D - LIGHTING DEVICES

D-1 Function

It is often desirable and necessary to supplement the reflectorized signs, barriers and channelizing devices with lighting devices that are available for the purpose indicated in the following paragraphs.

D-2 Electric Lights

Electric lights used in construction, maintenance, or utility areas may be flood lights, steady burning lights, or flashing lights.

A. Flood Lights

Construction, Maintenance, Utilities or Incident Management

Floodlights are used to light work activities, flagger stations and other restricted or hazardous areas at night when area lighting is not sufficient. Floodlights should be positioned or shielded to prevent glare to the drivers. The increased visibility provided by floodlighting may enable the driver to see distracting portions of the work area. In this case, steady burning warning lights mounted on channelizing devices may be advisable. Floodlighting the work area cannot be considered as illuminating signs or devices. Each illuminated sign or device should have its own light source.

During the planning and design of a street improvement project, consideration may be given to specifying that proposed street lighting be completed as one of the earlier stages during construction. Consideration should also be given for providing temporary luminaires at certain locations such as the work activity, certain crossroads, and transitions.

B. Hazard Identification Beacons

(Flashing Electric Lights)

A Hazard Identification Beacon generally is used at points of special hazard where the flashing beacon is effective in calling the attention to drivers to these locations. When used, the flashing beacon should operate 24 hours a day.

(1) Construction, Maintenance or Utilities

Because of the time and effort required to install and put the units into operation. Hazard Identification Beacons are used generally only at locations where frequent changes would not be required.

(2) Construction, Maintenance or Utilities

During normal day time operation, maintenance or utility operations, the functions of flashing beacons are adequately provided for by the lighting equipment on maintenance vehicles, either the emergency flashers, the rotating dome light, or both.

C. Steady Burning Electric Lamps

As used herein, steady burning electric lamps shall mean a series of low wattage yellow electric lamps.

D. Electrical Power to Operate Lights

The electrical power to operate the lights shall be supplied by either batteries or A.C. current. If A.C. current is used to supply the power necessary for the operation of the lights, it is required that a standby system using batteries be maintained to guarantee the automatic continuous operation of the lights in the event that a power failure should occur. The installation shall meet the National Electrical Code.

D-3 Lanterns or Flares

Lanterns and Flares are single unit, portable, constant burning, low intensity types of lights with open or enclosed flame. The flammable fuel used in the lanterns or torches may be a hazard to life and property, and their use, therefore, is not permitted.

D-4 Warning Lights

Warning lights are portable, enclosed lights. The color of the light emitted shall be amber or red as required elsewhere in this manual. They may be used in either a steady burn or flashing mode.

A. Type "A" low intensity flashing warning lights are most commonly mounted on portable barriers, drums, vertical panels, and are intended to continually warn drivers that they are approaching or proceeding in a hazardous area.

B. Type "B" high intensity flashing warning lights are intended to be mounted on advance warning signs and barricade installations.

Type "B" high intensity flashing warning lights, shall be maintained so as to be capable of being visible on a sunny day when viewed without the sun directly on or behind the device from a distance of 1,000 feet. This light shall be operational 24 hours a day.

C. Type "A" flashing warning light shall be maintained so as to be capable of being visible on a clear night from a distance of 3,000 feet, required operation dusk to dawn.

D. Lens directed warning lights shall be in accordance with the requirements of the latest ITE Standard for flashing and steady-burn barricade warning lights.

D-5 General Requirements - Barricade Lights

A. The lens shall be self-illuminated by means of an electric lamp behind the lens. Type "A" also shall be externally illuminated by reflex-reflective element built into the lens to enable it to be seen by reflex-reflection of the light from the headlights of oncoming automotive traffic.

B. When the unit is to be operated by batteries, they must be entirely enclosed in a case which is constructed of No. 18 U.S. standard gauge steel or any other material which by engineering judgement is considered capable of withstanding considerable abuse. The case must be secured by a locking device.

C. When the unit is to be operated by a 120 volt, 60 cycle power supply, the unit shall be supplied with a separate ground wire and be protected with suitable fuses. At no time shall the effective intensity have a value greater than 500 candelas. The connections and equipment used shall be in accordance with the pertinent current standard of the Institute of Electrical and Electronic Engineers, the American Society for Testing Materials, and the National Board of Fire Underwriters. In those areas where there are pertinent local ordinances and requirements, the wiring, material and installation procedures shall comply with the local requirements. It is required that a standby power source be maintained to guarantee the automatic continuous operation of the lights.

D. (1) Swivel Head

If swivel capabilities as described in this Section are not incorporated in the device used to mount a Type "A" or Type "B" light to a barricade or sign, the head shall be mounted on the housing in a manner permitting it to be swiveled through a minimum 90o arc in a horizontal plane. If swiveling is to be accomplished by rotation of the head, construction shall be such that the head rotation will not damage the wiring.

(2) Housing

Definition - Housing is defined as the case containing the batteries and circuitry.

Material - The housing shall be constructed of No. 18 U.S. Standard Gauge Steel or any other material which by engineering judgement is considered capable of withstanding considerable abuse.

(3) Hoods

The hood shall have a nominal measurement of 4" from front to back.

(4) Photoelectric controls, if provided on Type "A" light, shall keep the light operating whenever the ambient light falls below 20 foot candelas.

D-6 Testing Quality and Marking of All Lights

A. Testing and Certification

(1) If required by the purchaser, certification as to conformance to these specifications shall be furnished by the manufacturer based on results of tests made by independent testing laboratory.

(2) If required by the purchaser, barricade warning lights furnished under this specification shall be tested in accordance with the latest revision of ASTA Test Procedures T-101. (American Traffic Service Association).

B. Quality

All electrical components, the quality of the materials used, and the workmanship of all lights furnished for use shall be the same as that of corresponding models approved under this specification.

C. Identification

Each light shall be plainly marked as to type and the manufacturer's name and model number in order to facilitate identification and approval.

D. Testing Procedures

Reflex-reflection shall be tested in accordance with S.A.E. Standard J 594d.

The lens shall not be less than seven inches (7") in diameter including a reflex-reflector ring of 1/2" minimum width around the periphery.

E. Number of Lens

(1) Type "A" shall have either a bidirectional or unidirectional lens.

(2) Type B shall have a unidirectional lens.

F. Lens Material

The lens shall be one - piece construction. The lens material shall be plastic capable of producing a lens that can meet the chromaticity and luminous transmission requirements of specification. The lens material shall meet the test requirements set forth in S.A.E. Standard 357b (Society of Automotive Engineers, Inc., "Lighting Equipment and Photometric Tests") except that the exposure time and conditions (S.A.E. Standard, Paragraph 3.4.3.) for the purposes of this standard shall be one year.

D-7 Lights on Channelizing Devices

There shall be minimum of one(1) Type "B" flashing amber lights on the first two devices in the series, except where otherwise noted. The last device in the series shall have one(1) Type "A" light.

At isolated hazards within a general construction, maintenance, and utility areas Type B flashers shall be used. Normally hazards more than 300 feet apart shall be considered isolated. However, the Traffic Engineer may determine otherwise.

Non-directional reflective panels can be used in lieu of lights on curb barrier at fifty (50) foot intervals. At least six (6) reflective panels shall be used in every case. (see D-9 for details)

Two (2) red Type "B" flashing lights shall accompany any stop sign mounted on a barricade or placed to stop traffic for construction, maintenance, or utility activity except manually operated signs.

When a roadway is closed to all traffic, two (2) Type "B" red flashing lights shall be mounted per travel lane facing oncoming traffic on and above the devices which completely close that travel lane.

When at least one lane of a roadway remains open to travel, two (2) Type "B" amber flashing lights shall be mounted per travel lane facing oncoming traffic on and above the devices which completely close any travel lane.

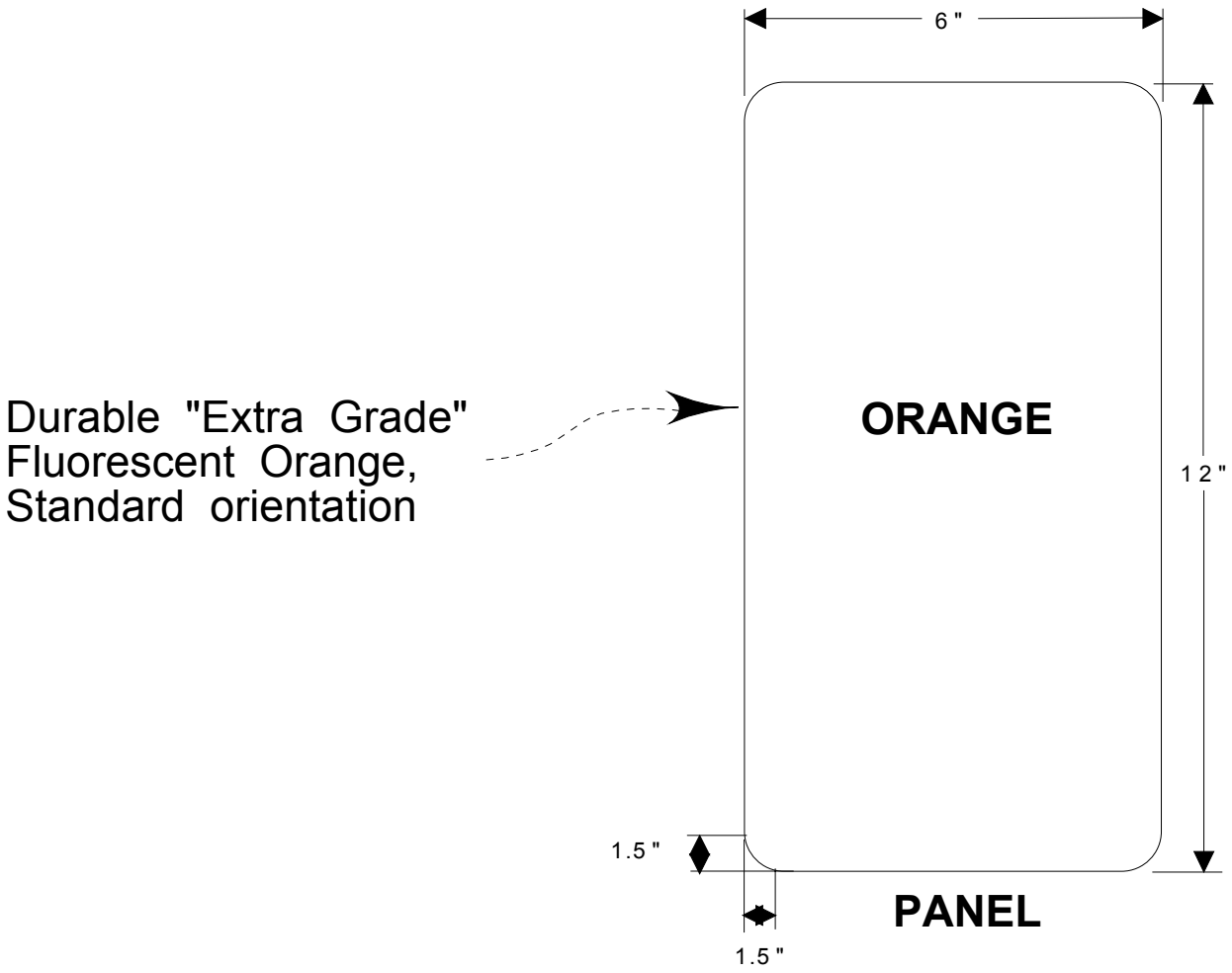
On two-way roadways, two (2) Type "B" amber flashing lights shall be mounted on and above the devices which close the travel lane nearest the lane open to travel.

D-8 Lights on Signs

When used at night, or when specified by the Engineer, the first sign and the second sign in the series approaching a work area or project shall each have at least one (1) Type "B" amber flashing lights located above the center line of the sign unless the sign face is made of florescent orange "Extra Grade" material (see B-1). When the second sign in a series is rectangular two (2) Type "B" amber flashing lights shall be used and be mounted above the sign.

D-9 Non-directional Reflective Panel

Design
Non-directional Reflective Panel shall be 6 inches wide and 12 inches high with rounded corners. The Non-directional Reflective Panel shall have fluorescent orange 3M Extra Grade retroreflective sheeting, on both sides.



Application
Non-directional Reflective Panel can be used on curb barrier at fifty (50) foot intervals. There shall be at least six(6) reflective panels used in every case. The panels shall be attached to the portable barrier in such a manner as to prevent accidental removal. Bolts or epoxy based adhesives are acceptable. Other methods can be submitted for approval by the Engineer

NOTE:
On two(2) lane roads warning Non-directional Reflective Panel shall have reflective sheeting on both sides visible in both directions.

D-10 Traffic Control Signals

Traffic control signals may be used for special applications to control vehicular traffic movements at construction, maintenance or utility work areas. The installation may be temporary, portable or short term. The specifications here shall apply to every stop & go traffic control signal of whatever nature.

Typical applications include:

A. A highway or street intersection with a temporary "haul road" or equipment crossing.
B. Through areas requiring one way traffic operations.

All traffic signal and control equipment shall meet the applicable standards and specifications prescribed in the Department's Manual on Uniform Traffic Control Devices. Normally, these installations shall be operated by means of traffic actuation or manual control.

D-11 Portable Traffic Signal Operation

A. Contractor shall submit a plan indicating the placement and operation of the portable traffic signals to the Chief Traffic Engineer for approval 10 days prior to use. Portable traffic signals must be of a type approved for use on construction/utility or maintenance operations required by the Chief Traffic Engineer.

B. Additional signing and devices shall be installed as required by the Engineer.

C. Portable traffic signals shall not be used where:

(1) Approaching speeds are greater than 50 M.P.H.
(2) Sight distance to the signals is less than required in the MUTCD.
(3) Overhead signals are required by field conditions.

D. The operator must have an unobstructed view of both ends of the roadway segment being controlled when manual controls are in use.

E. If the total distance between each pair of the traffic signals is greater than 1,000 feet or the operator's view of the signal head or traffic flow through the work zone is obstructed, under manual operation a separate operator is required at each end and communication must be maintained between the operators.

F. Signal heads shall be a minimum of four feet off the edge of the travelway, and a minimum of eight feet from the bottom of the signal head to the roadway. A signal face shall be located on each side of roadway.

G. Minimum change interval (yellow) is three seconds.

H. Minimum clearance interval (red) is determined by the length of the area controlled by the traffic signals and speed of traffic flow through the work area.

I. The location of the portable traffic signals may be modified, with the project engineer's approval to obtain the required visibility for both operator and motorists.

J. All vehicles in the work area shall display flashing lights installed for the purpose of warning approaching drivers of a vehicular traffic hazard requiring unusual care in approaching, overtaking, or passing.

K. Provide for alternate operation of the signal during period of failure, either flash, manually or by having manual traffic direction.

L. Have properly skilled maintenance responding to the site within two hours of notification for all emergency calls. Lamp failure shall be responded by the next business day, in cases where redundant lamps exist. Provide adequate stand-by equipment to minimize the interruption of signal operation due to equipment failure.

M. Provide properly skilled maintenance for all components.

N. Maintain the appearance of the installation in a manner consistent with the intention of this manual, with particular emphasis on painting and cleaning of the optical system.

O. Every controller should be kept in effective operation in strict accordance with its predetermined timing schedule.

P. A careful check of the correctness of time operation of the controller should be made frequently enough to insure its operating in accordance with the planned timing schedule. Timing changes should be made only by authorized persons. A written record shall be made of all timing changes.

Q. All Traffic Signal Equipment shall be carefully cleaned and serviced at least as frequently as specified by the manufacturer and more frequently if experience proves it necessary. The contractor/utility company or maintenance department must replace the lamps in accordance with the manufacturers recommendations and a record of this must be maintained by the contractor/utility company or maintenance department.

D-12 Flashing Lights on Vehicles

In many of the typical applications shown in this manual, there is reference to flashing lights on vehicles in the work area.

Any and all vehicles within the work area shall be equipped and display flashing lights as described below.

On expressways and other high volume, high speed roadways (above 50 m.p.h.) a light bar or other high powered strobe system is recommended and will be required after June 30, 1999.

The referenced flashing lights are not the vehicle emergency flashers, but a separate large rotating amber beacon or strobe light. Said beacon or strobe light shall be mounted on the vehicle in such a manner as to be clearly visible from all directions around the vehicle. These warning lights shall be visible from a distance of not less than 500 feet under normal atmospheric conditions at night.

D-13 Changeable Message Sign

Changeable message signs are capable of displaying various messages to the motorist. Their use will sometimes facilitate or supplement incident management, construction, maintenance or utility work zone signing.

Changeable message sign using Lamp Matrix shall not be used as alternate to arrow panel.

These devices are normally trailer or truck mounted and have their own power system.

Help with message content is available from either DelDOT Bureau of Traffic or DelDOT Safety Officers. In case of dispute the Chief Traffic Engineer has final authority over message content.

Messages, or series of messages can be preprogrammed into the device or can be added with an additional memory device; displaying panels may have one, two or three lines of copy.

When using this sign device the words should be chosen to ensure that the message is clear. A lengthy message may distract the motorist from his driving task for too long a time. One (1) second is required for a motorist to read each short word and only eight (8) seconds are available to read a message. Total message shall be no longer than eight (8) short words. The C.M.S. signs are especially useful in the following situations:

When different messages are needed during the day due to changing work operation.

For upstream traffic diversion when instructions vary with traffic conditions.

For emergency conditions.

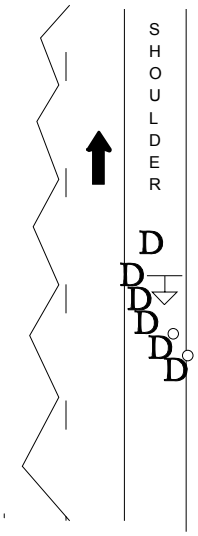
Some of the suggested guidelines for placement of the C.M.S.

Place approximately 3/4 mile in advance of the lane closure.

Place on same side of roadway as the closed lane for shoulder placement.

Six (6) channelizing devices (plastic drums or cones) are required for protection of the C.M.S.. See figure for placement of channelizing devices. If the unit will be on site at night, one (1) "B" amber light is required on the first two(2) channelizing devices (must be plastic drums).

Emergency operations of less than 48 hours duration may use reflectorized cones in lieu of drums and the two(2) "B" amber lights.



SYMBOLS

D Drums

Changeable Message Sign
(bottom of all signs must be at least five(5) feet above roadway surface)

LIGHT SYMBOLS

Type "B" amber high-intensity light

D-14 Crash Cushions

Crash cushions are devices designed to absorb the energy of an impacting vehicle in a controlled manner such that the impact forces on the passengers are tolerable. Two types of crash cushions commonly used in work zones are sand-filled plastic barrels and (see C-14, C-15 for proper placement) collapsible structures. Any device used must meet NCHRP 350 crash worthyness requirements.

Crash cushions should be designed to meet the needs of each location, depending on the type, length and width of the hazard and this information should be included on the highway construction plans. They are used to protect traffic from hazard, such as exposed barrier ends or bridge parapets.

Crash cushions should be installed and maintained in accordance with manufacturers recommendations. Crash cushions that are impacted should be promptly inspected and repaired or replaced. A supply of replacement parts should be available for prompt repair.

D-15 Truck Mounted Attenuator (TMA)

The TMA is a light weight attenuator system designed for installation at the back of highway maintenance and service trucks. The attenuation capability of the TMA provides a safety crash cushion between approaching traffic and highway crews.

When impacted head-on at highway speeds by errant vehicles within the weight range of 2,250 to 4,500 pounds, the TMA shall be able to:

A. Decelerate the errant vehicle to a tolerable speed.
B. Reduce the acceleration and roll ahead movements of the truck.
C. T.M.A.'s used at a site shall be crash rated for the posted speed limit of that site.
D. T.M.A shall not be located closer to the work area than as defined by the T.M.A. manufacturer nor located at a distance to no longer protect the work area.

T.M.A.

Truck Mounted Attenuators are required on all limited access highways and on all highways which have four or more lanes with the posted speeds of 45 M.P.H. or greater, and on all U.S. routes (except U.S. 9) for the following operations:

1 - pavement marking
2 - roadside spraying
3 - patching
4 - rotomilling
5 - portable barrier placement
6 - other situations where the Engineer or authorized representative feel such protection is warranted.

Application

The TMA shall be employed whenever construction, utility, or maintenance activities within ten (10) feet of the travelway, not protected by safety barriers, present a hazard to motorists or the workers as determined by the Engineer.

D-16 Shadow Vehicles

Moving operations, such as lane striping or sweeping, need traffic controls that move with the work operations. Shadow vehicles may be used to assist traffic control for moving operations. Signs and other warning devices may be placed on the work vehicle (depending on the type of work) or the shadow vehicle, or both. Need for a shadow vehicle depends on the speed of traffic compared to the speed of the work vehicle, exposure to traffic of workers and the type of work activity. Portable crash cushions can be attached to the shadow vehicle to protect motorists and workers from a collision. Signs, flags, flashing lights, or arrow panels may be attached to shadow vehicles to warn traffic. Arrow panels may be used on multilane highways but should not be used on a two-lane, two-way road.

D-17 Arrowpanels

Acceptability depends upon the distance over which the message is clearly conveyed. Any arrowpanels submitted for approval must be at least as clear and as strong as the herein described panels at any given distance in a side by side comparison. Approval prior to installation and or use is required.

Arrowpanels shall have a rectangular panel face or background finished in nonreflective black. Mode selection shall include Left Arrow, Right Arrow, Left and Right Arrow, and Caution. The Caution mode shall consist of four (4) or more lamps arranged in a pattern which will not indicate a direction. Mode selection controls shall include a lamp intensity adjustment capable of dimming lamp output a minimum of 50 percent. The flashing rate of the lamps shall not be less than 30 times per minute, nor more than 40 per minute.

Arrowpanels may be trailer mounted, vehicular mounted, or mounted on any suitable support. If panel is vehicular mounted, the controls shall be remoted to the cab and positioned within arms reach of the operator.

Arrowpanels enhance the effectiveness of other traffic control devices by providing a high impact directional message to the approaching driver. To the extent that they attract attention and provide information, they assist in directing and or controlling traffic around work sites on or adjacent to the travelway.

Arrowpanels are not to be used in lieu of other traffic control devices except as specifically authorized.

An arrowpanel may be used as the sole traffic control device under any emergency condition until a complete system of devices can be installed.

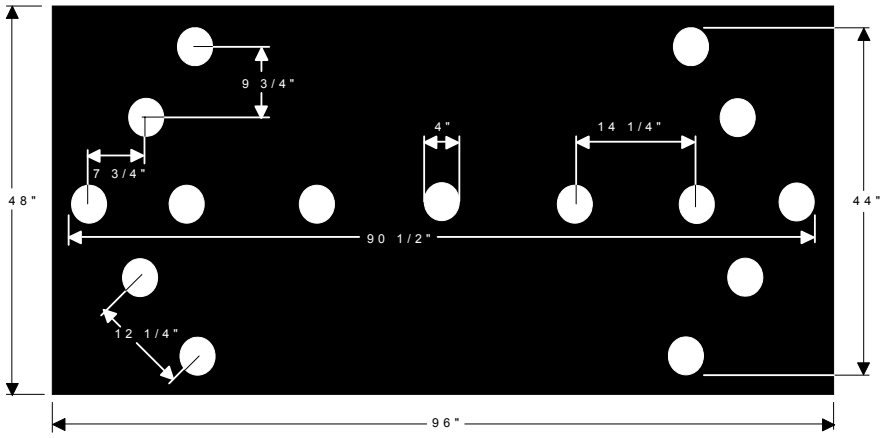
*

Type "A" Arrowpanels are appropriate for use on low speed urban streets. Type "B" Arrowpanels are appropriate for intermediate speed facilities and for maintenance, or mobile, operations on high speed roadways. Type “C” Arrowpanels are intended to be used on high speed, high volume traffic control projects. Arrowpanels of any size will not be used on a two lane road to indicate a lane transition where a conflict with vehicles approaching from the opposite direction will be created. Arrowpanels should not be used for shoulder or roadside work except in caution mode. The caution mode consists of four or more lamps arranged in a pattern which will not indicate a direction.

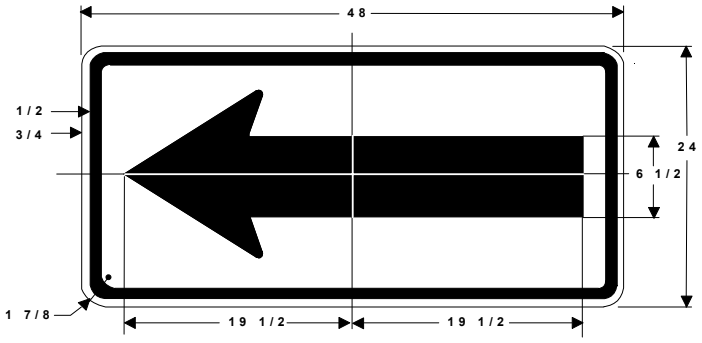
For stationary lane closures, the arrowpanel should be placed on the shoulder at the beginning of the taper, or where there are narrow shoulders in the closed lane behind the channelizing devices on the same side the lane closure. Placement at the start of the taper is preferred to placement in the middle of the taper.

Arrowpanels are traffic control devices which are capable of projecting an image of an arrow toward approaching vehicles. There are three approved configurations:

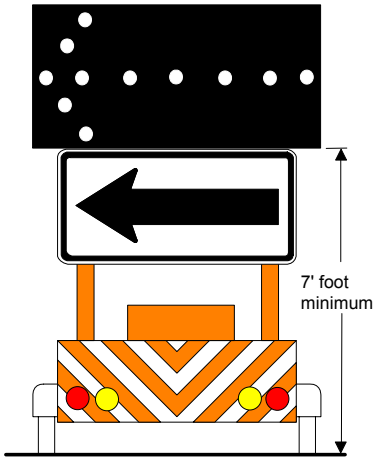
TYPE	OVERALL SIZE	NUMBER OF LAMPS	SIZE OF LAMPS DIAMETER	Minimum Legibility Distance (miles)
A	24"x48"	12	4" minimum	1 / 2
B	30"x60"	13	4" minimum	3 / 4
C	48"x96"	15	4" minimum	1



(W1-6) CENTERED AND ATTACHED TO BOTTOM OF ARROWPANEL



(W1-6)



FOR THIS APPLICATION THE W1-6 SIGN SHALL BE OF "DIAMOND GRADE" MATERIAL.