum:

1. Approach-Only sensor.
2. Equipped with a low power K-Band transmitter.
3. Part 90 FCC acceptance, 3 amps, 10.8 V<sub>DC</sub> to 16.6 V<sub>DC</sub>. Fuse and reverse polarity protected.
4. Range of 1,000 feet for mid-size vehicle, capable of accurately sensing speeds of 10 mph to 99 mph with over speed function that operates when a vehicle approaches over the posted speed limit.

**990-3.6 Truck Mounted Changeable Message Sign:**

**990-3.6.1 General:** Truck mounted changeable message signs shall meet the physical display and operational requirements of the MUTCD and be listed on the APL.

1. Sign shall be secured on the vehicle for normal operation.
2. A fault light shall be located on rear of the sign and operate whenever the sign is displaying a message. The light shall flash at the same rate as the message being displayed.
3. An operator's manual shall be furnished with each sign.
4. The manufacturer name, model or part number, and date of manufacture or serial number shall be permanently affixed to the sign housing.

**990-3.6.2 Display Panel and Housing:**

1. The housing maximum size shall not exceed a width of 96 inches.
2. The housing shall be designed to withstand exposure to the elements and include a locking device to secure the housing from unauthorized entry.
3. Provisions (by convection or fan) shall be made for heat dissipation within the unit.
4. The message matrix panel background and frame for the dynamic message assembly shall be painted flat black, Federal Specification TT-E-489.



5. The face of the display shall be easily opened from the front. Faces that open up shall be locked to stay open far enough to allow for servicing of all message panel components.

6. The face of the sign shall be covered by an impact resistant polycarbonate face that aids against glare and includes an ultraviolet inhibitor to protect from fading and yellowing.

7. The display panel support structure, when raised in the upright position, shall be designed to allow for a minimum height of 7 feet from the bottom of the panel to the ground.

8. The unit shall have a manual and automatic control mechanism to raise and lower the display assembly. A locking device shall also be provided to ensure the display panel will remain in the raised or lowered position.

#### **990-3.6.3 Message Matrix:**

1. The matrix shall utilize light emitting diodes (LED).

2. LEDs used shall be amber (590 nm dominate wavelength) and shall meet the visibility requirements of this specification. LEDs shall have a viewing angle no less than 30 degrees. LED intensity shall not fall below 80 percent within three years.

3. All display modules shall be identical and interchangeable.

4. The matrix shall be capable of displaying a minimum of two lines of eight characters each, using a 10 inch font that meets the height to width ratio and character spacing requirements in the MUTCD, Section 2L.04 (paragraphs 05, 06, and 08) and Section 6F.60, paragraph 15.

5. The matrix shall provide variable letter, graphic and symbol sizes from 10 to 36 inches. The matrix must display characters that meet or exceed the numeral and letter sizes prescribed in the MUTCD and SHS companion document. Fonts and graphics must mimic the characteristics of fonts and graphics defined in NEMA TS4, the MUTCD, and SHS.

#### **990-3.6.4 Electrical System:**

1. The power supply shall be a 12 V<sub>DC</sub> system designed to operate the sign with a dedicated battery that is charged by the vehicle electrical system, but isolated so it does not drain the vehicle battery.

2. All internal sign components shall be treated with a protective, weather-resistant polyurethane or silicone conformal coating to protect against the adverse effects of humidity and moisture.

#### **990-3.6.5 Sign Controller:**

1. The sign controller shall be housed inside the sign and shall be equipped with a security lockout feature to prevent unauthorized use.

2. An external weather-resistant, hand-held control keypad shall be used to display the message on the sign.

3. The sign controller shall have the capability to provide a predetermined or blank default message upon loss of controller function.

#### **990-3.6.6 Operation and Performance:**

1. The message shall be displayed in upper case.

2. The message matrix panel shall be visible from one-half mile. With a 10 inch character displayed, the sign shall be legible from a distance of 400 feet in both day and night conditions. Under variable light level conditions, the sign shall automatically adjust its light source to meet the 400 foot visibility requirement.



3. The sign shall have the capability to store a minimum of 40 common messages and graphics of which a minimum of 30 shall be user-programmable messages.

4. All messages shall be capable of being flashed or sequenced. In the sequence mode, the message shall consist of no more than two phases, with each phase consisting of no more than three lines of text. Both message dwell time and message flash rate shall be individually programmable.

**990-3.7 Automated Flagger Assistance Devices (AFAD).**

**990-3.7.1 General:** AFAD's shall meet the physical display and operational requirements in the MUTCD and be listed on the APL. Manufacturers seeking evaluation of their product for the APL must include detailed vendor drawings, signed and sealed by a Professional Engineer registered in the State of Florida, showing typical application of the device in accordance with Standard Plans, Index 102-603. All electronic assemblies shall meet the requirements of NEMA TS-5-2017 Section 4.

**990-3.7.2 Stop/Slow Automated Flagger Assistance Devices:** Provide a remotely operated Stop/Slow AFAD including a Stop/Slow sign that alternately displays the stop face and the slow face of a Stop/Slow paddle.

When a gate arm is used, ensure that the gate arm descends to a down position across the approach lane of traffic when the stop face is displayed and then ascends to an upright position when the slow face is displayed.

Ensure the gate arm is fully retroreflectorized on both sides, with vertical alternating red and white stripes at 16 inch intervals measured horizontally in accordance with the MUTCD. When the arm is in the down position blocking the approach lane:

1. The minimum vertical aspect of the arm and sheeting shall be 2 inches; and,
2. The end of the arm shall reach at least to the center of the lane being controlled.

**990-3.7.3 Red/Yellow Lens Automated Flagger Assistance Devices:** Provide a remotely operated Red/Yellow Lens AFAD that alternately displays a steadily illuminated circular red lens and a flashing circular yellow lens to control traffic.

Ensure that the Red/Yellow Lens AFAD includes a gate arm that descends to a down position across the approach lane of traffic when the steady circular red lens is illuminated and then ascends to an upright position when the flashing circular yellow lens is illuminated.

Ensure that the gate arm is fully retroreflectorized on both sides, with vertical alternating red and white stripes at 16 inch intervals measured horizontally in accordance with the MUTCD. When the arm is in the down position blocking the approach lane:

1. The minimum vertical aspect of the arm and sheeting shall be 2 inches; and,
2. The end of the arm shall reach at least to the center of the lane being controlled.

Do not provide a change interval between the display of the steady circular red indication and the display of the flashing circular yellow indication. Provide a steady illuminated circular yellow indication, with at least a 5 second duration, between the transition from flashing circular yellow indication and the display of the steady circular red indication. The Engineer may approve a different duration, provided it falls within the range recommended by the MUTCD.



#### **990-4 Removable Tape.**

**990-4.1 General:** Removable tape shall be one of the products listed on the Department's Approved Product List (APL). Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6. Evaluation of Removable Tape will utilize data from an independent laboratory or data from the National Transportation Product Evaluation Program (NTPEP).

**990-4.2 Composition:** Removable tape shall be one of the products listed on the APL. The pavement stripes and markings shall consist of high quality plastic materials, pigments, and glass spheres or other retroreflective materials uniformly distributed throughout their cross-sectional area, with a reflective layer of spheres or other retroreflective material embedded in the top surface. No foil type materials shall be allowed.

**990-4.3 Skid Resistance:** The surface of the stripes and markings shall provide a minimum skid resistance value of 35 BPN (British Pendulum Number) when tested according to ASTM E303. Bike lane symbols and pedestrian crosswalks shall provide a minimum skid resistance value of 55 BPN.

**990-4.4 Thickness:** The APL will list the specified thickness of each approved product.

**990-4.5 Durability and Wear Resistance:** When properly applied, the material shall provide neat, durable stripes and markings. The materials shall provide a cushioned resilient substrate that reduces sphere crushing and loss. The film shall be weather resistant and, through normal wear, shall show no significant tearing, rollback or other signs of poor adhesion. Durability is the measured percent of pavement marking material completely removed from the pavement. The pavement marking material line loss must not exceed 5.0% of surface area.

**990-4.6 Conformability and Resealing:** The stripes and markings shall be capable of conforming to pavement contours, breaks and faults under traffic at pavement temperatures recommended by the manufacturer. The film shall be capable of use for patching worn areas of the same types of film in accordance with the manufacturer's recommendations.

**990-4.7 Tensile Strength:** The stripes and markings shall have a minimum tensile strength of 40 psi when tested according to ASTM D638. A rectangular test specimen 6 inches by 1 inch by 0.05 inches minimum thickness shall be tested at a temperature range of 40°F to 80°F using a jaw speed of 0.25 inches per minute.

**990-4.8 Elongation:** The stripes and markings shall have a minimum elongation of 25% when tested in accordance with ASTM D638.

**990-4.9 Plastic Pull test:** The stripes and markings shall support a dead weight of 4 pounds for not less than five minutes at a temperature range of 70°F to 80°F. Rectangular test specimen size shall be 6 inches by 1 inch by 0.05 inches minimum thickness.

**990-4.10 Adhesive:** Precoat removable tape with a pressure sensitive adhesive capable of being affixed to asphalt concrete and portland cement concrete pavement surfaces without the use of heat, solvents, and other additional adhesives or activators. Ensure that the adhesive does not require a protective liner when the removable tape is in rolled form for shipment. Ensure that the adhesive is capable of temporarily bonding to the roadway pavement at temperatures of 50°F and the above without pick-up distortion by vehicular traffic.

**990-4.11 Color:** Meet the requirements of 971-1.6.

**990-4.12 Removability:** Ensure that the manufacturer shows documented reports that the removable tape is capable of being removed intact or in substantially large strips after being in place for a minimum of 90 days and under an average daily traffic count per lane of at least 5,000 vehicles per day.



## **990-5 Temporary Raised Pavement Markers (RPMs).**

Temporary RPMs shall meet the requirements of Section 970.

## **990-6 Temporary Glare Screen.**

**990-6.1 Design and Installation:** Manufactured glare screen systems may be modular or individual units listed on the APL and shall meet the following requirements:

1. Glare screen units shall be manufactured in lengths such that when installed the joint between any one modular unit will not span barrier sections. Color shall be green, similar to FED-STD-595-34227.
2. Blades, rails and/or posts shall be manufactured from polyethylene, fiberglass, plastic, polyester or polystyrene, and be ultraviolet stabilized and inert to all normal atmospheric conditions and temperature ranges found in Florida.
3. For paddle type designs, the blade width shall not be more than 9 inches. Blades or screen for individual or modular systems shall be 24 inches to 30 inches high and capable of being locked down at an angle and spacing to provide a cut-off angle not less than 20 degrees.
4. For glare screen mounted on temporary concrete barrier, a strip (minimum 3 inch width and minimum 72 square inches) of reflective sheeting as specified in 994-2 must be placed on each side of a panel, centered in each barrier section (at a spacing not to exceed 15 feet) and positioned in such a manner as to permit total right angle observation by parallel traffic.
5. Prior to approval an impact test shall be performed by the manufacturer to verify the safety performance of the proposed system. The minimum impact strength of the posts, blades, rail and the barrier attachment design shall be sufficient to prevent the unit from separating from the barrier when impacted by a 3 inches outside diameter steel pipe traveling at 30 mph and impacting mid-height on the glare screen assembly.
6. All hardware shall be galvanized in accordance with ASTM A123 or stainless steel in accordance with AISI 302/305.

Alternative designs for temporary glare screen may be submitted as a Cost Savings Initiative Proposal in accordance with 4-3.9.

## **990-7 Temporary Traffic Control Signals.**

**990-7.1 General:** Temporary traffic control signals shall meet the physical display and operational requirements of conventional traffic signal described in the MUTCD for portable traffic signals and be listed on the APL. The standard includes but is not limited to the following:

1. Use signal heads having three 12 inch vehicular signal indications (Red, Yellow and Green). Ensure there are two signal heads for each direction of traffic.
2. The traffic signal heads on this device will be approved by the Department.
3. Department approved lighting sources will be installed in each section in accordance with the manufacturer's permanent directional markings, that is, an "Up Arrow", the word "UP" or "TOP," for correct indexing and orientation within a signal housing.
4. The masts supporting the traffic signal heads will be manufactured with the lowest point of the vehicular signal head as follows:
  - a. Eight feet above finished grade at the point of their installation for "pedestal" type application or
  - b. Seventeen to 19 feet above pavement grade at the center of roadway for "overhead" type application.



5. The yellow clearance interval will be programmed 3 seconds or more. Under no condition can the yellow clearance interval be manually controlled. It must be timed internally by the controller as per Department specifications.

6. The green interval must display a minimum of 5 seconds before being advanced to the yellow clearance interval.

7. The controller will allow for a variable all red clearance interval from 0 seconds to 999 seconds.

8. Portable traffic control signals will be either manually controlled or traffic actuated. Indicator lights for monitoring the signal operation of each approach will be supplied and visible from within the work zone area.

9. When the portable traffic control signals are radio actuated the following will apply:

a. The transmitter will be FCC Type accepted and not exceed 1 watt output per FCC, Part 90.17. The manufacturer must comply with all “Specific limitations” noted in FCC Part 90.17.

b. The Controller will force the traffic signal to display red toward the traffic approach in case of radio failure or interference.

10. The trailer and supports will be painted construction/maintenance orange enamel in accordance with the MUTCD color.

11. Ensure the certification number is engraved or labeled permanently on equipment.

12. Ensure the device has an external, visible, water resistant label with the following information: “Certification of this device by the Florida Department of Transportation allows for its use in Construction Zones Only”.

13. All electronic assemblies shall meet the requirements of NEMA TS-5-2017 Section 4.

## **990-8 Work Zone Signs.**

**990-8.1 Post Mounted Sign Supports:** Provide steel u-channel posts that conform to ASTM A499 Grade 60. For each u-channel post, punch or drill 3/8 inch diameter holes on 1 inch centers through the center of the post, starting approximately 1 inch from the top and extending the full length of the post. Ensure that the weight per foot of a particular manufacturer’s post size does not vary more than plus or minus 3.5% of its specified weight per foot. Taper the bottom end of the post for easier installation. Machine straighten the u-channel to a tolerance of 0.4% of the length. Use only non-corrosive metal, aluminum, or galvanized steel attachment hardware.

**990-8.2 Portable Sign Stands:** Provide portable sign stands that meet the requirements of MASH TL-3.

**990-8.2.1 Product Application:** Manufacturers seeking inclusion on the APL must submit the following:

1. Product Drawing, which at a minimum includes:

a. Model Number

b. Sign panel size

c. Allowable sign panel substrate material

d. Height to bottom of sign panel

e. Any field assembly details and technical information necessary for proper application and installation

2. Crash testing reports.



3. All relevant FHWA Eligibility Letters.

**990-8.3 Sign Panels:** Use signs that meet the material and process requirements of ASTM D4956 and Section 994. Use the Type VI sheeting for vinyl signs. Mesh signs must meet the color, daytime luminance, and non-reflective requirements of Section 994, Type VI. Use Type IV sheeting for fluorescent orange work zone signs. Use Type IV and Type XI sheeting for all other work zone signs.

**990-9 Temporary Raised Rumble Strips.**

**990-9.1 General:** Temporary raised rumble strips shall meet the physical display and operational requirements in the MUTCD for temporary raised rumble strips and be listed on the APL. The temporary raised rumble strip may be either a removable striping type or a portable type described below:

**990-9.1.1 Removable Striping Type:**

Table 990-2	
Characteristic	Requirement
Composition:	Removable Polymer Striping Tape with pre-applied adhesive
Color:	White, Black or Orange
Cross-section:	0.25 in. to 0.50 in. (height) x 4 in. (wide)

**990-9.1.2 Portable Type:**

Table 990-3	
Characteristic	Requirement
Composition:	Molded Engineered Polymer, Steel or Aluminum
Weight	Internally ballasted to a minimum of 100 lbs. to maintain position in use without the use of adhesives or mechanical fasteners
Color:	White, Black or Orange
Shape	Beveled on the leading edge
Cross-section:	0.625 in. to 0.875 in. (height) x 12 in. to 14 in. (wide)

**990-10 Temporary Barrier.**

Producers of temporary concrete barrier seeking inclusion on the Department's Production Facility Listing shall meet the requirements of Section 105.

Manufacturers seeking evaluation of proprietary temporary barrier systems for inclusion on the APL must meet MASH TL-3 criteria and submit the following:

1. Product drawings, signed and sealed by a Professional Engineer registered in the State of Florida, which at a minimum must include:
  - a. Freestanding and anchored details, as appropriate
  - b. Section views and tables showing required setback distance (deflection space) for all installation configuration options
  - c. Alignment and Length of Need requirements
  - d. Transition and overlap details
  - e. End treatment details
2. Installation manuals
3. Crash testing reports



4. All relevant FHWA Eligibility Letters

**990-11 Temporary Crash Cushion (Redirective or Gating).**

Manufacturers seeking evaluation of crash cushions for inclusion on the APL must meet MASH TL-2 or TL-3 criteria and submit the following:

1. Product drawings, signed and sealed by a Professional Engineer registered in the State of Florida, which at a minimum must include:

- a. Anchorage details for both the crash cushion and abutting temporary barrier
- b. Tables showing the relevant system information and lengths for all options
- c. Length of need location
- d. Transition details
- e. List of all components

2. Installation manuals

3. Crash testing reports

4. All relevant FHWA Eligibility Letters

**990-12 Truck Mounted Attenuators and Trailer Mounted Attenuators:**

Equip truck mounted and trailer mounted attenuator units with lights and reflectors in compliance with applicable Florida motor vehicle laws, including turn signals, dual tail lights, and brake lights. Ensure that lights are visible in both the raised and lowered positions if the unit is capable of being raised.

Install either alternating black with yellow or white with orange sheeting on the rear of trailer mounted attenuators and truck mounted attenuators in both the operating and raised position. Use Type III (work zone) or Type IV sheeting consisting of 4 or 6 inch wide stripes installed to form chevrons that point upward. All sheeting except black must be retroreflective.

Manufacturers seeking evaluation of truck mounted attenuators or trailer mounted attenuators for inclusion on the APL must meet the MASH TL-2 or TL-3 criteria and submit the following:

- 1. Minimum and maximum support vehicle weights
- 2. User manuals
- 3. Crash testing reports
- 4. All relevant FHWA Eligibility Letters

**990-13 Channelizing Devices.**

**990-13.1 General:** Provide channelizing devices in accordance with the MUTCD and the dimensions shown in the Standard Plans.

**990-13.2 Product Application:** Manufacturers seeking inclusion of channelizing devices on the APL shall submit the following:

1. For Cones, Drums, and Temporary Tubular Markers:

- a. Photographs
- b. Drawings of sufficient detail to distinguish between similar devices
- c. Manufacturer self-certification of MASH compliant

2. For Barricades and Vertical Panels:

- a. Installations Instructions
- b. Photographs



- c. Drawings (may be included in Installation Instructions) of sufficient detail to distinguish between similar devices
- d. Any field assembly details and technical information necessary for proper application and installation
- e. Crash testing reports demonstrating the device meets MASH TL-3
- f. All relevant FHWA Eligibility Letters

#### **990-14 Pedestrian Longitudinal Channelizing Devices.**

**990-14.1 General:** Provide pedestrian Longitudinal Channelizing Devices (LCDs) in accordance with the MUTCD and the Standard Plans.

**990-14.2 Product Application:** Manufacturers seeking inclusion of pedestrian LCDs on the APL must submit the following:

- a. Installations Instructions
- b. Photographs
- c. Drawings (may be included in Installations Instructions) of sufficient detail to distinguish between similar devices
- d. Any field assembly details and technical information necessary for proper application and installation
- e. Crash testing reports demonstrating the device meets MASH TL-3
- f. All relevant FHWA Eligibility Letters

#### **990-15 Flagger Equipment.**

**990-15.1 STOP/SLOW Paddles:** Provide STOP/SLOW paddles with rigid handles in accordance with the MUTCD and the Standard Plans.

**990-15.1.1 Product Application:** Manufacturers seeking inclusion of STOP/SLOW Paddles on the APL must submit the following:

- a. Photographs or drawings of sufficient detail to distinguish between similar devices
- b. Manufacturer self-certification of MASH compliance

#### **990-16 Portable Temporary Lane Separator.**

**990-16.1 General:** Provide portable temporary lane separator in accordance with the Standard Plans and must come in connectable sections of 36 inches to 48 inches in length.

**990-16.2 Product Application:** Manufacturers seeking inclusion of portable temporary lane separator on the APL shall submit the following:

- a. Installations Instructions
- b. Photographs
- c. Drawings (may be included in Installation Instructions) of sufficient detail to distinguish between similar devices
- d. Any field assembly details and technical information necessary for proper application and installation
- e. Crash testing reports demonstrating the device meets MASH TL-3
- f. All relevant FHWA Eligibility Letters



## Supplemental Resources



# FDOT Standard Plans

(<http://www.fdot.gov/design/StandardPlans/>)



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### Standard Plans for Road and Bridge Construction



#### Standard Plans

Standard Plans for Road and Bridge Construction  
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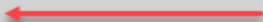
### Standard Plans for Road and Bridge Construction



Year	Standard Plans	Support	Interim Revisions	Implementation Bulletin	Effective Date
FY 2021-22	Road Construction Bridge Construction	CADD/CEL	Interim	RDB20-10	07/01/21
FY 2020-21	Road Construction Bridge Construction	CADD/CEL	Interim	RDB19-08	07/01/20
FY 2019-20	Road Construction Bridge Construction	CADD/CEL	Interim	RDB18-10	07/01/19
FY 2018-19	Road Construction Bridge Construction	CADD/CEL	Interim	RDB17-13	07/01/18



## General Construction Operations-Roadway

Maintenance of Traffic 					
102-100		Temporary Barrier	415	SPI	XLS
102-110		Type K Temporary Concrete Barrier System	414		
102-120		Low Profile Barrier	412		
102-600	Errata	General Information for Traffic Control Through Work Zones <i>Quick Reference Sheet: 102 Series Tables</i>	600	SPI	
102-601		Two-Lane and Multilane Roadway, Work Beyond the Shoulder	601		
102-602		Two-Lane and Multilane, Work on Shoulder	602		
102-603		Two-Lane, Two-Way, Work Within the Travel Way	603		
102-604		Two-Lane, Two-Way, Intersection Work	604		
102-606		Two-Lane Roadway, Lane Closure Using Temporary Traffic Signals	606		
102-607	Errata	Mobile Operations	607		
102-608		Two-Lane, Two-Way, Temporary Diversion Connection	608		
102-613	Errata	Multilane Roadway, Lane Closures	613		
102-615		Multilane Roadway, Intersection Work	615		
102-620		Multilane Roadway, Temporary Diversion	620		
102-625		Temporary Road Closure	625		
102-628		Two-Way Left Turn Lanes	628		
102-655		Traffic Pacing	655	SPI	
102-660		Sidewalk Closure	660	SPI	
102-661		Bicycle Lane Closures	NEW		
102-665		Limited Access Temporary Opening	665	SPI	
102-680		Haul Road Crossing	NEW	SPI	



# Standard Specifications

(<http://www.fdot.gov/programmanagement/Implemented/SpecBooks/default.shtm>)



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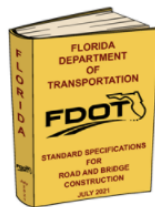
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This document contains the most recent published version of FDOT's Standard Specifications for Road and Bridge Construction, effective for project lettings beginning JULY 2021. Please view and read the Distribution memo for more information.

[July 2021 Distribution Bulletin](#)

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Revisions to the published Standard Specifications for Road and Bridge Construction may be implemented to enhance safety; reduce costs; comply with new laws, rules or policies; incorporate new technology; update industry standards or practices; and other critical updates.

[July 2021 eBook - History of Revisions](#)

[July 2021 Redline eBook](#)

[July 2021 Workbook](#)

[Mandatory Revisions](#)

## Basis of Estimates

(<http://www.fdot.gov/programmanagement/Estimates/BasisofEstimates/BOEManual/BOEOnline.shtm>)

## Approved Products List (APL)

(<https://fdotwp1.dot.state.fl.us/ApprovedProductList/Specifications>)



## TTC Definitions Quick Reference

- **Travel Way:** The portion of the roadway for the movement of vehicles.
- **Driver:** Any person in physical control of a vehicle on a travel way or steering a vehicle being towed by another vehicle.
- **Road User:** Individuals who use roadway facilities. They may include drivers, pedestrians, bicyclists, and transit users.
- **Roadwork:** All operations by state, counties, contractors, municipalities, utilities, and other authorized parties conducted in or adjacent to the travel way.
- **Roadside:** Where work activity is taking place adjacent to traveled way.
- **Two-Lane Two-Way:** Two lanes of moving motor vehicle traffic going in opposite directions.
- **Multilane:** Two or more lanes of moving motor vehicle traffic in one direction.
- **Moving:** Construction, maintenance, or utility activity that moves in continuous fashion along the road without stopping, usually at low speeds.
- **Mobile:** Work that moves intermittently or continuously.
- **Short Duration:** Daytime work that occupies location up to one hour.
- **Clear Zone:** Total roadside border area, starting at the edge of travel way, available for an errant driver to stop or regain control of a vehicle.
- **Offset Zone:**
  - ✓ 15' or more from edge of travel way
  - ✓ Behind existing barrier
  - ✓ More than 2' behind the curb
- **Above Ground Hazard:** Anything (except Temporary Traffic Control devices) within the travel way or clear zone, is more than 4" high, firm and unyielding.
- **Drop Off:** A drop in elevation, parallel to the adjacent travel lanes, more than 3" with slopes steeper than 1:4.
- **Crashworthy:** Roadside appurtenance that has been successfully crash tested.
- **Lane Constriction:** One or more lanes narrowed but number of lanes remains the same.
- **Lane Closure:** One or more lanes of traveled way closed to traffic with at least one lane left open.
- **Shoulder Closure:** Activity that closes roadway shoulder but does not reduce number of lanes.
- **Intermittent Closure:** A work zone where traffic in one or both directions is stopped for short period to allow work to proceed.
- **Center Skip Line Stripes:** 40 feet from end/start to end/start (10-foot line segment plus 30-foot gap).
- **Reflective Pavement Markers (RPMs):** Spaced 40 feet apart, reflective plastic roadway markers usually found on/near center roadway line.
- **Tangent:** A line of devices placed parallel to the work zone.



<b>TABLE 1</b> <b>CHANNELIZING DEVICE SPACING</b>				
Work Zone Speed (mph)	Maximum Spacing (feet)			
	Cones or Temporary Tubular Markers		Type I Barricades, Type II Barricades, Vertical Panels, or Drums	
	Taper	Tangent	Taper	Tangent
≤ 45	25	50	25	50
≥ 50	25	50	50	100

<b>TABLE 3</b> <b>WORK ZONE SIGN SPACING "X"</b>	
Road Type	Minimum Spacing (feet)
Arterials and Collectors with Work Zone Speed ≤ 40 mph	200
Arterials and Collectors with Work Zone Speed ≥ 45 mph	500
Limited Access Roadways (See Note)	1,500
<b>NOTE:</b> For Limited access roadways with work zone speed ≤ 55 mph, the minimum spacing may be reduced in accordance with the MUTCD and as approved by the Engineer.	

<b>TABLE 5</b> <b>CLEAR ZONE WIDTHS FOR WORK ZONES</b>		
Work Zone Speed (mph)	Travel Lanes & Multilane Ramps (feet)	Auxiliary Lanes & Single Lane Ramps (feet)
60-70	30	18
55	24	14
45-50	18	10
30-40	14	10
ALL SPEEDS CURB & GUTTER	4' BEHIND FACE OF CURB	4' BEHIND FACE OF CURB
<b>NOTE:</b> For temporary conditions where existing curb has been removed but not reconstructed, curb and gutter values may be used.		

<b>TABLE 2</b> <b>TAPER LENGTH "L"</b>	
FORMULAS	
$S \leq 40$	$L = (WS^2)/60$
$S \geq 45$	$L = WS$
Where: L = Taper Length in feet W = Width of Offset in feet S = Work Zone Speed in mph	
<b>NOTE:</b> See Table 9 for example taper length values.	

<b>TABLE 4</b> <b>BUFFER LENGTH "B"</b>	
Work Zone Speed (mph)	Minimum Length (feet)
25	155
30	200
35	250
40	305
45	360
50	425
55	495
60	570
65	645
70	730
<b>NOTE:</b> When Buffer Length "B" cannot be attained due to geometric constraints, use the greatest length possible, but not less than 155 feet.	

<b>TABLE 6</b> <b>MINIMUM RADII FOR NORMAL CROWN</b>	
Work Zone Posted Speed (mph)	Minimum Radius (feet)
70	4090
65	3130
60	2400
55	1840
50	1390
45	1080
40	820
35	610
30	430
Superelevate When Smaller Radii is Used	



**TABLE 7**  
**POST AND FOUNDATION TABLE FOR WORK ZONE SIGNS**

SIGN SHAPE	SIGN SIZE (inches)	NUMBER OF STEEL U CHANNEL POSTS	Notes For Table:
Octagon	30x30	1	<p>1. Use 3 lb/ft posts for Clear Height up to 10' and 4 lb/ft posts for Clear Height up to 12'.</p> <p>* Use 4 lb/ft U-channel sign post with a mounting height of 7' min. and 8' max. Attach sign panel using Z-bracket detail on Sheet 6.</p> <p>2. Minimum foundation depth is 4.0' for 3 lb/ft posts and 4.5' for 4 lb/ft posts.</p> <p>3. For both 3 lb/ft and 4 lb/ft base or sign posts installed in rock, a minimum cumulative depth of 2' of rock layer is required.</p> <p>4. The soil plate as shown on the APL vendor drawing is not required for base posts or sign posts installed in existing rock (as defined in Note 3), asphalt roadway, shoulder pavement or soil under sidewalk.</p> <p>5. For diamond warning signs with supplement plaque (up to 5 ft<sup>2</sup> in area), use 4 lb/ft posts for up to 10 ft Clear Height (measure to the bottom of diamond warning sign).</p>
Triangle	36x36x36	1	
	48x48x48	1	
	60x60x60	2	
Rectangle (W x H)	24x18	1	
	24x30	1	
	30x24	1	
	36x18	1	
	36x24	1	
	48x18	1	
	48x24	1	
	36x48	2	
	48x30	2	
	48x36	2	
	54x36	2	
	48x60	3	
Square	30x30	1	
	36x36	2	
	48x48	2	
Diamond	48x48	2	
Circle	36Ø	2	

**TABLE 8**  
**DROP-OFF PROTECTION REQUIREMENTS**

Condition	X (ft)	D (in.)	Device Required
1	0-12	> 3	Temporary Barrier
2	> 12-CZ	> 3 to ≤ 5	Channelizing Device
3	0-CZ	> 5	Temporary Barrier
4	Removal of Bridge or Retaining Wall Barrier		Temporary Barrier
5	Removal of portions of Bridge Deck		Temporary Barrier

**TABLE 9**  
**EXAMPLE "L" VALUES**

S (mph)	W (feet)											
	5			8			10			12		
	L	L/2	L/3	L	L/2	L/3	L	L/2	L/3	L	L/2	L/3
25	52	26	17	83	42	28	104	52	35	125	63	42
30	75	38	25	120	60	40	150	75	50	180	90	60
35	102	51	34	163	82	54	204	102	68	245	123	82
40	133	67	44	213	107	71	267	133	89	320	160	107
45	225	113	75	360	180	120	450	225	150	540	270	180
50	250	125	83	400	200	133	500	250	167	600	300	200
55	275	138	92	440	220	147	550	275	183	660	330	220
60	300	150	100	480	240	160	600	300	200	720	360	240
65	325	163	108	520	260	173	650	325	217	780	390	260
70	350	175	117	560	280	187	700	350	233	840	420	280

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102 SERIES TABLES