

INDIANA DEPARTMENT OF TRANSPORTATION

# LIMITED VERTICAL CLEARANCE BRIDGE WARNING SYSTEM STUDY FINAL REPORT

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# GLOSSARY

TERM	DEFINITION
<b>Limited Clearance</b>	Any vertical clearance restriction. This notably applies to all Indiana through-truss bridges.
<b>Fracture critical members</b>	A steel member in tension, or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse. (Federal Highway Administration)
<b>Low Clearance</b>	“Vertical clearance less than 12 in above the statutory maximum vehicle height” (Federal Highway Administration (FHWA), 2009, Section 2C.27). According to Indiana Code (IAC) § 9-20-3-3, the statutory maximum vehicle height is 13ft 6 in. Therefore, for the purposes of this report, low clearance is defined as vertical clearances less than 14ft 6in.
<b>Maximum legal vehicle height</b>	Maximum height limitation for vehicles in Indiana – “A vehicle may not exceed a total maximum height of thirteen (13) feet, six (6) inches.” – Indiana Administrative Code § 9-20-3-3 Sec. 3. (a)
<b>Statutory maximum vehicle height</b>	Maximum height limitation for vehicles in Indiana – “A vehicle may not exceed a total maximum height of thirteen (13) feet, six (6) inches.” – Indiana Administrative Code § 9-20-3-3 Sec. 3. (a)

# ABBREVIATIONS

TERM	DEFINITION
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ADTT	Average Daily Truck Traffic
AISC	American Institute of Steel Construction
BIAS	Bridge Inspection Application System
CCTV	Closed Circuit Television
CDL	Commercial Driver's License
CFR	Code of Federal Regulations
DOR	Department of Revenue
FHWA	Federal Highway Administration
GDO	Garage Door Openers
HBPA	Historic Bridges Programmatic Agreement
IAC	Indiana Administrative Code
IDM	Indiana Design Manual
IIHS	Insurance Institute for Highway Safety
INDOT	Indiana Department of Transportation
LED	Light-Emitting Diode
LPA	Local Public Agency
LRFD	Load and Resistance Factor Design
MASH	Manual for Assessing Safety Hardware
MUTCD	Manual of Uniform Traffic Control Devices
NBI	National Bridge Inventory
OHVDS	Overheight Vehicle Detection System

# 1 EXECUTIVE SUMMARY

Vertical clearance through and below bridge structures is a statewide asset maintenance issue. Warning signage is no guarantee of avoiding vehicle collisions with bridge members (bridge strikes) from overheight vehicles. Even when the vertical clearance meets standards but is limited, vehicle collisions remain a risk for these structures because of the potential for human error, such as oversized vehicles traveling without permits or off the approved route.

It is the intent of this report to provide general guidance to bridge asset owners and an escalating menu of available additional warning measures, to alert motorists to the presence of limited vertical clearance.

Low clearance is defined as “vertical clearance less than 12 in above the statutory maximum vehicle height” (Federal Highway Administration (FHWA), 2009, Section 2C.27). According to Indiana Code (IAC) § 9-20-3-3, the statutory maximum vehicle height is 13ft 6 in. Therefore, for the purposes of this report, low clearance is defined as vertical clearances less than 14ft 6in. The Manual of Uniform Traffic Control Devices (MUTCD) only requires signage for low vertical clearance structures.

Limited clearance is defined in this report as any vertical clearance restriction. This notably applies to many Indiana through-truss bridges with portal frames higher than 14ft 6in. There is no requirement to provide warning signage on limited clearance structures.

Even when a bridge is signed for low vertical clearance or if a bridge exceeds minimum vertical clearance standards, a culturally, community or economically significant bridge with limited vertical clearance is at risk to being damaged by overheight vehicles, causing undue burden to the owner and community. In other words, if a bridge is important enough and could conceivably be struck by an overheight vehicle, additional warning measures may be warranted.

Bridge assets are important infrastructure to Indiana communities. Depending on the extent of damage incurred, the repair or replacement of a through-truss bridge can be extremely costly. Unlike county courthouses, public schools, and other public building infrastructure; Local Public Agency (LPA) and Indiana Department of Transportation (INDOT) owned bridge assets cannot be insured against damage caused by illegal (above statutory maximum vehicle height) bridge strikes or legal loads which ignore posted warning signage. Barring some recoupment of funds from litigation against the driver and their insurer, the burden of their repair and replacement is the sole responsibility of the bridge asset owner.

In this report, we examine the means available to Indiana bridge asset owners to alert drivers to limited clearance bridges with the goal of reducing or eliminating vehicle bridge strikes.

**There has been very limited academic study of the efficacy of the measures presented in this report. All discussion of the efficacy of measures presented is based on anecdotal evidence. All recommendations made are based on this anecdotal evidence, sources referenced, and the engineering judgement of the authors. Recommendations made in this report shall not be considered a guarantee of performance. Costs presented are based on hypothetical sites, assumptions listed, and historic INDOT pricing data for the pay items listed. The reader shall exercise engineering judgement in the implementation of these recommendations.**

Anecdotal evidence from asset owners interviewed points toward a benefit for the asset owner in reducing bridge strikes by installing additional warning and/or detection measures for suitable to the site. However, there is an opportunity for further academic study.

Table 7-1 on page 30 summarizes the available warning measures for limited vertical clearance bridges. **The design of all measures is subject to site specific considerations and engineering judgment. Owners must also consider liability and future maintenance cost associated with each type of measure.** Monitoring of all systems would be the responsibility of the owner.



## 2 INTRODUCTION

Vertical clearance through and below bridge structures is a statewide asset maintenance issue. For both the State of Indiana and Local Public Agencies (LPAs), the presence of low vertical clearance structures on the public transportation system requires additional signage. Warning signage is no guarantee of avoiding vehicle collisions with bridge members (bridge strikes) from overheight vehicles. Even when the vertical clearance meets standards but is limited<sup>1</sup>, vehicle collisions remain a risk for these structures because of the potential for human error, such as oversized vehicles traveling without permits or off the approved route.

Bridge strikes on historic through-truss structures with limited clearance have the potential to cause extensive damage due to fracture critical members which provide less redundancy than beam-and-deck structures. A strike-damaged historic bridge may require specialized repairs to avoid degrading the historic character of the structure. If damage is especially severe, the bridge strike may necessitate the removal and replacement of the historic bridge. For this reason, this report is intended to evaluate options for protecting these historic bridges from bridge strikes, with a focus on vulnerable through-trusses. However, these findings may be applied to any vertically limited clearance on low-volume roads. This report will not cover the feasibility or viability of countermeasures for structures designed with redundancy or over high-volume roads or interstates.<sup>2</sup>

The purpose of this study is to briefly categorize low vertical clearance warning measures which are intended to reduce bridge strike collisions. This report covers information on types of measures, preferred application, restrictions, benefits, drawbacks, installation costs, maintenance, and efficacy. This report also identifies a list of historic through trusses in Indiana with increased risk of collisions or damage by over-height vehicles due to low vertical clearance. The included list may not be all-inclusive.



Figure 2-1: Bridge strike on Bridge No. 41-82-03286 HSBL (NBI No. 014310) by an off-route overheight vehicle.

**There has been very limited academic study of the efficacy of the measures presented in this report. All discussion of the efficacy of measures presented is based on anecdotal evidence. All recommendations made are based on this anecdotal evidence, sources referenced, and the engineering judgement of the authors. Recommendations made in this report shall not be considered a guarantee of performance. Costs presented are based on hypothetical sites, assumptions listed, and historic INDOT pricing data for the pay items listed. The reader shall exercise engineering judgement in the implementation of these recommendations.**

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<sup>1</sup> This notably applies to many Indiana through-truss bridges with portal frames higher than 14ft 6in. There is no federal or state requirement to provide warning signage on limited clearance structures.

<sup>2</sup> This report is focused on structures on low volume roads for the purpose of providing like comparisons between options. Site conditions and considerations are so different on extremely high-volume roads, and most thru trusses are on low volume roads. Attempting to cover structures on high volume roads would expand the scope of this report to a point where the information would not be specific enough to be useful.



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## 2.1 PURPOSE & NEED

From 2012-2020, Indiana averaged more than 2 historic bridge strikes per year which caused noteworthy damage to historic structures (Obtained from Historic Bridges Programmatic Agreement Annual Reports from 2012 to 2020). In many cases, that damage resulted in costly repairs. In most cases, the damage directly impacted the historical components of the bridges. It is likely that these structures are subject to unreported, minor bridge strikes as well. It is in the interest of both historic preservation advocates and historic bridge asset owners throughout Indiana to prevent bridge strikes to these structures to preserve cultural heritage and to save infrastructure funding.

The purpose of this study is to investigate, document, and assess the various limited vertical clearance bridge warning systems which are currently available. The intent of this report is to provide information to historic bridge asset owners in Indiana to allow them to evaluate the potential implementation of overheight vehicle warning systems. The intent of this report is to understand the possible positive and negative consequences of installation of these systems to allow asset owners to determine which risk reduction measures, if warranted, are the best fit for their site.

The active preservation of historic bridges is an important part of maintaining the cultural heritage of Indiana. Few Indiana transportation assets inspire devoted following and fan pages; however, Indiana's historic bridges are the subject of online followers, Instagram pages<sup>3</sup>, and message boards<sup>4</sup>. Communities adopt historic bridges as local icons and promote them as tourism attractions. Indiana's standard license plate even features a timber, covered-bridge, through-truss.



Figure 2-2: Indiana Standard Passenger license plate featuring a covered bridge.

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<sup>3</sup> Indiana Covered Bridge Crew Instagram page: <https://www.instagram.com/coveredbridgecrew/>

<sup>4</sup> Historic Bridge Online Forums: [https://historicbridges.org/map\\_ind.php](https://historicbridges.org/map_ind.php); <https://bridgehunter.com/in/>

Vehicle collisions with historic bridges cause safety risks to road users. Along with being disruptive to the travelling public, these collisions require the utilization of local resources for the emergency response, inspection of the bridge, possible road closure, and eventual repair. When historic bridges require repairs or replacement, doing so reduces the cultural integrity of the historic asset. Repair costs, if not recovered from the vehicle operator, may be an unexpected expense to the owner.

From cost data obtained of the limited sample size of bridges that were repaired, noting that these are severe bridge strikes, the average cost of repairs exceeds \$500,000 per bridge. This figure only accounts for bridge repair costs. It does not account for loss of usage of roads or cost of local resources to respond to a bridge collision event. This figure does not account for variation in severity of collisions. See Table 2-1 below.



Figure 2-3: Overheight vehicle damage to DeKalb County Bridge No. 3 (Bridge No. 17-00003; NBI No. 1700004). September 2012. (KPC News)

Table 2-1: Sample of notable historic bridge strikes in Indiana over the past 10 years with available repair cost data:

BRIDGE	LOCATION	BRIDGE NO.	YEAR OF BRIDGE STRIKE	REPAIR COST
US 41 SB over Pigeon Creek	Evansville, Vanderburgh County	Bridge No. 41-82-03286 HSBL; NBI No. 014310	2020	\$3,564,703 <sup>5</sup>
Jackson Covered Bridge	Parke County	Bridge No. 61-00199; NBI No. 6100148	2020, 2017	Data unavailable
Richland-Plummer Creek Covered Bridge	Greene County	Bridge No. 28-00086; NBI No. 2800060	2019	Data unavailable
CR300W over Wabash River	Wells County	Bridge No. 90-00193; NBI No. 9000144	2018	Data unavailable
Holliday Road over Big Eagle Creek	Boone County	Formerly identified as Bridge No. 06-00207; NBI No. 0600140	2017	\$1,123,000 (Now a pedestrian walkway)
CR 350 W over Sugar Creek	Boone County	Bridge No. 06-00032; NBI No. 0600022	2017	\$250,000
CR 100 N over Coal Creek	Fountain County	Bridge No. 23-00131; NBI No. 2300103	2017	Data unavailable
CR 175 E over Patoka River	Orange County	Bridge No. 59-00102; NBI No. 5900070	2017	Data unavailable

<sup>5</sup> Repair cost shown for Bridge No. 41-82-03286 HSBL is based on an Opinion of Probable Cost in the alternatives analysis. The structure was replaced after an alternatives analysis found the repair to be neither feasible nor prudent due to the extent of the damage. This limited-clearance, but not low-clearance, bridge strike was the catalyst for the creation of this report.

BRIDGE	LOCATION	BRIDGE NO.	YEAR OF BRIDGE STRIKE	REPAIR COST
S Gospel St Bridge over Lick Creek	Paoli, Orange County	Bridge No. 59-00200; NBI No. 5900102	2016	\$750,000
Indiana Ave over Elkhart River	Goshen, Elkhart County	Bridge No. 20-00403; NBI No. 2000170	2016	Data unavailable
SR 135 over Indian Creek	Morgan County	Bridge No. 135-55-01522 B; NBI No. 26700	2015	\$342,279
S Boston Rd over Middle Fork Blue River	Washington County	NBI No. 8800038	2013	Data unavailable
CR 550 S over Big Walnut Creek	Putnam County	Bridge No. 67-00125; NBI No. 6700111	2013	Data unavailable
Spencerville Covered Bridge	Spencerville, Dekalb County	Bridge No. 17-00003; NBI No. 1700004	2012	\$89,000

## 2.2 APPLICABLE CODES AND STATUTES IN INDIANA

### 2.2.1 LIMITED & LOW VERTICAL CLEARANCE

Low clearance is defined as “vertical clearance less than 12 in above the statutory maximum vehicle height” (Federal Highway Administration (FHWA), 2009, Section 2C.27). According to Indiana Administrative Code (IAC) § 9-20-3-3, the statutory maximum vehicle height is 13ft 6 in. Therefore, for the purposes of this report, low clearance is defined as vertical clearances less than 14ft 6in.

“Limited Clearance” is not defined in code. Therefore, for the purposes of this report, Limited clearance is defined as any vertical clearance restriction. This notably applies to all Indiana through-truss bridges.

A through-truss bridge with portal frames higher than 14ft 6in would not be considered “low clearance” but is still “limited clearance”. There is no requirement to provide warning signage on limited clearance structures providing greater than 14ft 6in of vertical clearance.

### 2.2.2 INDIANA DOR PERMITTING SYSTEM FOR OVERSIZE LOADS

Oversized vehicles are required to obtain a permit for their designated route through the Indiana Department of Revenue (DOR), Motor Carrier Services Division website<sup>6</sup>. The permitting system is effective at route finding for oversize loads on state-owned corridors. According to Indiana law, oversized loads are vehicles that exceed 13ft 6in in height, 8ft 6in in width, 60 feet (two-vehicle combination) or 53 feet (semi-tractor-semi-trailer combination) in length, or 80,000 pounds gross vehicle weight (subject to axle weights) (Indiana Department of Revenue, 2021).

The DOR permit system considers possible routes based on the following:

<sup>6</sup> Indiana Oversize Overweight Permitting System website: <<https://www.in.gov/dor/motor-carrier-services/oversizeoverweight-osw/>>

- Load carrying capacity of bridges: When a permit is applied for, the system evaluates each bridge for the specific load and configuration to determine if a viable route is available. For super-loads, the system will push the load capacity consideration to INDOT staff to manually review the permit vehicle load ratings along the route.
- Geometry of the bridges crossed: When a permit is applied for, the system compares the height of the load provided by the carrier to the known vertical clearance of every structure in the system to determine if a viable route is available.

Even with the permitting system in place, the following factors could contribute to the probability of a bridge impact happening.

- The permitting system only considers State-owned assets, which make up a small percentage of Indiana's steel through trusses. Although carriers are legally required to obtain authorization from LPAs, LPAs rely largely on self-reporting from the hauling company and driver.
- The use of GPS and Automatic Re-routing: Automatic navigation systems do not consider the geometry of the route when determining routes and detours around slow traffic. This has been a reported issue on LPA systems during interstate slowdowns. Ultimately it is still the carrier's responsibility to stay on the approved route provided in their permit. Attempts to contact GPS technology companies by INDOT and in conjunction with the preparation of this report have not been successful.<sup>7</sup>

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## 2.3 LOW RISK & HIGH RISK STRUCTURES WITH LIMITED CLEARANCE

For the purposes of this report, limited clearance structures have been divided into two categories: low risk and high risk. These are not legal definitions and are included for clarification.

Low risk structures are defined, for the purposes of this report, as meeting all following criteria:

- Non-historic structures
- Structures with redundant structural elements (not fracture critical)
- Structures with vertical clearance greater than statutory maximum vehicle height (greater than 13ft 6 in)

High risk structures are defined, for the purposes of this report, as meeting any of the following criteria:

- Community-valued structures
- Non-redundant structures (fracture critical)
- Structures with a history of overheight vehicle bridge strikes requiring repairs or causing undue burden on asset owner
- Structures with vertical clearance lower than statutory maximum vehicle height (lower than 13ft 6in)

Ultimately, it is at the discretion of the bridge asset owner if the limited clearance structure is considered a high risk or low risk structure. Though this report does not focus on low risk structures, bridge owners could consider any of the options outlined for what might be considered low risk structures as well. The design of all measures is subject to site specific considerations and engineering judgment.<sup>8</sup>

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<sup>7</sup> Attempts to contact navigation map services were made through online feedback forms hosted on the respective applications, the only means available according to customer service, for Google Maps, Waze, and Apple Maps. INDOT's previous efforts to contact navigation map services directly were described by Ed Cox from the Traffic Management Group on January 3rd, 2022 via email as "I have had limited success in getting construction detours posted. I have had no success in anything with low clearances or avoiding city streets etc. The only way to contact them is through email feedback which is not quick."

<sup>8</sup> Based on our examination of recent strikes and anecdotal evidence from owners, both rural low volume corridors and high-volume corridor pose a risk

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## 2.4 EFFICACY

The efficacy of the measures listed in this report is generally unknown. However, when information pertaining to the performance of measure is available for a type of warning or monitoring system, it is provided.

It should be noted that some of the measures discussed in this report might benefit from being combined with targeted law enforcement at a bridge. The effectiveness of monitoring and enforcement strategies were beyond the scope of this study, which is focused on installable measures to reduce bridge strikes. However, if it is known that there are certain times when it is more likely for a limited clearance bridge to be at risk, the owner could work with local law enforcement to develop a plan for targeted monitoring and enforcement.

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## 2.5 INSTALLATION COSTS

Costs presented in this report are based on hypothetical sites, assumptions listed, and historic INDOT pricing data for the pay items listed. Installation cost data is included for reference and informational purposes only. The reference cost data and pay items shown shall not be used as a substitute for professional engineering design.

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of overheight strikes to bridges. A rural low volume corridor may have an increased risk of agricultural machinery and a high-volume road may have an increased of truck strikes. Trucks may also be detoured off planned routes which could cause strikes even when not overheight. Ultimately, it is at the bridge owner's discretion if a bridge is low risk or high risk based on traffic counts and composition.

# 3 MINIMUM REQUIRED BY CODE

## 3.1 STATIC SIGNAGE

### 3.1.1 DESCRIPTION

Static signage is required for low clearance bridges, see 3.1.2.

In Indiana, the standards for this signage are according to the Manual of Uniform Traffic Control Devices (MUTCD).

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#### MUTCD Section 2C.27 Low Clearance Signs (W12-2 and W12-2a)

##### Standard:

The Low Clearance (W12-2) sign (see Figure 2C-5) shall be used to warn road users of clearances less than 12 inches above the statutory maximum vehicle height.

##### Guidance:

*The actual clearance should be displayed on the Low Clearance sign to the nearest 1 inch not exceeding the actual clearance. However, in areas that experience changes in temperature causing frost action, a reduction, not exceeding 3 inches, should be used for this condition.*

*Where the clearance is less than the legal maximum vehicle height, the W12-2 sign with a supplemental distance plaque should be placed at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around.*

*In the case of an arch or other structure under which the clearance varies greatly, two or more signs should be used as necessary on the structure itself to give information as to the clearances over the entire roadway.*

*Clearances should be evaluated periodically, particularly when resurfacing operations have occurred.*

##### Option:

The Low Clearance sign may be installed on or in advance of the structure. If a sign is placed on the structure, it may be a rectangular shape with the appropriate legend.

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Refer to Appendix B for sample signage details.

### 3.1.2 PREFERRED APPLICATION

Static signage is required on bridges with vertical clearances less than 14ft 6in in accordance with Manual of Uniform Traffic Control Devices (MUTCD) and Indiana Code 9-20-3-3. In addition to static signage on the structure, MUTCD guidance recommends providing low clearance static signage in advance of a structure at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around when the vertical clearance is less than 13ft 6in.<sup>9</sup>



Figure 3-1: Bridge strike with static signage. Bridge shown carries Union Station railroads tracks over S Meridian Street in downtown Indianapolis. Note that after this photo was taken, flashing beacons were added to this bridge crossing.

<sup>9</sup> Advanced signage for low clearance at the nearest intersecting road, nearest off-ramp at which a vehicle can detour, or turn around was noted consistently in interviews with bridge asset owners as an important and effective reduction of strikes measure.



Bridge asset owners with a high risk bridge site (as defined by this report), may desire additional warning measures to draw the attention of motorists.

### 3.1.3 RESTRICTIONS

Static signage is required to be installed at low vertical clearance bridges. The purpose of this signage is to alert vehicles to the presence of a low clearance structure.

There are no restrictions on use of static signage use for structures with limited clearance greater than 14ft 6in or in advance of a structure at nearest intersection, turnaround, or detour point with clearance over 13ft 6in. The installation of static signage in these situations is not addressed by the code.

### 3.1.4 BENEFITS

Static signage is the least expensive option for warning vehicles of limited clearance. Minimal maintenance is required for this warning system. Maintenance is comparable to all other roadway signage.

### 3.1.5 DRAWBACKS

Although specific data is not readily available, some of the examples presented in this report and anecdotal evidence suggest that static signage is not always sufficient to prevent bridge strikes in limited clearance locations.

Potential issues:

- Static signage alone is not effective in warning drivers if the driver does not know the height of their vehicle. It is common for drivers without a Commercial Driver's License (CDL) to pilot legal loads which are at or near the statutory height limit.

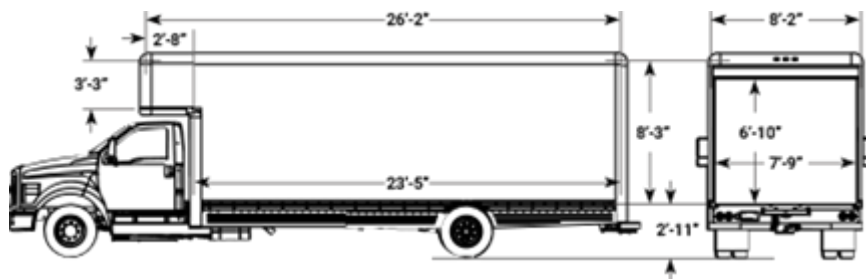


Figure 3-2: Dimensions of a 26ft U-Haul™ Moving Truck, showing a vehicle height of 11ft 1in.

Available for rental without a Commercial Driver's License (CDL)

<https://www.uhaul.com/Truck-Rentals/26ft-Moving-Truck/>

- Changes to the load itself may affect vehicle height without the driver's knowledge. Equipment containing pneumatic or hydraulic components which have malfunctioned during transport have caused major damage to Indiana bridges in recent years.<sup>10</sup>
- Anecdotal evidence from bridge asset owners largely agreed during interviews conducted for this report that some drivers do not pay attention to these signs or mistakenly believe that the signage is conservative and the listed height is lower than the actual vertical clearance, resulting in bridge strikes.

<sup>10</sup> Trucking company cited following I-465 bridge crash (WRTV 6, <<https://www.wrtv.com/news/call-6-investigators/call-6-trucking-company-cited-following-i-465-bridge-crash>> )

### 3.1.6 INSTALLATION COSTS

#### FAVORABLE SITE CONDITIONS

Assumed favorable site conditions for this type of warning system include:

- Excellent clearance area visibility
- Long sightlines
- Area with minimal competing signage for driver attention
- Low design speed
- Vertical clearance more than 13ft 6in

The estimated cost of installation at a favorable site is \$2000. This estimate assumes the following installation for cost development purposes:

- Two (2) W12-2 and W16-2p sign assemblies and posts
- Two (2) W12-2a signs and bridge brackets

#### UNFAVORABLE SITE CONDITIONS

Assumed unfavorable site conditions for this type of warning system include:

- Limited structure clearance visibility
- Short or congested sightlines
- Urban area with competing signage for driver attention
- High design speed
- Vertical clearance less than 13ft 6in

The estimated cost of installation at an unfavorable site is \$3000. This estimate assumes the following installation for cost development purposes:

- Four (4) W12-2 and W16-2p sign assemblies and posts
- Two (2) W12-2a signs and bridge brackets

### 3.1.7 MAINTENANCE

Signs should be replaced every 10 years. Tree clearing may be required for visibility of warning signs.

Signs placed on the bridge structure should be inspected as part of the routine NBI inspections. Routine bridge inspections include photo documentation and measure vertical clearance. For high-risk structures, it is good practice for owners to verify the information provided in the bridge structure inventory reports and monitor the condition of the provided signage at more frequent intervals. NBI inspections may not include photo documentation of advanced warning signs. It is good practice to routinely document advanced warning signage to supplement the data included in the NBI inspections.

# 4 ADDITIONAL PASSIVE WARNING MEASURES

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## 4.1 STATIC SIGNAGE WITH ALWAYS FLASHING LIGHTS

### 4.1.1 DESCRIPTION

Static signage is augmented by the addition of always flashing beacons or light-emitting diodes (LED) along the border of the sign to better attract the attention of the driver. Flashing lights shall be yellow in accordance with MUTCD 4L.03(02). The flashing lights can be powered using a solar panel and battery or grid power source.



Figure 4-1: 24-7 Flashing Beacon with Clearance Sign

See Appendix C for installation details.

### 4.1.2 PREFERRED APPLICATION

The addition of always flashing light is preferable for a structure with a history of being struck by vehicles at low speeds where suspected inattentive drivers are generally to blame for bridge strikes.

### 4.1.3 RESTRICTIONS

This measure may not be suitable in residential areas where constantly flashing lights may cause disruption to residents. This measure also requires a power supply, which can be provided by a readily accessible service location or by sign-mounted solar and batteries.

#### 4.1.4 BENEFITS

The always flashing lights enhances drivers' attention to the signs. Additionally, flashing beacons may draw driver's attention during dark conditions and alert drivers to the importance of the sign.

This is a relatively inexpensive means of increasing driver awareness.

#### 4.1.5 DRAWBACKS

This measure is not effective if driver does not know the height of their vehicle. The lights require electrical infrastructure (solar and battery or grid power source) for a passive system. In urban areas where there are many competing lighted signs and advertisements, the sign may still become lost in the visual noise. Drivers may mistakenly believe that signage is conservative and that the listed height is lower than actual. Drivers may become accustomed to and ignore flashing lights during repeat trips.

#### 4.1.6 INSTALLATION COSTS

##### **FAVORABLE SITE CONDITIONS**

Assumed favorable site conditions for this type of warning system include:

- Excellent clearance area visibility
- Long sightlines
- Area with minimal competing signage for driver attention
- Low design speed
- Vertical clearance more than 13ft 6in

The estimated cost of installation at a favorable site is \$12,000. This estimate assumes the following installation for cost development purposes:

- Two (2) Solar power beacon assemblies
- Two (2) W12-2 and W16-2p sign assemblies and posts
- Two (2) W12-2a signs and bridge brackets

##### **UNFAVORABLE SITE CONDITIONS**

Assumed unfavorable site conditions for this type of warning system include:

- Limited structure clearance visibility
- Short or congested sightlines
- Urban area with competing signage for driver attention
- High design speed
- Vertical clearance less than 13ft 6in

The estimated cost of installation at an unfavorable site is \$22,000. This estimate assumes the following installation for cost development purposes:

- Four (4) Solar power beacon assemblies
- Four (4) W12-2 and W16-2p sign assemblies and posts
- Two (2) W12-2a signs and bridge brackets

## 4.1.7 MAINTENANCE

Maintenance includes replacing signs every 10 years, periodically replacing bulbs when they go out, cleaning and replacing solar panels and electrical costs. Tree clearing may be required for visibility of warning signs. Routine inspection, testing and documentation of the performance of components would be needed. Usage of flashing LEDs in the border of signs instead of flashing beacons may reduce future maintenance efforts (D. Boruff, Manager of Traffic Administration, INDOT, primary source comment, March 25, 2022).

## 4.1.8 EFFICACY

The addition of flashing beacons and the associated efficacy regarding preventing bridge strikes has not been studied. However, a study on the effectiveness on flashing beacons in reducing accidents at a hazardous rural curve “revealed a 50 percent reduction in total accidents but a 91 percent reduction in accidents of the speed/lost-control/fixed-object type – the type expected to be most directly affected by the installation of a flashing beacon” (Janoff & Hill, 1986). An FHWA evaluation of the safety of intersection conflict warning systems which comprise of warning signs and flashing yellow warning lights found that it improved safety at non-signalized, stop-controlled intersections by reducing severe crashes by up to 20 to 30 percent (Federal Highway Administration, 2016). These findings suggest improvement in other signed roadway situations featuring flashing lights such as overheight vehicle bridge strikes but would require further study to corroborate.

Engineering judgement points to the conclusion that the presence of these flashing beacons increases attention from drivers to limited clearance signage.

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## 4.2 RIGID VERTICAL CLEARANCE BAR ATTACHED TO BRIDGE (NOT RECOMMENDED)

### 4.2.1 DESCRIPTION

Static signage can be augmented by a fixed rigid bar, set equal to or below the limited clearance height of the structure, attached to the portal of the protected limited clearance structure.

The intent of the bar, colloquially known as a "headache bar", is to alert drivers to the limited clearance via collision with the overheight vehicle, potentially stopping or damaging the overheight vehicle. Rigid vertical clearance bars are stationary structures which convey height restrictions through visual, physical impact, and auditory means.

The following are installation examples of rigid vertical clearance bars attached to bridges:



**JACKSON COVERED BRIDGE (BRIDGE NO. 61-00199; NBI NO. 6100148)**

Figure 4-2: Vertical clearance bar constructed at entrance of Jackson Covered Bridge in Parke County,

- Location: Parke County, IN
- Unique Features: Warning painted on vertical clearance bar.

**NORTH MANCHESTER COVERED BRIDGE  
(BRIDGE NO. 85-00645, NBI NO. 8500685)**



Figure 4-3: Vertical clearance bar constructed at entrance of North Manchester Covered Bridge in Wabash County, IN.

- Location: Wabash County, IN
- Unique Features: Signage is placed on vertical clearance bar

**CR 100 E OVER WABASH RIVER BRIDGE  
(BRIDGE NO. 86-00036, NBI NO. 8600029)**



Figure 4-4: Vertical clearance bar constructed at entrance of CR100E over Wabash River bridge in Warren County, IN.

- Location: Warren County, IN
- Unique Features: Signage is placed on vertical clearance bar



## 4.2.2 PREFERRED APPLICATION

The use of this type of Passive Warning Measure is not recommended for new installations for the following reasons:

- The owner of the protected asset assumes additional liability by installing a potential hazard in the vehicle path. While the bridge itself is equal in vertical clearance to the installed headache bar, the bridge is an existing condition. Installation of a new hazard at a low clearance is introducing additional hazards to the roadway system.
- Headache bar may dislodge upon impact and be thrown into traffic.
- Headache bar attached to the structure portal may still damage the structure during impact loading.
- Installation of new infrastructure in low clearance situations violates AASHTO guidance for highway design. See 4.2.3.

## 4.2.3 RESTRICTIONS

AASHTO Policy for highway design limits the installation of structures above the traveled way, even in advance of lesser clearance.

“The vertical clearance of all structures above the traveled way and shoulders should be at least 1 ft [0.3 m] greater than the legal vehicle height, and allowance should be made for future resurfacing.” (AASHTO A Policy on Geometric Design of Highways and Streets 10.8.4.2)

“Vertical clearance shall be provided of not less than 17 ft to the sign, light fixture, walkway, or sign bridge over the entire width of the pavement and shoulders unless the grade separation structures or other structures nearby have lesser vertical clearance. In cases of lesser clearance, the overhead sign support may be as low as 1 ft higher than the vertical clearance of other supports.” 2.4.2.1—Vertical Clearances, LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

## 4.2.4 BENEFITS

This vertical clearance bar may protect limited clearance structures from direct collision. The bar can be made to be aesthetically unobtrusive by fashioning it to match the construction style of the associated historic bridge.

## 4.2.5 DRAWBACKS

Overheight vehicle may be damaged by the collision with vertical clearance bar. Additionally, the structure may still sustain damage if struck as it is attached to the structure. The addition of a vertical clearance bar attached to the bridge alters the aesthetics of the historic structure. In a situation where an overheight vehicle hits the vertical clearance bar, the collision could result in debris on the roadway which may put other motorists at risk (A. Rearick, Director of Bridge Management, INDOT, primary source interview, March 31, 2020).

It stands to reason that the level of risk to motorists, posed by collision with vertical clearance bars, is lower on urban, low-speed roads, compared to highway structures. An example of an urban, low-speed road is the Paoli Gospel Street Bridge, see figure 4-5. However, we did not find specific data to support this reduced risk in code.

## 4.2.6 INSTALLATION COSTS

The use of this type of Passive Warning Measure is not recommended.

## 4.2.7 MAINTENANCE

Replacing/repairing Vertical Clearance Bar after being struck by overheight vehicle. Inspection and documentation that the bar is in place and not damaged should be performed during routine bridge inspections. Tree clearing may be required for visibility of warning signs.

## 4.2.8 EFFICACY

The efficacy of vertical clearance bars placed in advance or at a bridge in reducing overheight vehicle collisions could not be determined quantitatively due to lack of definitive data. However, based on surveys from state DOTs, passive systems have been shown to result in a “slight reduction” in overheight vehicle collisions at structures where they are installed (Mattingly, 2003). Note that the overall efficacy of these systems has not been widely studied.

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## 4.3 FREESTANDING PORTAL FRAME VERTICAL CLEARANCE BAR (NOT RECOMMENDED)

### 4.3.1 DESCRIPTION

Static signage can be augmented by a fixed rigid portal frame, set equal in elevation to the vertical clearance of the structure, placed in advance of a limited clearance structure. The intent of the bar, colloquially known as a "headache bar", is to alert drivers to the limited clearance via advanced collision with the overheight vehicle, potentially stopping or damaging the overheight vehicle. Rigid vertical clearance bars are stationary structures which convey height restrictions through visual, physical impact, and auditory means.

#### **GOSPEL STREET BRIDGE (BRIDGE NO. 59-00200, NBI NO. 5900102)**



Figure 4-5: Portal frame placed in advance of Gospel Street Bridge in Paoli, Orange County, IN.

- Location: Paoli, Orange County, IN
- Unique Features: Frame was fashioned to match the style of the bridge.

### 4.3.2 PREFERRED APPLICATION

The use of this type of Passive Warning Measure is not recommended for new installations for the following reasons:

- The owner of the protected asset assumes additional liability by installing a potential hazard in the vehicle path. While the bridge itself is equal in vertical clearance to the installed headache bar, the bridge is an existing condition. Installation of a new hazard at a low clearance is introducing additional hazards to the roadway system.
- Headache bar may dislodge upon impact and be thrown into traffic.

- Installation of new infrastructure in low clearance situations violates AASHTO guidance for highway design. See 4.3.3.

### **4.3.3 RESTRICTIONS**

AASHTO Policy for highway design limits the installation of structures above the traveled way, even in advance of lesser clearance.

“The vertical clearance of all structures above the traveled way and shoulders should be at least 1 ft [0.3 m] greater than the legal vehicle height, and allowance should be made for future resurfacing.” (AASHTO A Policy on Geometric Design of Highways and Streets 10.8.4.2)

“Vertical clearance shall be provided of not less than 17 ft to the sign, light fixture, walkway, or sign bridge over the entire width of the pavement and shoulders unless the grade separation structures or other structures nearby have lesser vertical clearance. In cases of lesser clearance, the overhead sign support may be as low as 1 ft higher than the vertical clearance of other supports.” 2.4.2.1—Vertical Clearances, LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

### **4.3.4 BENEFITS**

This vertical clearance bar may protect limited clearance structures from direct collision. The bar can be made to be aesthetically unobtrusive by fashioning it to match the construction style of the associated historic bridge.

### **4.3.5 DRAWBACKS**

Overheight vehicle may be damaged by the collision with vertical clearance bar. Additionally, the structure may still sustain damage if the vertical clearance bar is installed near enough to the structure or if it is struck by debris from the collision with the vertical clearance bar. The addition of a vertical clearance bar in advance of the bridge alters the view of the historic structure. In a situation where an overheight vehicle hits the vertical clearance bar, the collision could result in debris on the roadway which may put other motorists at risk (A. Rearick, Director of Bridge Management, INDOT, primary source interview, March 31, 2020).

### **4.3.6 INSTALLATION COSTS**

The use of this type of passive warning measure is not recommended.

### **4.3.7 MAINTENANCE**

The maintenance associated with this warning measure includes replacing or repairing vertical clearance bar after being struck by overheight vehicle. Inspection and documentation that the bar is in place and not damaged should be performed during routine bridge inspections. Tree clearing may be required for visibility of warning signs.

### **4.3.8 EFFICACY**

The efficacy of vertical clearance bars placed in advance or at a bridge in reducing overheight vehicle collisions could not be determined quantitatively due to lack of definitive data. However, based on surveys from state DOTs, passive systems have been shown to result in a “slight reduction” in overheight vehicle collisions at structures where they are installed (Mattingly, 2003). Note that the overall efficacy of these systems has not been widely studied.

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## 4.4 FLEXIBLE VERTICAL CLEARANCE BAR

### 4.4.1 DESCRIPTION

Static signage is augmented by a flexible vertical clearance bar, set equal in elevation to the vertical clearance of the structure, placed in advance of a limited clearance structure. The lightweight, high visibility flexible bar should prominently display the maximum vertical clearance, and may be supported by chains, cables, or other non-rigid break-away means to avoid damage to errant overheight vehicles.

#### **CR 300 W OVER WABASH RIVER BRIDGE (BRIDGE NO. 90-00193, NBI NO. 9000144)**



Figure 4-6: Flexible vertical clearance bar ahead of bridge on in Wells County, IN

- Location: Wells County, IN
- Unique Features: Flexible vertical clearance bar is attached to a standard cantilever signpost with chains.

### 4.4.2 PREFERRED APPLICATION

The use of this type of passive warning measure is preferable for a structure with a history of being struck in rural settings, especially low speed roadways.

Installation details are included in Appendix D.

This passive warning system should be designed in combination with an exit or turnaround to allow for the driver to safely avoid collision with the bridge

### 4.4.3 RESTRICTIONS

Support structures shall be designed in accordance with the LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals and other applicable AASHTO codes. The flexible vertical clearance bars and/or the support structures they are mounted on should meet the Manual for Assessing Safety Hardware (MASH) crashworthiness standards. The structures would have to be placed outside the clear zone or be protected by guardrail or barrier wall.

As of the date of this report, there are currently no systems for flexible vertical clearance bars that have been MASH approved. MASH approval requires a field crash test study of the device.

“The vertical clearance of all structures above the traveled way and shoulders should be at least 1 ft [0.3 m] greater than the legal vehicle height, and allowance should be made for future resurfacing.” (AASHTO A Policy on Geometric Design of Highways and Streets 10.8.4.2)

“Vertical clearance shall be provided of not less than 17 ft to the sign, light fixture, walkway, or sign bridge over the entire width of the pavement and shoulders unless the grade separation structures or other structures nearby have lesser vertical clearance. In cases of lesser clearance, the overhead sign support may be as low as 1 ft higher than the vertical clearance of other supports.” 2.4.2.1—Vertical Clearances, LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals

“Each new overhead sheet sign installation will require a minimum vertical clearance of 17'-6” above the roadway and shoulders’ highest point, but not greater than 19'-0”. Each new overhead panel sign will require a vertical clearance above the roadway and shoulders’ highest point of 17'- 6”. This includes an additional 6 in. clearance for a future overlay” (Indiana Design Manual 502-1.01(06) Overhead Sign)

While not specifically mentioned and requires additional clarification, a flexible warning device is not specifically prohibited by code as interpreted. This report recommends further study and clarification from AASHTO and future inclusion in subsequent editions of the LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

#### **4.4.4 BENEFITS**

There is a reduced risk of high impact collisions or causing damage to overheight vehicles or producing debris that may strike other vehicles in comparison to other vertical clearance bars. This measure only warns drivers when vehicle is overheight. This system does not require driver knowledge to indicated overheight.

#### **4.4.5 DRAWBACKS**

The installation of this vertical clearance bar may impact the aesthetics of the historic bridge & area surrounding it. Since the vertical clearance bar is flexible and is designed to move when hit, it may swing in windy conditions. Drivers may not notice or ignore striking the vertical clearance bar.

For this reason, installation for low-speed bridge approaches is preferred unless specific design features are included to reduce the effect of windy conditions and vehicle wake on the flexible warning device.

#### **4.4.6 INSTALLATION COSTS**

##### **FAVORABLE SITE CONDITIONS**

Assumed favorable site conditions for this type of warning system include:

- 2-lane bidirectional roadway at low speed

The estimated cost of installation at a favorable site is \$50,000. This estimate assumes the following installation for cost development purposes:

- Two (2) Sign monotube structures
- Four (4) Signal Strain Foundations
- Four (4) Chains & (2) Tubular Markers

## **UNFAVORABLE SITE CONDITIONS**

Assumed unfavorable site conditions for this type of warning system include:

- 4-lane separated bidirectional roadway
- Monotube Poles/Foundations inside Clear Zone

The estimated cost of installation at an unfavorable site is \$72,000. This estimate assumes the following installation for cost development purposes:

- (2) Sign monotube structures
- (4) Signal Strain Foundations
- (4) Chains & (2) Tubular Markers
- (4) 100' of Guardrail for Monotube Protection

### **4.4.7 MAINTENANCE**

The vertical clearance bar would require replacing or repairing after being struck by overheight vehicle, if damaged. Inspection and documentation that the bar is in place and not damaged should be performed during routine bridge inspections. If guardrail or barrier wall is not already present, routine maintenance of installed guardrail would have to be performed. Tree clearing may be required for visibility of warning signs.

### **4.4.8 EFFICACY**

The efficacy of vertical clearance bars placed in advance or at a bridge in reducing overheight vehicle collisions could not be determined quantitatively due to lack of definitive data. However, based on surveys from state DOTs, passive systems have been shown to result in a “slight reduction” in overheight vehicle collisions at structures where they are installed (Mattingly, 2003). Note that the overall efficacy of these systems has not been widely studied.



# 5 ACTIVE WARNING MEASURES

Active overheight vehicle detection systems (OHVDS) are commercially available in the United States. These systems consist of a detection point coupled with warning signs. These systems, when triggered, are designed to actively alert only those vehicles which are overheight.

While elaborate systems and custom systems are available, and more prevalent in other countries, this report will focus on commonly installed and available systems in the United States.

The OHVDS work using pairs of sensors (one light transmitter and one receiver) which transmit and detect infrared or visible red beams that are installed at the height of the available vertical clearance. When the sensor beams are blocked, the constant light beam is interrupted, and a computer or circuit detects the interruption, which then activates the warning system.

These types of detection systems are very similar, technologically, to garage door obstruction sensors and elevator obstruction sensors<sup>11</sup>.

These OHVDS warning systems are linked to further advance warning signage and messaging systems, commonly consisting of:

- Static sign with flashing beacons activated by the OHVDS
- LED blankout signs activated by the OHVDS
- dynamic message signs activated by the OHVDS
- Auditory messaging or alarm activated by the OHVDS

Major manufacturers include TAPCO and TRIGG Industries who offer commercially available systems in the United States. Based on our research, there are additional manufacturers available outside of the United States market. However, for the purposes of this report, we did not contact them directly. Bespoke installations using available off-the-shelf electronics are available as well. TAPCO system specification guide is included in Appendix E. TRIGG system specification guide is included in Appendix E. It is beyond the scope of this report to examine the differences between these manufacturer's systems.

This report section focuses on multi-beam OHVDS sensors<sup>12</sup>, as further described in 5.1.

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<sup>11</sup> “The mandatory rule (16 CFR part 1211) primarily requires that all residential GDOs (Garage Door Openers) sold in the United States have an inherent reversing mechanism capable of reversing the motion of a moving garage door within 2 seconds, to reduce the risk of entrapment. [...] In addition, the rule requires that the operator shall be provided with a means for connection of an external entrapment-sensing device. Most GDOs on the market today use an electric eye as the external entrapment-sensing device. The purpose of this device is to monitor the area under the garage door to detect people who might become entrapped by the garage door. The standard also allows a device, known as a “door edge sensor,” similar to the sensors used on elevator doors, or allows for any other device that provides equivalent protection.” Federal Register << <https://www.federalregister.gov/documents/2018/07/13/2018-14909/safety-standard-for-automatic-residential-garage-door-operators>>>

<sup>12</sup> Note: While single-beam detection systems exist, they are not generally suitable or recommended for highway application. Single-beam detection systems will activate whenever the single sensor beam is blocked. In addition to detecting overheight vehicles, false warning activation may occur when a bird, leaf, or other debris blocks the single sensor. By pairing two parallel sensors in proximity (Dual Beam & “Z”- Pattern), the number of false (non-vehicular) detections is greatly reduced for a negligible increase in cost when compared to mounting equipment and other installation costs.

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## 5.1 DUAL BEAM/“Z-PATTERN” OVERHEIGHT VEHICLE DETECTION

### 5.1.1 DESCRIPTION

The dual beam sensors comprise of a transmitter and detector with two infrared or visible red beams between them (Refer to Appendix E, Sheet 6 for detector details).

The z-pattern sensors comprise of a “master” and “remote” where both sensors house one transmitter and one detector, and the “master” is connected to the warning system (Refer to Appendix E, Sheet 6 for detector details). This detection system automatically switches to a single beam detection mode if the sun or other interference saturates one detector.

The following additional features are available for customizing the detection and warning system to the site:

- Sensors with heated lenses for winter conditions
- Remote notification system to provide timestamped email notifications each time the sensor is activated.
- Audible warning systems (alarm bell/horn/siren)
- Solar power (Location dependent)

### WEST CENTRAL AVENUE RAILWAY OVERPASS

System Type: Z-Pattern Detectors with 24-7 Flashing Beacons and Dynamic Message Sign

Location: Delaware, Delaware County, OH

Unique Features: Outfitted with a camera with a live feed to monitor truck turnarounds.



Figure 5-2: Sensors at intersection.



Figure 5-1: Signage at low clearance bridge.



Figure 5-3: Dynamic Message Sign with warning message.



Figure 5-4: 24-7 Flashing Beacon with Clearance Sign

This installation includes the use of always flashing beacons to enhance drivers' attention to the low vertical clearance sign.

### **KARL BROWN WAY TRAIN TRESTLE**

System Type: Detectors with Warning Beacons

Location: Loveland, Clermont County, OH

Unique Features: Outfitted with a siren



Figure 5-5: Advance static signage.



Figure 5-6: Advance signage with sensor-triggered flashing lights and static signage on low clearance bridge.





Figure 5-7: Siren.



Figure 5-8: Sensors at intersection.

This installation is particularly beneficial in this location due to the alignment of the approach roadway which hinders drivers' direct view of the structure until directly in front of it. This installation includes a siren which is not recommended in residential areas where sirens may cause noise pollution or disruptions to the public.

## 5.1.2 PREFERRED APPLICATION

This dual beam detection system is direction discerning and therefore, suited for applications on bidirectional roads.

The "Z-Pattern" detection system is also direction discerning and suited for application on bidirectional roads. The "Z-Pattern" system has receivers and transmitters on both sides, allowing for redundancy when faced with excessive snow, rain, and sun glare during sunrise and sunset when the intense sunlight is near parallel to the sensors. Therefore, it performs more reliably in than dual beam detection for applications on North-South roadways or roadways with bad weather conditions.

Advance warning static signage is recommended in addition to an overheight vehicle detection system connected to a warning system. A dedicated dynamic message sign or LED blankout sign which only displays a warning message when the detection system is activated is preferred by the manufacturer for capturing a possible overheight vehicle driver's attention (S. Slade, TRIGG Industries, primary source interview, May 20, 2021). This detection and warning system should be designed in combination with an exit or turnaround to allow for the driver to safely avoid collision with the bridge.

Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations. Design drawings are shown in Appendix E.

- Refer to Sheet 1 for typical details for a 2-Lane bidirectional road with an exit preceding the bridge.
- Refer to Sheet 2 for typical details for a 2-Lane one-way road with an exit preceding the bridge.

- Refer to Sheet 3 for typical details for a 2-Lane bidirectional road with a turnaround area<sup>13</sup> preceding the bridge.
- Refer to Sheet 4 for typical signage details.
- Refer to Sheet 5 for typical section views at overheight vehicle detectors and at bridge.
- Refer to Sheet 6 for typical overheight vehicle detector types.
- Refer to Sheet 7 for suggested camera placement.

### 5.1.3 RESTRICTIONS

Applications on a multi-lane highway or road increases the risk of confusing messaging for motorists. If it is unclear to the vehicle operators which vehicle is overheight and being detected, this may decrease the overall efficacy of the warning. This issue could be mitigated with a multilane sign with beacons over each lane and separate detection but this warning system would be subject to increased construction and design costs (D. Boruff, Manager of Traffic Administration, INDOT, primary source interview, April 12, 2021). This measure also requires a power supply.

### 5.1.4 BENEFITS

These systems do not require impact with overheight vehicle to provide warning to driver, preventing repeated damage to warning system and subsequent repairs. These systems also only warn drivers when vehicle is overheight. These systems do not require the driver to know height of their vehicle to work.

The z-pattern detectors are less likely to malfunction compared to the dual beam detection because the detector setup is less prone to being oversaturated with sunlight.

### 5.1.5 DRAWBACKS

These modern looking systems may impact the aesthetics of the historic bridge & area surrounding it. There is also the risk of the system malfunctioning (i.e., false detection) or not functioning. Drivers may think vehicle is not overheight in case of false negative malfunction. Drivers may ignore warning in case of repeated false positive malfunction. This risk can be reduced (but not eliminated) by using static signage in conjunction with LED Blankout signage, that may serve as a warning in a case where the system does not function as intended.

If an overheight vehicle comes to an abrupt stop on the roadway after reading the warning signs, it may cause safety risks to other drivers. For this reason, it is desirable to provide appropriate advanced warning signage and provide a safe turnaround or exit maneuver for trucks to avoid hitting the bridge. (See Appendix E, Sheet 3 for suggested signage and turnaround layout for low-volume roads.)

### 5.1.6 INSTALLATION COSTS

#### FAVORABLE SITE CONDITIONS (DUAL BEAM)

Assumed favorable site conditions for this type of warning system include:

- 2-lane Bidirectional Road with Exit Example
- Excellent clearance area visibility
- Long sightlines- Area with minimal competing signage for driver attention

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<sup>13</sup> Turnarounds can be costly and intrusive to natural areas (environmental impacts) where many historic structures are. Turnaround area available should be considered in the design of all measures.

The estimated cost of installation at a favorable site is \$129,000. This estimate assumes the following installation for cost development purposes:

- Four (4) Panel Signs (9'x6')
- Eight (8) Sign Posts, and (8) Foundations
- Two (2) LED Blank Out Signs on Signal Cantilevers with Foundations
- Two (2) Detector Systems on Telescoping Poles
- Two (2) Controllers with Wireless Communications
- Service Point

NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.

### **UNFAVORABLE SITE CONDITIONS (DUAL BEAM)**

Assumed unfavorable site conditions for this type of warning system include:

- 2-lane Bidirectional Road with Turnaround Example
- Excellent clearance area visibility
- Long sightlines- Area with minimal competing signage for driver attention
- Signal cantilever structure inside clear zone

The estimated cost of installation at an unfavorable site is \$142,000 + cost of turnaround construction. This estimate assumes the following installation for cost development purposes:

- Four (4) Panel Signs (12'x6' and 11'x6')
- Eight (8) Sign Posts, and (8) Foundations
- Two (2) LED Blank Out Signs on Signal Cantilevers with Foundations
- Two (2) Detector Systems on Telescoping Poles
- Two (2) Controllers with Wireless Communications
- Service Point
- 100' of Guardrail for each signal cantilever

NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.

NOTE: The cost of the turnaround was not estimated due to the potentially extreme variability in existing conditions of proposed sites.

### **FAVORABLE SITE CONDITIONS (Z-PATTERN)**

Assumed favorable site conditions for this type of warning system include:

- 2-lane Bidirectional Road with Exit Example
- Excellent clearance area visibility
- Long sightlines- Area with minimal competing signage for driver attention

The estimated cost of installation at a favorable site is \$135,000. This estimate assumes the following installation for cost development purposes:

- Four (4) Panel Signs (9'x6')
- Eight (8) Sign Posts, and (8) Foundations
- Two (2) LED Blank Out Signs on Signal Cantilevers with Foundations



- Two (2) Detector Systems on Telescoping Poles
- Two (2) Controllers with Wireless Communications
- Service Point

NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.

**UNFAVORABLE SITE CONDITIONS (Z-PATTERN)**

Assumed unfavorable site conditions for this type of warning system include:

- 2-lane Bidirectional Road with Turnaround Example
- Excellent clearance area visibility
- Long sightlines- Area with minimal competing signage for driver attention
- Signal cantilever structure inside clear zone

The estimated cost of installation at an unfavorable site is \$148,000 + cost of turnaround construction. This estimate assumes the following installation for cost development purposes:

- Four (4) Panel Signs (12'x6' and 11'x6')
- Eight (8) Sign Posts, and (8) Foundations
- Two (2) LED Blank Out Signs on Signal Cantilevers with Foundations
- Two (2) Detector Systems on Telescoping Poles
- Two (2) Controllers with Wireless Communications
- Service Point
- 100' of Guardrail for each signal cantilever

NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.

NOTE: The cost of the turnaround was not estimated due to the potentially extreme variability in existing conditions of proposed sites.

**5.1.7 MAINTENANCE**

Maintenance needed of the detection and warning system will vary based on the location of installation. Anticipated maintenance is similar to other traffic detection devices installed in Indiana and subject to weather and outdoor conditions. Maintenance should be considered when selecting system for location. For example, trees may create additional maintenance for systems with sensors and therefore may be deemed to be less feasible at those locations. Prior to installation, the asset owner should consider maintenance needs and coordinate maintenance responsibilities with appropriate agencies. Routine inspection, testing and documentation of the performance of components would be needed.

Table 5-1: Expected Maintenance Work and Frequency

MAINTENANCE WORK	EXPECTED FREQUENCY
Cleaning sensor lenses	As needed. Typically, semi-annually or quarterly
Testing sensor	Annually
Replacing electromechanical part	Every 15-25 years

## 5.1.8 EFFICACY

Most state departments of transportation that use an active warning system have not reported performance data on the systems in place (Maghiar, et. al., 2017).

Based on data from two pilot project sites in Houston, Texas, there was an 75% average reduction in bridge strikes compared over the same 3-month period in 2015 and 2014 before and after installing the detection and warning system. There were 13 strikes in the before period of the study and 2 strikes in the after period. The type of system installed at these pilot locations was comprised of z-pattern detectors, an integrated camera with image capture and video capture capabilities, wireless communication to provide real-time alerts, and a dedicated dynamic message sign with top mounted flashing beacons (Stevens et. al., 2015).

In Delaware, Ohio, after the installation of the z-pattern detection and dynamic message sign warning systems, there was a reduction in bridge strikes of 60% from 2018 to 2019 with a noted decrease in severity of strikes (Access Delaware, 2020).

The available evaluations are based on 3 locations over a limited study period and does not account for changes in truck traffic volumes. There is not a large enough sample size to draw definitive conclusions.

Generally, this is an area of study with very limited data. Anecdotally, and based on a handful of monitored sites, a reduction in frequency of bridge strikes is anticipated with an OHVDS. Based on these studies alone, there was an average reduction in bridge strikes of 60% to 75%. This information is promising but includes an extremely limited sample size.

The reduction in strikes will be dependent on the site, quality of the design, availability of turn-around areas, and ease and availability of appropriate detour route.

# 6 ADDITIONAL MONITORING SYSTEMS

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## 6.1 CAMERA (CCTV) MONITORING SYSTEM

### 6.1.1 DESCRIPTION

A monitoring system for all traffic is a camera placed in advance of a bridge to monitor overheight vehicles that attempt to cross limited vertical clearance bridges. The video feed for this type of monitoring system runs 24/7.

A detection activated monitoring system is a camera placed in advance of a bridge to monitor overheight vehicles that attempt to cross limited vertical clearance bridges. The video feed for this type of monitoring system is activated when an overheight vehicle is detected via overheight vehicle sensors.

### 6.1.2 PREFERRED APPLICATION

This monitoring system is ideally installed with an additional warning device as it may not be effective without another system in place.

### 6.1.3 RESTRICTIONS

Cameras are not used for red-light or speed enforcement in Indiana per the Insurance Institute for Highway Safety (IIHS)<sup>14</sup>. The closest analog in the Indiana Code refers to overweight vehicle detection via cameras through the weigh-in-motion pilot program. The relevant Indiana Code statute is as follows:

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#### *IC 8-2.1-28-4 Rules*

*Sec. 4. The department may adopt rules under IC 4-22-2 to carry out this chapter. If the department adopts rules under this section, the rules must establish the following:*

*(1) Technical standards for the installation of electronic weigh-in-motion stations, including:*

*(A) roadway sensors;*

*(B) cameras;*

*(C) laser measurement devices;*

*(D) roadway pressure sensors;*

*(E) speed sensors; and*

*(F) all other equipment necessary to establish electronic weigh-in-motion stations.*

*(2) Weight tolerances for electronic weigh-in-motion stations, frequency of testing of weight tolerances, and certification programs for weight tolerances.*

*(3) Smoothness standards for approach and departure pavement, and a program to monitor roadway smoothness affecting electronic weigh-in-motion stations.*

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Automated enforcement of overheight vehicles is not part of Indiana Code. The use of CCTV recording for the monitoring of bridge structures is not prohibited. However, any videos obtained cannot be legally used for evidence during a bridge strike event.

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<sup>14</sup> <https://www.iihs.org/topics/red-light-running/automated-enforcement-laws>

## **6.1.4 BENEFITS**

Knowledge of monitoring and recording devices may deter drivers who know their vehicle is overheight from using the route.

## **6.1.5 DRAWBACKS**

Monitoring systems may not be effective for prevention unless used in conjunction with other warning devices. Monitoring devices may not be effective if driver does not know the height of their vehicle.

CCTV monitoring systems require owner monitoring and data storage operations, equipment inspections, and associated maintenance costs. Is it conceivable that artificial intelligence may be implemented in the future to assist owners in monitoring for overheight vehicles and flagging video recordings.

## **6.1.6 INSTALLATION COSTS**

Assumed site conditions for this type of warning system include:

- Existing site pole and mounting hardware available
- Easily accessible electrical service connection

The estimated cost of installation is \$9,000 - \$15,000. This estimate assumes the following installation for cost development purposes:

- CCTV Camera Assembly

## **6.1.7 MAINTENANCE**

The maintenance associated with this monitoring system includes cleaning camera lenses, electricity costs, wireless costs, periodic replacement (3-5 years) of camera and camera equipment. Detection activated monitoring systems, if used in conjunction with cameras, would also require adjustments or calibration of sensors. Tree clearing may be required in the line of sight of monitoring systems. Routine inspection, testing and documentation of the performance of components would be needed.

# 7 SUMMARY OF VERTICAL CLEARANCE MEASURES

Table 7-1: Summary of limited vertical clearance bridge warning measures.

Type of System	Description	Preferred Applications	Restrictions	Benefits	Drawbacks	Installation Cost Range * (Favorable Site Conditions)	Installation Cost Range * (Unfavorable Site Conditions)	Maintenance	
Minimum Required by Code	Static Signage	<ul style="list-style-type: none"> <li>-The Low Clearance (W12-2) sign (see Figure 2C-5) shall be used to warn road users of clearances less than 12 inches above the statutory maximum vehicle height<sup>1</sup>.</li> <li>-The Low Clearance sign may be installed on or in advance of the structure* - (IMUTCD 2C.27)</li> </ul>	<ul style="list-style-type: none"> <li>- Required on bridges with vertical clearances less than 14ft 6in in accordance with IMUTCD and IC 9-20-3-3.</li> <li>- Recommended in advance of a structure at the nearest intersecting road or wide point in the road at which a vehicle can detour or turn around when the vertical clearance is less than 13ft 6in.</li> </ul>	<ul style="list-style-type: none"> <li>- Installation required for low vertical clearance structures<sup>2</sup>.</li> <li>- May be used for limited clearance<sup>3</sup> structures, but not required.</li> </ul>	<ul style="list-style-type: none"> <li>- This is the minimum required advanced warning system as required by MUTCD.</li> <li>- Least expensive option for notifying vehicles as required by code.</li> <li>- Minimal maintenance required for warning system, comparable to all other roadway signage.</li> </ul>	<ul style="list-style-type: none"> <li>- Strong anecdotal evidence from multiple independent sources note that static signage is not sufficient on its own to prevent bridge strikes in limited clearance locations.</li> <li>- Not effective if driver does not know the height of their vehicle.</li> </ul>	<p>\$2,000</p> <p>Defined as a site with:</p> <ul style="list-style-type: none"> <li>- Excellent clearance area visibility</li> <li>- Long sightlines</li> <li>- Area with minimal competing signage for driver attention</li> <li>- Low design speed</li> <li>- Vertical clearance more than 13ft 6in</li> </ul> <p>Assumed Installation for cost development purposes:</p> <ul style="list-style-type: none"> <li>- (2) W12-2 and W16-2p sign assemblies and posts</li> <li>- (2) W12-2a signs and bridge brackets</li> </ul>	<p>\$3,000</p> <p>Defined as a site with:</p> <ul style="list-style-type: none"> <li>- Limited structure clearance visibility</li> <li>- Short or congested sightlines</li> <li>- Urban area with competing signage for driver attention</li> <li>- High Design Speed</li> <li>- Vertical clearance less than 13ft 6in</li> </ul> <p>Assumed Installation for cost development purposes:</p> <ul style="list-style-type: none"> <li>- (4) W12-2 and W16-2p sign assemblies and posts</li> <li>- (2) W12-2a signs and bridge brackets</li> </ul>	<ul style="list-style-type: none"> <li>- Signs should be replaced every 10 years</li> <li>- Tree clearing may be required</li> </ul>
	Static Signage with Always Flashing Lights	<ul style="list-style-type: none"> <li>- Static signage is augmented by the addition of always flashing beacons or LED lights along the border of the sign to better attract the attention of the driver.</li> </ul>	<ul style="list-style-type: none"> <li>- Preferable for a structure with a history of being struck by vehicles at low speeds where suspected inattentive drivers are generally to blame for bridge strikes.</li> </ul>	<ul style="list-style-type: none"> <li>- Not suitable to residential areas where constantly flashing lights may cause disruption to residents.</li> <li>- Requires power supply.</li> </ul>	<ul style="list-style-type: none"> <li>- Enhances drivers' attention to the signs.</li> </ul>	<ul style="list-style-type: none"> <li>- Not effective if driver does not know the height of their vehicle.</li> <li>- Requires electrical infrastructure (solar &amp; battery or grid power source).</li> <li>- May become lost in visual noise in urban areas with competing lighted signs or advertisements.</li> <li>- Drivers may become accustomed to and ignore beacons during repeat trips.</li> </ul>	<p>\$12,000</p> <p>Defined as a site with:</p> <ul style="list-style-type: none"> <li>- Excellent clearance area visibility</li> <li>- Long sightlines</li> <li>- Area with minimal competing signage for driver attention</li> <li>- Low design speed</li> <li>- Vertical clearance more than 13ft 6in</li> </ul> <p>Assumed Installation for cost development purposes:</p> <ul style="list-style-type: none"> <li>- (2) Solar power beacon assemblies</li> <li>- (2) W12-2 and W16-2p sign assemblies and posts</li> <li>- (2) W12-2a signs and bridge brackets</li> </ul>	<p>\$22,000</p> <p>Defined as a site with:</p> <ul style="list-style-type: none"> <li>- Limited structure clearance visibility</li> <li>- Short or congested sightlines</li> <li>- Urban area with competing signage for driver attention</li> <li>- High design speed</li> <li>- Vertical clearance less than 13ft 6in</li> </ul> <p>Assumed installation for cost development purposes:</p> <ul style="list-style-type: none"> <li>- (4) Solar power beacon assemblies</li> <li>- (4) W12-2 and W16-2p sign assemblies and posts</li> <li>- (2) W12-2a signs and bridge brackets</li> </ul>	<ul style="list-style-type: none"> <li>- Signs should be replaced every 10 years</li> <li>- Tree clearing may be required</li> <li>- Periodically replacing bulbs when they go out</li> <li>- Cleaning and replacing solar panels</li> <li>- Electrical costs</li> <li>- Routine inspection, testing and documentation of the performance of components</li> </ul>
Additional: Passive Warning Measures	Rigid Vertical Clearance Bar attached to Bridge	<ul style="list-style-type: none"> <li>- Static signage is augmented by a fixed rigid bar, set equal to or lower in elevation to the limited clearance height of the structure, attached to the portal of the protected limited clearance structure.</li> <li>- The intent of the bar, known as a "headache bar", is to alert drivers to the limited clearance via collision with the overheight vehicle at the entrance to the bridge, potentially stopping or damaging the overheight vehicle.</li> </ul>	<ul style="list-style-type: none"> <li>- The use of this type of Passive Warning Measure is not recommended. The owner of the protected asset assumes additional liability by installing a potential hazard in the vehicle path.</li> </ul>	<ul style="list-style-type: none"> <li>- "The vertical clearance of all structures above the traveled way and shoulders should be at least 1 ft [0.3 m] greater than the legal vehicle height, and allowance should be made for future resurfacing." (AASHTO A Policy on Geometric Design of Highways and Streets 10.8.4.2)</li> </ul>	<ul style="list-style-type: none"> <li>- May protect limited clearance structure from direct collision.</li> <li>- Can be made to be aesthetically unobtrusive by fashioning it to match the construction style of the associated historic bridge.</li> <li>- Only warns drivers when vehicle is overheight.</li> <li>- Does not require driver to know height of vehicle.</li> </ul>	<ul style="list-style-type: none"> <li>- Overheight vehicle may be damaged by collision with Vertical Clearance Bar.</li> <li>- Structure may still sustain damage if struck as it is attached to the structure.</li> <li>- Alters the aesthetics of the historic structure.</li> </ul>	<p>- The use of this type of Passive Warning Measure is not recommended.</p>	<p>- The use of this type of Passive Warning Measure is not recommended.</p>	<ul style="list-style-type: none"> <li>- Tree clearing may be required</li> <li>- Replacing/repairing Vertical Clearance Bar after being struck by overheight vehicle</li> <li>- Routine inspection and documentation that the bar is in place and not damaged</li> </ul>

Type of System		Description	Preferred Applications	Restrictions	Benefits	Drawbacks	Installation Cost Range * (Favorable Site Conditions)	Installation Cost Range * (Unfavorable Site Conditions)	Maintenance
	Freestanding Portal Frame Vertical Clearance Bar	- Static signage is augmented by a fixed rigid portal frame, set equal in elevation to the vertical clearance of the structure, placed in advance of a limited clearance structure. - The intent of the bar, known as a "headache bar", is to alert drivers to the limited clearance via advanced collision with the overheight vehicle, potentially stopping or damaging the overheight vehicle.	- The use of this type of Passive Warning Measure is not recommended. The owner of the protected asset assumes additional liability by installing a potential hazard in the vehicle path.	- The vertical clearance of all structures above the traveled way and shoulders should be at least 1 ft [0.3 m] greater than the legal vehicle height, and allowance should be made for future resurfacing." (AASHTO A Policy on Geometric Design of Highways and Streets 10.8.4.2)	- May protect limited clearance structure from direct collision. - May be made to be aesthetically unobtrusive by fashioning it to match the aesthetic style of the associated historic bridge. - Only warns drivers when vehicle is overheight. - Does not require driver to know height of vehicle.	- Overheight vehicle may be damaged by collision with Vertical Clearance Bar. - May impact the aesthetics of the historic bridge & area surrounding it. - Vertical supports shall be treated like any other roadside hazard and should be protected if within the clear zone.	- The use of this type of Passive Warning Measure is not recommended.	- The use of this type of Passive Warning Measure is not recommended.	- Tree clearing may be required - Replacing/repairing Vertical Clearance Bar after being struck by overheight vehicle - Routine inspection and documentation that the bar is in place and not damaged
	Flexible Vertical Clearance Bar	- Static signage is augmented by a flexible vertical clearance bar, set equal in elevation to the vertical clearance of the structure, placed in advance of a limited clearance structure. - The lightweight, high visibility flexible bar should prominently display the maximum vertical clearance, and may be supported by chains, cables, or other non-rigid break-away means to minimize damage to errant overheight vehicles.	- Preferable for a structure with a history of being struck by vehicles at low speeds.	- Structural support shall be in accordance with AASHTO. - The use of a flexible hanging warning device is not prohibited. - Recommend additional guidance from AASHTO.	- Reduced risk of high impact collisions, causing damage to overheight vehicles or producing debris that may strike other vehicles. - Only warns drivers when vehicle is overheight. - Does not require driver to know height of vehicle.	- May impact the aesthetics of the historic bridge & area surrounding it. - Vertical clearance bars may swing in windy conditions. - Driver may not notice or ignore striking the vertical clearance bar.	\$50,000  Defined as a site with: - 2-lane bidirectional roadway  Assumed Installation for cost development purposes: - (2) Sign monotube structures - (4) Signal Strain Foundations - (4) Chains & (2) Tubular Markers	\$72,000  Defined as a site with: - 4-lane separated bidirectional roadway - Monotube Poles/Foundations inside Clear Zone  Assumed Installation for cost development purposes: - (2) Sign monotube structures - (4) Signal Strain Foundations - (4) Chains & (2) Tubular Markers - (4) 100' of Guardrail for Monotube Protection	- Tree clearing may be required - Replacing/repairing Vertical Clearance Bar after being struck by overheight vehicle - Routine inspection and documentation that the bar is in place and not damaged
Additional: Active Warning Measures	Single Beam Overheight Vehicle Detection	- Non-direction discerning sensors connected to a warning system providing a message to drivers that only activates when a overheight vehicle is detected.	- The use of this type of Active Warning Measure is not recommended as it is suited for one-way applications at very low speeds, such as entrances to parking structures.	- This type of detector does not perform well with bidirectional traffic or high speeds.	- The use of this type of Active Warning Measure is not recommended.	- The use of this type of Active Warning Measure is not recommended.	- The use of this type of Active Warning Measure is not recommended.	- The use of this type of Active Warning Measure is not recommended.	- Cleaning sensor lenses as needed - Testing sensor annually - Replacing electromechanical part every 15-25 years - Tree clearing may be required - Routine inspection, testing and documentation of the performance of components
	Dual Beam Overheight Vehicle Detection	- Direction discerning sensors connected to a warning system providing a message to drivers that only activates when a overheight vehicle is detected.	- Suited for applications on bidirectional roadways	- Unsuitable for multilane applications unless designed with separate detection and multilane sign with beacons over each lane - Performance may be suboptimal on North-South roadways and in bad weather conditions. - Requires a power supply	- Does not require impact with overheight vehicle to provide warning to driver - Only warns drivers when vehicle is overheight - Does not require driver to know height of vehicle	- May impact the aesthetics of the historic bridge & area surrounding it. - Drivers may think vehicle is not overheight in case of false negative malfunction. - Drivers may ignore warning in case of repeated false positive malfunction.	\$129,000  Defined as a site with: - 2-lane Bidirectional Road with Exit (Example shown in Appendix E, page 1) - Excellent clearance area visibility - Long sightlines- Area with minimal competing signage for driver attention  Assumed Installation for cost development purposes: - (4) Panel Signs (9'x6') - (8) Sign Posts, and (8) Foundations (Fdns) - (2) LED Blank Out Signs on Signal Cantilevers <sup>5</sup> w/ Fdns - (2) Detector Systems on Telescoping Poles - (2) Controllers with Wireless Communications - Service Point  NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.	\$142,000 + turnaround construction  Defined as a site with: - 2-lane Bidirectional Road with Turnaround (Example shown in Appendix E, page 3) - Excellent clearance area visibility - Long sightlines- Area with minimal competing signage for driver attention - Signal cantilever structure inside clear zone  Assumed Installation for cost development purposes: - (4) Panel Signs (12'x6' and 11'x6') - (8) Sign Posts, and (8) Foundations (Fdns) - (2) LED Blank Out Signs on Signal Cantilevers <sup>5</sup> w/ Fdns - (2) Detector Systems on Telescoping Poles - (2) Controllers with Wireless Communications - Service Point - 100' of Guardrail for each signal cantilever  NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.  NOTE: The cost of the turnaround was not estimated due to the potentially extreme variability in existing conditions of proposed sites.	- Cleaning sensor lenses as needed - Testing sensor annually - Replacing electromechanical part every 15-25 years - Tree clearing may be required - Routine inspection, testing and documentation of the performance of components



Type of System		Description	Preferred Applications	Restrictions	Benefits	Drawbacks	Installation Cost Range * (Favorable Site Conditions)	Installation Cost Range * (Unfavorable Site Conditions)	Maintenance
	Z-Pattern Overheight Vehicle Detection	- Direction discerning sensors connected to a warning system providing a message to drivers that only activates when a overheight vehicle is detected.	- Suited for applications on bidirectional roadways. - Performs more reliably than dual beam overheight vehicle detection for North-South roadways or roadways with bad weather conditions.	- Unsuitable for multilane applications unless designed with separate detection and multilane sign with beacons over each lane. - Requires a power supply.	- Does not require impact with overheight vehicle to provide warning to driver. - Only warns drivers when vehicle is overheight. - Does not require driver to know height of vehicle. - Less likely to malfunction compared to the dual beam detection.	- May impact the aesthetics of the historic bridge & area surrounding it. - Drivers may think vehicle is not overheight in case of false negative malfunction. - Drivers may ignore warning in case of repeated false positive malfunction.	\$135,000  Defined as a site with: - 2-lane Bidirectional Road with Exit (Example shown in Appendix E, page 1) - Excellent clearance area visibility - Long sightlines- Area with minimal competing signage for driver attention  Assumed Installation for cost development purposes: - (4) Panel Signs (9'x6') - (8) Sign Posts, and (8) Foundations (Fdns) - (2) LED Blank Out Signs on Signal Cantilevers <sup>5</sup> w/ Fdns - (2) Detector Systems on Telescoping Poles - (2) Controllers with Wireless Communications - Service Point  NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.	\$148,000 + turnaround construction <sup>4</sup>  Defined as a site with: - 2-lane Bidirectional Road with Turnaround (Example shown in Appendix E, page 3) - Excellent clearance area visibility - Long sightlines- Area with minimal competing signage for driver attention - Signal cantilever structure inside clear zone  Assumed Installation for cost development purposes: - (4) Panel Signs (12x6' and 11x6') - (8) Sign Posts, and (8) Foundations (Fdns) - (2) LED Blank Out Signs on Signal Cantilevers <sup>5</sup> w/ Fdns - (2) Detector Systems on Telescoping Poles - (2) Controllers with Wireless Communications - Service Point - 100' of Guardrail for each signal cantilever  NOTE: This cost could be reduced by decreasing the sign size depending on the roadway classification and speed.  NOTE: The cost of the turnaround was not estimated due to the potentially extreme variability in existing conditions of proposed sites.	- Cleaning sensor lenses as needed - Testing sensor annually - Replacing electromechanical part every 15-25 years - Tree clearing may be required - Routine inspection, testing and documentation of the performance of components
Additional: Monitoring Systems	Monitoring System for all Traffic	- Camera placed in advance of a bridge to monitor overheight vehicles that attempt to cross limited vertical clearance bridges. - Video feed runs 24/7.	- May not be effective without other installed measures.	- Video footage obtained can not be used as evidence in case of litigation. - Cameras may not be used for red-light or speed enforcement in Indiana. - Requires a power supply.	- Monitoring may deter drivers who know their vehicle is overheight from using the route.	- Not effective if driver does not know the height of their vehicle.	\$9,000 - \$15,000  Defined as a site with: N/A  Assumed Installation for cost development purposes: - (1) CCTV assembly - Camera mounting infrastructure and service point already in place	\$9,000 - \$15,000  Defined as a site with: N/A  Assumed Installation for cost development purposes: - (1) CCTV assembly - Camera mounting infrastructure and service point already in place	- Cleaning the camera lenses - Data Costs - Electricity Costs - Tree clearing may be required - Periodic replacement of equipment exposed to elements - Routine inspection, testing and documentation of the performance of components
	Detection Activated Monitoring System	- Camera placed in advance of a bridge to monitor overheight vehicles that attempt to cross limited vertical clearance bridges. - Video feed is activated when an overheight vehicle is detected via overheight vehicle sensors.	- May not be effective without other installed measures.	- Video footage obtained can not be used as evidence in case of litigation. - Cameras may not be used for red-light or speed enforcement in Indiana. - Requires a power supply.	- Monitoring may deter drivers who know their vehicle is overheight from using the route.	- Not effective if driver does not know the height of their vehicle. - May require more active monitoring, data analysis, data storage, and other associated maintenance.	\$9,000 - \$15,000  Defined as a site with: N/A  Assumed Installation for cost development purposes: - (1) CCTV assembly - Camera mounting infrastructure and service point already in place	\$9,000 - \$15,000  Defined as a site with: N/A  Assumed Installation for cost development purposes: - (1) CCTV assembly - Camera mounting infrastructure and service point already in place	- Cleaning the camera lenses - Data Costs - Electricity Costs - Tree clearing may be required - Periodic replacement of equipment exposed to elements - Routine inspection, testing and documentation of the performance of components

\* Installation costs are defined by assumptions for the site described and based on 2021 unit prices. Site conditions will vary which affect unit prices. Costs shown do not include mobilization, demobilization, engineering effort, design effort, construction engineering, right-of-way, utility costs, or environmental.

<sup>1</sup> Statutory maximum vehicle height is defined as "Maximum height limitations - Sec. 3. (a) A vehicle may not exceed a total maximum height of thirteen (13) feet, six (6) inches." - IC 9-20-3-3

<sup>2</sup> Low Clearance is defined as clearances less than 12 inches above the statutory maximum vehicle height.

<sup>3</sup> Limited Clearance is defined in this report as any vertical clearance restriction.

<sup>4</sup> Turnarounds can be costly and intrusive to natural areas (environmental impacts) where many historic structures are. Turnaround area available should be considered in the design of all measures.

<sup>5</sup> A sign cantilever structure, rather than signal, may be needed depending on the loading of the LED Blankout sign designed for.

# 8 HISTORIC THROUGH TRUSSES

The following is a list of extant historic through trusses in Indiana with vertical clearance information. This list was obtained from the Indiana Bridge Inspection Application System (BIAS) in July of 2021.

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## HISTORIC THRU TRUSSES IN INDIANA

This list was obtained from the Indiana Bridge Inspection Application System (BIAS) in July of 2021.

This list does not include bridges in pedestrian use (or slated for pedestrian use), bridges currently closed to vehicular traffic, bridges closed to the public, bypassed bridges, or bridges slated for replacement.

This is a list of historic thru truss bridges. This list does not include low clearance historic bridges of different construction types.

The data included for Average Daily Traffic (ADT) and Percentage of Truck Traffic changes over time and should be checked for most current info.

OWNER	STRUCTURE NUMBER	NBI NUMBER	FACILITY CARRIED	FEATURE INTERSECTED	HISTORICAL SIGNIFICANCE	STRUCTURE TYPE	YEAR BUILT	YEAR RECONSTRUCTED	LATITUDE	LONGITUDE	MINIMUM VERTICAL CLEARANCE	ADT	% TRUCK TRAFFIC	FUNCTIONAL CLASSIFICATION	COMMENTS
County > ALLEN	02-00032	200022	VAN ZILE RD	ST JOSEPH RIVER	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1883	1999	41.2464	-84.9730	17.67	179 (2018)	1.1%	Rural Local	Low-volume road
County > ALLEN	02-00242	200178	HAMILTON RD	REBECCA KNIGHT DRAIN	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1883	1999	40.9460	-85.3356	17.08	156 (2018)	0.6%	Rural Local	Low-volume road
County > ALLEN	02-00290	200216	MARION CENTER RD	ST MARYS RIVER	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1895	2005	40.9298	-85.0553	20.67	141 (2018)	2.1%	Rural Local	Low-volume road
County > BARTHOLOMEW	03-00046	300042	CR 410N	CLIFTY CREEK	Eligible for National Register	Steel Thru Truss	1911	1995	39.2637	-85.7048	17.17	110 (2018)	1.8%	Urban Local	Low-volume road
County > BARTHOLOMEW	03-00047	300043	CR 1150E	CLIFTY CREEK	Eligible for National Register	Steel Thru Truss	1910	N/A	39.2921	-85.6957	16.67	80 (2018)	6.3%	Rural Local	Low-volume road
County > BARTHOLOMEW	03-00073	300068	CR 900N	FLATROCK RIVER	On National Register	Steel Thru Truss	1911	1997	39.3337	-85.8645	11.67	310 (2018)	1.6%	Rural Local	Low-volume road
County > BARTHOLOMEW	03-00133	300123	CR 400N	FLATROCK RIVER	On National Register	Steel Thru Truss	1913	1999	39.2595	-85.9224	14.83	1110 (2018)	0.3%	Rural Major Collector	
County > BOONE	06-00032	600022	CR 350W	SUGAR CREEK	Eligible for National Register	Steel Thru Truss	1910	2018	40.1528	-86.5342	14.67	170 (2017)	0.6%	Rural Local	Low-volume road
County > BROWN	07-00052	700036	COVERED BRIDGE RD.	BEAN BLOSSOM CREEK	Eligible for National Register	Wood or Timber Thru Truss	1880	N/A	39.2609	-86.2553	11.45	50 (2021)	10.0%	Rural Local	Low-volume road
County > CARROLL	08-00039	800030	CR 50E	WILDCAT Creek	On National Register	Wood or Timber Thru Truss	1870	1999	40.4837	-86.5118	13	91 (2011)	5.5%	Rural Local	Low-volume road
County > CARROLL	08-00121	800093	CR 300N	DEER Creek	On National Register	Steel Thru Truss	1898	2007	40.5905	-86.6216	14	102 (2011)	4.9%	Rural Local	Low-volume road
County > CRAWFORD	13-00007	1300004	CR 590 NORTH	BLUE RIVER	Eligible for National Register	Steel Thru Truss	1910	1995	38.3771	-86.2594	17	411 (2015)	2.4%	Rural Major Collector	
County > CRAWFORD	13-00044	1300035	ARCHIBALD FALLS RD	LITTLE BLUE RIVER	Eligible for National Register	Steel Thru Truss	1892	2005	38.1420	-86.4029	14.5	271 (2015)	2.2%	Rural Local	Low-volume road
County > CRAWFORD	13-00045	1300036	ALTON FREDONIA RD	LITTLE BLUE RIVER	Eligible for National Register	Steel Thru Truss	1900	2009	38.1212	-86.4130	14.5	271 (2015)	3.7%	Rural Major Collector	Low-volume road
County > DEARBORN	15-00015	1500014	BELLS BRANCH RD	LAUGHERY CREEK	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1916	2009	38.9370	-85.0989	13.67	100 (2017)	10.0%	Rural Minor Collector	Low-volume road
County > DEARBORN	15-00159	1500091	GEORGE ST	HOGAN CREEK	On National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1887	1989	39.0579	-84.8993	18	3050 (2017)	0.2%	Urban Local	
County > DEARBORN	15-00223	1500116	CO PARK ENTRANCE	BRANCH OF TANNERS CREEK	Eligible for National Register	Wood or Timber Thru Truss	1879	1997	39.1703	-84.9085	12.75	30 (2017)	16.7%	Rural Local	Low-volume road
County > DEKALB	17-00003	1700004	MILL STREET	ST JOSEPH RIVER	On National Register	Wood or Timber Thru Truss	1873	1981	41.2814	-84.9146	12.5	200 (2021)	0.0%	Rural Local	Low-volume road
County > DELAWARE	18-00045	1800036	GREGORY ROAD	MISSISSINEWA RIVER	Eligible for National Register	Steel Thru Truss	1902	1985	40.3131	-85.3065	17	520 (2018)	0.2%	Rural Local	Low-volume road
County > DELAWARE	18-00130	1800110	CR 300S	WHITE RIVER	Eligible for National Register	Steel Thru Truss	1902	2009	40.1492	-85.5530	16	238 (2018)	0.4%	Rural Local	Low-volume road
County > ELKHART	20-00403	2000170	INDIANA AVE	ELKHART RIVER	On National Register	Steel Thru Truss	1896	2011	41.5933	-85.8485	16.25	3593 (2019)	0.1%	Urban Minor Arterial	
County > FOUNTAIN	23-00005	2300003	ALLEN Rd	COAL Creek	Eligible for National Register	Steel Thru Truss	1910	1963	40.0109	-87.3848	14.42	120 (2012)	5.0%	Rural Local	Low-volume road
County > FOUNTAIN	23-00097	2300075	CR 500E	North Fork of COAL Creek	Eligible for National Register	Steel Thru Truss	1915	N/A	40.1811	-87.1674	10.42	120 (2012)	5.0%	Rural Local	Low-volume road
County > FOUNTAIN	23-00131	2300103	CR 100N	COAL Creek	Eligible for National Register	Steel Thru Truss	1924	N/A	40.1425	-87.2498	15.5	117 (2012)	5.1%	Rural Local	Low-volume road
County > FOUNTAIN	23-00139	2300109	CR 800N	BIG SHAWNEE Creek	Eligible for National Register	Wood or Timber Thru Truss	1860	1925	40.2437	-87.2460	9.7	120 (2012)	5.0%	Rural Local	Low-volume road

## HISTORIC THRU TRUSSES IN INDIANA

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County > FOUNTAIN	23-00142	2300112	CR 230E	BIG SHAWNEE Creek	Eligible for National Register	Steel Thru Truss	1911	N/A	40.2450	-87.2184	15.67	120 (2012)	5.0%	Rural Local	Low-volume road
County > FOUNTAIN	23-00143	2300113	CR 300E	BIG SHAWNEE Creek	Eligible for National Register	Steel Thru Truss	1924	1993	40.2519	-87.2055	15	117 (2012)	5.1%	Rural Local	Low-volume road
County > FOUNTAIN	23-00211	2300140	WEAVER RD	SUGAR MILL CREEK	Eligible for National Register	Steel Thru Truss	1935	1993	39.9852	-87.1564	15	117 (2012)	5.1%	Rural Local	Low-volume road
County > FRANKLIN	24-00048	2400032	PIPE CREEK RD	PIPE CREEK	Eligible for National Register	Steel Thru Truss	1927	2010	39.4093	-85.1194	15.83	225 (2020)	1.8%	Rural Minor Collector	Low-volume road
County > FRANKLIN	24-00073	2400050	ENOCHSBURG RD	SALT CREEK	On National Register	Wood or Timber Thru Truss	1890	2009	39.3333	-85.2808	14	351 (2020)	1.1%	Rural Local	Low-volume road
County > FRANKLIN	24-00102	2400072	SNOWHILL RD	JOHNSON FORK WHITEWATER	On National Register	Wood or Timber Thru Truss	1894	2011	39.3256	-84.8519	13.8	203 (2020)	2.0%	Rural Local	Low-volume road
County > GRANT	27-00174	2700121	CR 990E	MISSISSINEWA RIVER	On National Register	Wood or Timber Thru Truss	1877	1999	40.3885	-85.4849	15	240 (2021)	0.0%	Rural Local	Low-volume road
County > GREENE	28-00086	2800060	CR 25E	PLUMMER CREEK	On National Register	Wood or Timber Thru Truss	1883	1997	38.9931	-86.9379	12.17	114 (2020)	4.4%	Rural Local	Low-volume road
County > GREENE	28-00233	2800162	CR 1000 West	Beehunter Ditch	Eligible for National Register	Steel Thru Truss	1907	1996	38.9665	-87.1294	14.67	360 (2011)	1.4%	Rural Minor Collector	Low-volume road
County > HANCOCK	30-00017	3000085	CR 675E	SUGAR CREEK	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1887	1983	39.9244	-85.6778	14.5	210 (2018)	2.4%	Rural Local	Low-volume road
County > HANCOCK	30-00105	3000525	CR 900E	BIG BLUE RIVER	On National Register	Steel Thru Truss	1916	N/A	39.7099	-85.6329	15.25	210 (2018)	1.4%	Rural Local	Low-volume road
County > HUNTINGTON	35-00019	3500015	CR 800S	SALAMONIE RIVER	Eligible for National Register	Steel Thru Truss	1928	2006	40.7123	-85.4538	14.92	157 (2021)	0.6%	Rural Local	Low-volume road
County > HUNTINGTON	35-00113	3500074	STATION RD	LITTLE WABASH RIVER	Eligible for National Register	Steel Thru Truss	1915	1988	40.9563	-85.3686	15	341 (2021)	0.6%	Rural Minor Collector	Low-volume road
County > HUNTINGTON	35-00123	3500083	CR 475 WEST	WABASH RIVER	On National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1920	2015	40.8795	-85.5429	14	972 (2021)	0.1%	Rural Minor Collector	
County > JAY	38-00008	3800190	CR 700E	WABASH RIVER	Eligible for National Register	Steel Thru Truss	1950	N/A	40.5682	-84.8486	15.25	277 (2019)	2.2%	Rural Local	Low-volume road
County > JEFFERSON	39-00030	3900020	CR 1350W	BIG CREEK	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1885	N/A	38.8118	-85.6383	12.5	100 (2020)	2.0%	Rural Local	Low-volume road
County > JENNINGS	40-00025	4000024	CR 575 W	SAND CREEK	Eligible for National Register	Wood or Timber Thru Truss	1887	2015	39.0846	-85.7203	13.5	75 (2019)	0.0%	Rural Local	Low-volume road
County > JENNINGS	40-00029	4000028	CR 250W	SAND CREEK	Eligible for National Register	Steel Thru Truss	1890	N/A	39.0844	-85.6587	8.5	100 (2020)	5.0%	Rural Local	Low-volume road
County > JENNINGS	40-00085	4000077	CR 625S	BIG GRAHAM CREEK	Eligible for National Register	Wood or Timber Thru Truss	1895	2014	38.8930	-85.6155	14	150 (2019)	3.3%	Rural Local	Low-volume road
County > KNOX	42-00045	4200150	WASHINGTON ROAD	WHITE RIVER	On National Register	Steel Thru Truss	1903	2016	38.6797	-87.2726	16	228 (2021)	1.3%	Rural Minor Collector	Low-volume road
County > LAWRENCE	47-00139	4700106	SADDLE BARN ROAD	LEATHERWOOD CREEK	Eligible for National Register	Steel Thru Truss	1905	1988	38.8599	-86.4630	14.67	365 (2016)	1.1%	Urban Local	Low-volume road
County > MADISON	48-00149	4800129	HUNTSVILLE PK	FALL CREEK	On National Register	Steel Thru Truss	1920	2014	40.0080	-85.7355	12	1253 (2016)	0.2%	Rural Local	Low-volume road
County > MARION	49-0501F	4900027	82ND STREET EB	WHITE RIVER	On National Register	Steel Thru Truss	1941	2008	39.9101	-86.1048	14.75	22060 (2019)	0.0%	Urban Other Principal Arterial	
County > MARTIN	51-00050	5100025	DEEP CUT LAKE ROAD	BEAVER CREEK	Eligible for National Register	Steel Thru Truss	1890	1950	38.6786	-86.7239	11.83	97 (2018)	1.0%	Rural Local	Low-volume road
County > MARTIN	51-00068	5100035	BROOKS BRIDGE ROAD	EAST FORK OF WHITE RIVER	Eligible for National Register	Steel Thru Truss	1894	2009	38.6141	-86.8487	17	107 (2013)	0.0%	Rural Minor Collector	Low-volume road
County > MIAMI	52-00063	5200050	CR 440 WEST	EEL RIVER	Eligible for National Register	Steel Thru Truss	1883	N/A	40.8141	-86.1568	20.58	100 (2011)	2.0%	Rural Local	Low-volume road
County > MIAMI	52-00159	5200122	BUSINESS 31	WABASH RIVER	Eligible for National Register	Steel Thru Truss	1939	1988	40.7424	-86.0966	14.33	8582 (2020)	0.1%	Urban Minor Arterial	

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County > MONROE	53-00114	5300110	FRIENDSHIP ROAD	STEPHENS CREEK	Eligible for National Register	Steel Thru Truss	1900	2002	39.1477	-86.4074	15.67	111 (2014)	4.5%	Rural Local	Low-volume road
County > MORGAN	55-00146	5500121	OLD SR 67	LAMBS CREEK	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1893	N/A	39.4240	-86.4753	13.5	230 (2018)	2.2%	Rural Local	Low-volume road
County > NEWTON	56-00149	5600093	CR 650 E	IROQUOIS RIVER	Eligible for National Register	Steel Thru Truss	1910	N/A	40.8949	-87.2685	10	143 (2018)	3.5%	Rural Local	Low-volume road
County > ORANGE	59-00018	5900013	CR 375 NORTH	LOST RIVER	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1894	N/A	38.6122	-86.5986	12.2	125 (2014)	4.0%	Rural Local	Low-volume road
County > ORANGE	59-00031	5900021	CR 500 WEST	LOST RIVER	Eligible for National Register	Steel Thru Truss	1900	1997	38.6238	-86.5590	13.25	135 (2014)	1.5%	Rural Local	Low-volume road
County > ORANGE	59-00049	5900035	FIRST CREEK	FRENCH LICK CREEK	Eligible for National Register	Steel Thru Truss	1904	1995	38.5415	-86.6126	12.4	175 (2014)	2.9%	Urban Collector	Low-volume road
County > ORANGE	59-00095	5900065	CR 700 SOUTH	PATOKA RIVER	Eligible for National Register	Steel Thru Truss	1885	1992	38.4551	-86.3921	10.42	100 (2014)	3.0%	Rural Local	Low-volume road
County > ORANGE	59-00102	5900070	CR 175 EAST	PATOKA RIVER	Eligible for National Register	Steel Thru Truss	1888	2004	38.4285	-86.4244	11.33	90 (2014)	3.3%	Rural Local	Low-volume road
County > ORANGE	59-00103	5900071	E OWL HOLLOW ROAD	PATOKA RIVER	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1884	N/A	38.4332	-86.4525	12	150 (2014)	3.3%	Rural Local	Low-volume road
County > ORANGE	59-00200	5900102	S GOSPEL STREET	LICK CREEK	On National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1880	2017	38.5545	-86.4685	10.75	600 (2014)	0.8%	Urban Local	Freestanding Portal Frame Vertical Clearance Bar in place.
County > OWEN	60-00014	6000014	TOWER RD	MILL CREEK	Eligible for National Register	Steel Thru Truss	1910	2005	39.4414	-86.7561	14.25	415 (2012)	1.2%	Rural Local	
County > OWEN	60-00198	6000142	JOHNSTOWN RD	EEL RIVER	Eligible for National Register	Steel Thru Truss	1918	N/A	39.1692	-87.0094	14.5	26 (2012)	19.2%	Rural Local	Low-volume road
County > PARKE	61-00019	6100015	CR 550E	BIG RACCOON Creek	On National Register	Wood or Timber Thru Truss	1907	N/A	39.6594	-87.1330	12.08	232 (2018)	2.2%	Rural Local	Low-volume road
County > PARKE	61-00035	6100028	CR 130E	Little RACCOON Creek	On National Register	Wood or Timber Thru Truss	1920	N/A	39.6847	-87.2123	13.08	35 (2018)	14.3%	Rural Local	Low-volume road
County > PARKE	61-00051	6100042	CR 325W	BIG RACCOON Creek	On National Register	Wood or Timber Thru Truss	1910	1977	39.6524	-87.2937	12.33	99 (2018)	5.1%	Rural Minor Collector	Low-volume road
County > PARKE	61-00062	6100050	CR 325W	ROCK Run Creek	On National Register	Wood or Timber Thru Truss	1908	2013	39.6621	-87.2945	13.17	99 (2018)	5.1%	Rural Minor Collector	Low-volume road
County > PARKE	61-00063	6100051	TICKRIDGE Rd	ROCK Run Creek	On National Register	Wood or Timber Thru Truss	1908	2017	39.6951	-87.2860	11.33	33 (2018)	15.2%	Rural Minor Collector	Low-volume road
County > PARKE	61-00069	6100057	ARABIA Rd	ROCKY Run Creek	On National Register	Wood or Timber Thru Truss	1909	N/A	39.7723	-87.3224	13.17	107 (2018)	4.7%	Rural Local	Low-volume road
County > PARKE	61-00074	6100060	CR 40N	LEATHERWOOD Creek	On National Register	Wood or Timber Thru Truss	1883	1977	39.7735	-87.3312	12.5	103 (2018)	4.9%	Rural Local	Low-volume road
County > PARKE	61-00083	6100068	CR 400S	Little RACCOON Creek	On National Register	Wood or Timber Thru Truss	1914	1977	39.7094	-87.1915	13.58	67 (2018)	7.5%	Rural Local	Low-volume road
County > PARKE	61-00085	6100070	CROOKS BRIDGE Rd	Little RACCOON Creek	On National Register	Wood or Timber Thru Truss	1856	N/A	39.7241	-87.1896	12.58	62 (2018)	8.1%	Rural Local	Low-volume road
County > PARKE	61-00101	6100086	OLD SR 36	WILLIAMS Creek	On National Register	Wood or Timber Thru Truss	1895	N/A	39.7615	-87.2065	11.83	228 (2018)	2.2%	Rural Local	Low-volume road
County > PARKE	61-00104	6100089	CR 620S	BIG RACCOON Creek	On National Register	Wood or Timber Thru Truss	1867	1990	39.6756	-87.1016	12.25	95 (2018)	5.3%	Rural Local	Low-volume road
County > PARKE	61-00155	6100112	CR 650N	Little RACCOON Creek	On National Register	Wood or Timber Thru Truss	1856	1996	39.8607	-87.0891	12	132 (2018)	2.3%	Rural Local	Low-volume road
County > PARKE	61-00191	6100140	STRAWBERRY Rd	LEATHERWOOD Creek	On National Register	Wood or Timber Thru Truss	1896	1977	39.7891	-87.3351	12	206 (2018)	2.4%	Rural Local	Low-volume road
County > PARKE	61-00199	6100148	BLOOMINGDALE Rd	SUGAR Creek	On National Register	Wood or Timber Thru Truss	1861	2007	39.8800	-87.2824	12	454 (2018)	1.1%	Rural Minor Collector	Vertical Clearance Bar attached to bridge in place.
County > PARKE	61-00204	6100152	TOWPATH Rd	MILL Creek	On National Register	Wood or Timber Thru Truss	1907	N/A	39.9086	-87.3610	12.5	122 (2018)	4.1%	Rural Local	Low-volume road

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County > PARKE	61-00206	6100154	CR 900N	RUSH Creek	On National Register	Wood or Timber Thru Truss	1904	1977	39.8988	-87.3147	11.83	119 (2018)	4.2%	Rural Local	Low-volume road
County > PARKE	61-00207	6100155	CR 800N	RUSH Creek	On National Register	Wood or Timber Thru Truss	1917	N/A	39.8834	-87.3262	13	51 (2018)	9.8%	Rural Local	Low-volume road
County > PARKE	61-00211	6100159	BOWSHER Rd	MILL Creek	On National Register	Wood or Timber Thru Truss	1915	N/A	39.9298	-87.3518	13.5	63 (2018)	7.9%	Rural Local	Low-volume road
County > PARKE	61-00227	6100171	COXFORD Rd	SUGAR Creek	On National Register	Wood or Timber Thru Truss	1913	1977	39.8854	-87.2238	13	70 (2018)	7.1%	Rural Local	Low-volume road
County > PARKE	61-00228	6100172	COXFORD Rd	SUGAR MILL Creek	On National Register	Wood or Timber Thru Truss	1906	1977	39.8984	-87.2332	13	70 (2018)	7.1%	Rural Local	Low-volume road
County > PIKE	63-00032	6300157	CR 500W	PATOKA RIVER	Eligible for National Register	Steel Thru Truss	1920	N/A	38.3772	-87.3707	16	7 (2019)	0.0%	Rural Local	Low-volume road
County > PIKE	63-00081	6300061	CR 300W	PATOKA RIVER	On National Register	Steel Thru Truss	1930	2015	38.3828	-87.3381	18	15 (2019)	0.0%	Rural Local	Low-volume road
County > PIKE	63-00246	6300160	CR 325W	S FORK PATOKA RIVER	On National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1876	2015	38.3789	-87.3397	14.75	15 (2019)	0.0%	Rural Local	Low-volume road
County > POSEY	65-00013	6500044	Raben Rd	Big Creek	Eligible for National Register	Steel Thru Truss	1905	N/A	37.9935	-87.9900	15	134 (2020)	3.0%	Rural Local	Low-volume road
County > POSEY	65-00053	6500006	Griffin Rd	Black River	Eligible for National Register	Steel Thru Truss	1892	N/A	38.1768	-87.9182	20.08	254 (2020)	0.8%	Rural Local	Low-volume road
County > PUTNAM	67-00029	6700017	CR 1350N	CORNSTALK CREEK	Eligible for National Register	Wood or Timber Thru Truss	1917	1990	39.8631	-86.8687	13.83	100 (2019)	5.0%	Rural Local	Low-volume road
County > PUTNAM	67-00052	6700039	CR 650N	BIG WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1901	2017	39.7491	-86.7752	11.5	225 (2019)	2.2%	Rural Local	Low-volume road
County > PUTNAM	67-00058	6700045	CR 900N	BIG WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1915	1988	39.7933	-86.7736	12.75	110 (2021)	4.5%	Rural Local	Low-volume road
County > PUTNAM	67-00073	6700059	CR 375E	CLEAR CREEK	Eligible for National Register	Steel Thru Truss	1920	2004	39.6959	-86.7843	13.33	110 (2019)	1.8%	Rural Local	Low-volume road
County > PUTNAM	67-00100	6700086	CR 450N	LITTLE WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1922	N/A	39.7274	-86.9763	12.75	175 (2019)	2.9%	Rural Local	Low-volume road
County > PUTNAM	67-00105	6700091	DUNBAR RD	BIG WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1880	N/A	39.6586	-86.8835	12	1375 (2020)	0.1%	Rural Local	
County > PUTNAM	67-00121	6700107	CR 375W	BIG WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1898	N/A	39.6263	-86.9169	13.58	110 (2020)	4.5%	Rural Local	Low-volume road
County > PUTNAM	67-00152	6700131	DEVIL BACKBONE RD	DEER CREEK	Eligible for National Register	Steel Thru Truss	1906	2006	39.6105	-86.7874	13	110 (2019)	0.9%	Rural Local	Low-volume road
County > PUTNAM	67-00170	6700148	HUFFMAN RD	BIG WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1880	N/A	39.5083	-86.9577	15.25	225 (2020)	2.2%	Rural Minor Collector	Low-volume road
County > PUTNAM	67-00187	6700161	CR 25E	DEER CREEK	On National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1890	N/A	39.5806	-86.8458	14.33	150 (2020)	3.3%	Rural Local	Low-volume road
County > PUTNAM	67-00249	6700204	CR 800N	BIG WALNUT CREEK	Eligible for National Register	Wood or Timber Thru Truss	1915	N/A	39.7747	-86.7842	12.67	125 (2019)	4.0%	Rural Local	Low-volume road
County > RIPLEY	69-00014	6900013	CAVEHILL ROAD	LAUGHERY CREEK	Eligible for National Register	Steel Thru Truss	1920	N/A	38.9972	-85.1824	15.12	100 (2018)	4.0%	Rural Local	Low-volume road
County > RIPLEY	69-00046	6900033	CR 25S	LAUGHERY CREEK	On National Register	Wood or Timber Thru Truss	1885	2005	39.0678	-85.2379	16.08	225 (2018)	0.4%	Rural Local	Low-volume road
County > RUSH	70-00094 B	7000084	CR 150N	FLATROCK RIVER	On National Register	Wood or Timber Thru Truss	1877	1996	39.6335	-85.4164	12.5	150 (2020)	2.0%	Rural Local	Low-volume road
County > RUSH	70-00100	7000090	CR 300N	FLATROCK RIVER	On National Register	Wood or Timber Thru Truss	1916	2004	39.6554	-85.4095	12.5	150 (2019)	3.3%	Rural Local	Low-volume road
County > RUSH	70-00112	7000101	OFFUTT BRIDGE RD	LITTLE BLUE RIVER	On National Register	Wood or Timber Thru Truss	1884	1996	39.6604	-85.5394	12.5	100 (2019)	1.0%	Rural Local	Low-volume road
County > RUSH	70-00146	7000132	CR 650S	FLATROCK RIVER	On National Register	Wood or Timber Thru Truss	1888	2003	39.5173	-85.5305	12.5	100 (2019)	5.0%	Rural Minor Collector	Low-volume road



## HISTORIC THRU TRUSSES IN INDIANA

OWNER	STRUCTURE NUMBER	NBI NUMBER	FACILITY CARRIED	FEATURE INTERSECTED	HISTORICAL SIGNIFICANCE	STRUCTURE TYPE	YEAR BUILT	YEAR RECONSTRUCTED	LATITUDE	LONGITUDE	MINIMUM VERTICAL CLEARANCE	ADT	% TRUCK TRAFFIC	FUNCTIONAL CLASSIFICATION	COMMENTS
County > RUSH	70-00191	7000176	CR 900S	FLATROCK RIVER	On National Register	Wood or Timber Thru Truss	1886	2010	39.4849	-85.5548	12.5	225 (2019)	1.3%	Rural Local	Low-volume road
County > VANDERBURGH	82-00810	8200071	HECKEL RD	BLUEGRASS CREEK	Eligible for National Register	Steel Thru Truss	1893	1999	38.0349	-87.4828	22	325 (2020)	0.3%	Urban Local	Low-volume road
County > VERMILLION	83-00067	8300038	CR 50N	Little VERMILION River	On National Register	Wood or Timber Thru Truss	1885	1983	39.8914	-87.4334	13	233 (2017)	1.3%	Rural Local	Low-volume road
County > WABASH	85-00018	8500045	N CHIPPEWA ST	EEL RIVER	On National Register	Wood or Timber Thru Truss	1877	1992	40.9156	-85.9242	18	100 (2014)	5.0%	Rural Local	Low-volume road
County > WABASH	85-00645	8500685	MILL ST/SINGER RD	EEL RIVER	On National Register	Wood or Timber Thru Truss	1872	2013	40.9961	-85.7655	7	480 (2014)	1.0%	Urban Local	Vertical Clearance Bar attached to bridge in place.
County > WARREN	86-00036	8600029	CR 100E	WABASH RIVER	Eligible for National Register	Steel Thru Truss	1905	1980	40.2544	-87.2997	19	230 (2014)	2.2%	Rural Major Collector	Low-volume road
County > WARREN	86-00092	8600078	CR 450E	BIG PINE CREEK	Eligible for National Register	Steel Thru Truss	1896	2002	40.4653	-87.2353	14.5	60 (2012)	8.3%	Rural Local	Low-volume road
County > WARRICK	87-00271	8700123	YANKEETOWN ROAD	LITTLE PIGEON CREEK	Eligible for National Register	Aluminum, Wrought Iron or Cast Iron Thru Truss	1885	2012	37.9102	-87.2956	15	60 (2021)	0.0%	Rural Local	Low-volume road
County > WARRICK	87-00371	8700170	OLD US 66	LITTLE PIGEON CREEK	Eligible for National Register	Steel Thru Truss	1928	2014	37.9105	-87.2715	14.5	473 (2021)	2.1%	Rural Major Collector	
County > WASHINGTON	88-20002	8800133	MAIN ST	S FK BLUE RIVER	On National Register	Steel Thru Truss	1884	2007	38.5010	-86.0098	14.33	613 (2019)	0.3%	Urban Local	
County > WELLS	90-00066	9000052	CR 1100 SOUTH	SALAMONIE RIVER	Eligible for National Register	Steel Thru Truss	1910	1980	40.5818	-85.3154	15.83	350 (2019)	0.9%	Rural Local	Low-volume road
County > WELLS	90-00193	9000144	CR 300W	WABASH RIVER	Eligible for National Register	Steel Thru Truss	1940	N/A	40.8015	-85.2799	15	1850 (2019)	0.4%	Rural Major Collector	Flexible Vertical Clearance Bar with Monitoring System in place.
State > Border Bridges	(161)75-74-04088 B	024727	SR 161	OHIO RIVER, US 60	May be eligible for National Register	Steel Thru Truss	1940	2016	37.7788	-87.1091	15.75	7268 (2016)	0.2%	Urban Other Principal Arterial	
State > Border Bridges	031-10-07102 A	008868	US 31	OHIO RIVER, I-64, STREETS	On National Register	Steel continuous Thru Truss	1929	1958	38.2636	-85.7517	21.25	15200 (2004)	0.0%	Urban Other Principal Arterial	
State > Border Bridges	041-93-00569 NBL	014202	US 41 NB	OHIO RIVER, ACCESS ROAD	Eligible for National Register	Steel Thru Truss	1932	1957	37.9044	-87.5508	19.82	18907 (2019)	0.0%	Urban Principal Arterial Other Freeway or Expressway	
State > Border Bridges	041-93-05000 SBL	014204	US 41 SB	OHIO RIVER, ACCESS ROAD	Eligible for National Register	Steel Thru Truss	1965	N/A	37.9044	-87.5514	17.92	19723 (2019)	0.1%	Urban Principal Arterial Other Freeway or Expressway	
State > Border Bridges	P066-65-06575	023305	SR 66, ILL SR 14	WABASH RIVER & SERVICE RD	On National Register	Steel Thru Truss	1930	1962	38.1315	-87.9428	15.67	1065 (2003)	0.2%	Rural Minor Arterial	
State > Crawfordsville	036-83-03492 C	011480	US 36	WABASH RIVER	Eligible for National Register	Steel Thru Truss	1949	2017	39.7923	-87.3760	15.33	3480 (2016)	0.3%	Rural Principal Arterial Other	
State > Crawfordsville	042-11-03101 C	015790	SR 42	EEL RIVER	On National Register	Steel Thru Truss	1938	1978	39.4443	-86.9937	14.5	710 (2009)	0.4%	Rural Major Collector	
State > Crawfordsville	225-79-04016 G	029150	SR 225	WABASH RIVER	Eligible for National Register	Steel Thru Truss	1912	1989	40.4955	-86.8233	17.42	960 (2009)	0.8%	Rural Major Collector	
State > Greenfield	001-68-03408 C	000300	SR 1	MISSISSINEWA RIVER	Eligible for National Register	Steel Thru Truss	1941	2008	40.2812	-85.1484	15.33	1120 (2007)	0.9%	Rural Major Collector	
State > Greenfield	026-38-03430 A	007040	SR 26	SALAMONIE RIVER	Eligible for National Register	Steel Thru Truss	1941	1979	40.4326	-84.9635	15	2233 (2017)	1.1%	Urban Minor Arterial	
State > La Porte	049-37-01938 C	017940	SR 49	KANKAKEE RIVER	Eligible for National Register	Steel Thru Truss	1941	2014	41.2541	-87.0335	14.53	5140 (2013)	0.2%	Rural Major Collector	
State > La Porte	075-08-03653 B	024970	SR 75	WILDCAT CREEK	Eligible for National Register	Steel Thru Truss	1947	2001	40.4818	-86.5301	14.83	2679 (2004)	0.4%	Rural Major Collector	
State > La Porte	119-66-03454 B	025850	SR 119	TIPPECANOE RIVER	Eligible for National Register	Steel Thru Truss	1948	2011	41.0068	-86.6028	14.83	1998 (2004)	0.5%	Rural Major Collector	
State > Seymour	(11)31A-36-01677 F	010250	SR 11	EAST FORK WHITE RIVER	Eligible for National Register	Steel Thru Truss	1941	2002	38.9989	-85.8915	14.75	7762 (2004)	0.1%	Rural Major Collector	
State > Seymour	046-15-01987 A	017540	SR 46	WHITEWATER RIVER	Eligible for National Register	Steel Thru Truss	1937	1985	39.2800	-84.8740	14.83	2681 (2004)	0.4%	Rural Major Collector	

## HISTORIC THRU TRUSSES IN INDIANA

OWNER	STRUCTURE NUMBER	NBI NUMBER	FACILITY CARRIED	FEATURE INTERSECTED	HISTORICAL SIGNIFICANCE	STRUCTURE TYPE	YEAR BUILT	YEAR RECONSTRUCTED	LATITUDE	LONGITUDE	MINIMUM VERTICAL CLEARANCE	ADT	% TRUCK TRAFFIC	FUNCTIONAL CLASSIFICATION	COMMENTS
State > Seymour	135-55-01522 B	026700	SR 135	INDIAN CREEK	Eligible for National Register	Steel Thru Truss	1933	2016	39.3669	-86.2614	14.83	5684 (2004)	0.2%	Rural Minor Arterial	
State > Seymour	P000-07-07101 D	060310	PARK ROAD	NORTH FORK SALT CREEK	On National Register	Wood or Timber Thru Truss	1838	2004	39.1955	-86.2165	9	400 (2019)	0.0%	Rural Local	Low-volume road
State > Seymour	P000-40-07088 B	060380	PARK ROAD	MUSCATATUCK RIVER	Eligible for National Register	Steel Thru Truss	1910	2004	38.9618	-85.6171	13.33	143 (2004)	7.0%	Rural Local	Low-volume road
State > Seymour	P000-41-07080 A	060270	PISGAH ROAD	SUGAR CREEK	On National Register	Steel Thru Truss	1885	2005	39.3822	-85.9981	17.83	102 (2004)	0.0%	Rural Local	Low-volume road
State > Seymour	P000-41-07430 A	060500	STONE ARCH ROAD	NINEVEH CREEK	Eligible for National Register	Steel Thru Truss	1885	2012	39.3660	-86.0663	14	143 (2004)	7.0%	Rural Local	Low-volume road

# 9 CONCLUSION

Anecdotal evidence and incomplete academic study point toward a benefit for an owner to install additional warning and/or detection measures suitable to the site. It is up to the asset owner to weigh the benefits, drawbacks, installation costs and maintenance of each additional measure that may be suitable to the individual site conditions.

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## 9.1 OPPORTUNITIES FOR ADDITIONAL ACADEMIC STUDY

There are opportunities for additional academic study to provide more information on the scale of overheight vehicle bridge strikes in Indiana as well as the efficacy of prevention measures. Areas of interest include:

- The relationship between the vertical clearance of a structure and the frequency of bridge strikes.
  - Detailed criteria to ascertain bridges at highest risk.
  - Dedicated studies of the efficacy of the various bridge strike prevention measures mentioned in this report with experimental pilot locations.
  - The relationship between visibility and bridge strikes as well as installation of roadway lighting at unlighted locations as possible mitigation for nighttime strikes.
- 

## 9.2 OPPORTUNITIES FOR DRIVER EDUCATION

A recurring complaint of bridge asset owners interviewed for this report, concerning the motoring public, is the apparent lack of awareness that drivers have regarding the height of the vehicles they are piloting. This lack of awareness undermines the potential effectiveness of all systems evaluated.

We recommend evaluating the addition of educational opportunities for drivers who are registering new vehicles, renting unfamiliar vehicles such as moving trucks, and testing for obtaining a Commercial Drivers License.

As part of the new vehicle registration process at the Bureau of Motor Vehicles, the height of vehicles could be listed and brought to the attention of the owner. As part of preparing for and testing for driver's licenses, there is an opportunity to educate drivers that posted clearance signage is not conservatively marked; drivers have a responsibility to know the height of their vehicle; and that driver should know and understand this signage to avoid damage to their vehicles and low clearance bridge assets.

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## 9.3 OPPORTUNITIES FOR BETTER ROUTING

Navigation and route planning are increasingly being performed by automated GPS systems with detour routing algorithms, such as Google Maps, Apple Maps, Waze, and others. During the research for this report, bridge asset owners, Local Public Agencies, and Department of Transportation officials identified opportunities for asset-aware routing and better communication with these entities. Opportunities for improvement include the ability for DOTs and LPAs to mark GIS mapping data with "Limiting Clearance" to avoid the automatic routing of trucks through these routes.

Communication with these large technology companies and associated product teams is difficult. Customer Service portals for Google Maps and others do not differentiate between queries from asset owners and users (motorists). There are opportunities for collaboration between owners and the technology companies that have the potential to result in better routing for motorists and fewer bridge strikes.

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# APPENDIX

# A

# BACKGROUND





## BACKGROUND

On January 21, 2020, the US 41 Southbound Bridge over Pigeon Creek in Vanderburgh County was struck by an oversized vehicle that was off the approved permit route and was therefore traveling illegally.

The US 41 Southbound bridge was a Parker through-truss with vertical clearance that exceeded design minimums for vertical clearance. This structure was classified as eligible for the National Register of Historic Places and had received routine rehabilitation the prior year.

The damage sustained from this collision resulted in the immediate closure and detour of the route and eventual replacement of the bridge due to the severity of damage sustained.

This feasibility study has been prepared as part of the mitigation efforts agreed upon by consulting parties in the Section 106 review process per the Memorandum of Agreement.



Figure A-0-1: Damage to the US 41 Through-Truss Bridge Portals.

# APPENDIX

## B

### STATIC SIGNAGE DETAILS



W12-2  
LOW CLEARANCE (ENGLISH)

LOW CLEARANCE (METRIC)

A	B	C	D	E	F	G	H	J	K	L	M	N
18	.375	.625	3.438	4	2.125	.5	1.5	1	1.5	.938	.625	.25
30	.5	.75	5.75	6.625	3.75	.75	2.5	1.688	1.875	1.563	1	.438
36	.625	.875	6.875	8	4.25	1	3	2	2.25	1.875	1.25	.5
48	.75	1.25	9.188	10.625	5.875	1.313	4	2.625	3	2.438	1.625	.625

P	Q	R	S
1.375	2	3	6 D
2.25	3.313	5	10 D
2.75	4	6	12 D
3.625	5.58	8	16 D

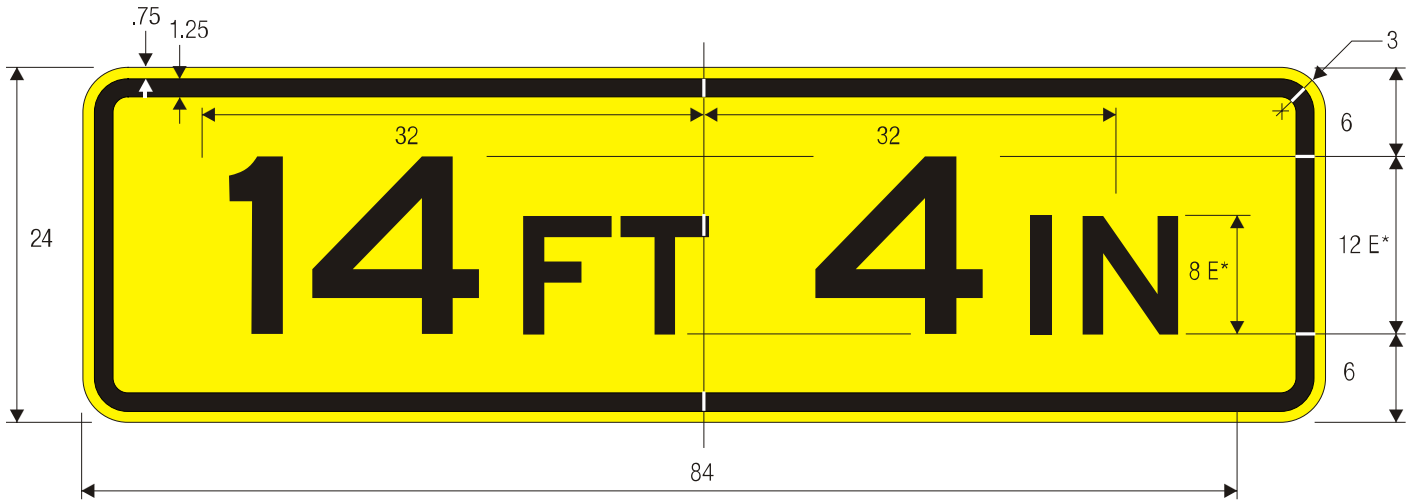
\*See page 6-3 for symbol design.  
\*\*Optically space numerals about center line.

WARNING SIGN COLORS:

SYMBOL & LEGEND—BLACK  
BACKGROUND —YELLOW (RETROREFLECTIVE)

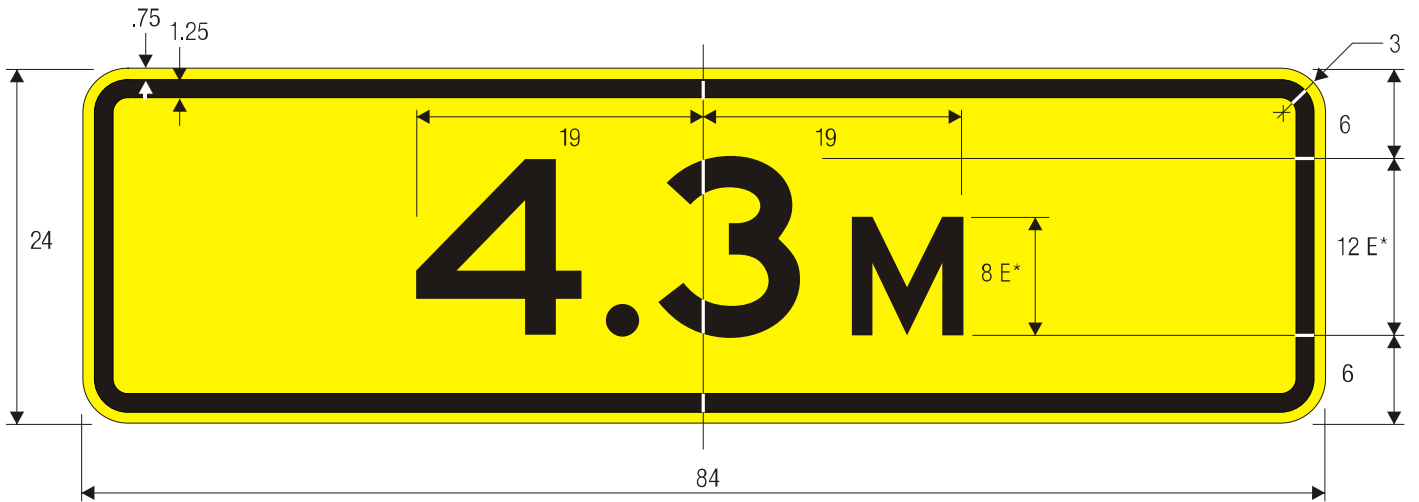
TTC SIGN COLORS:

SYMBOL & LEGEND—BLACK  
BACKGROUND —ORANGE (RETROREFLECTIVE)



W12-2p

LOW CLEARANCE (ENGLISH)



W12-2p metric

LOW CLEARANCE (METRIC)

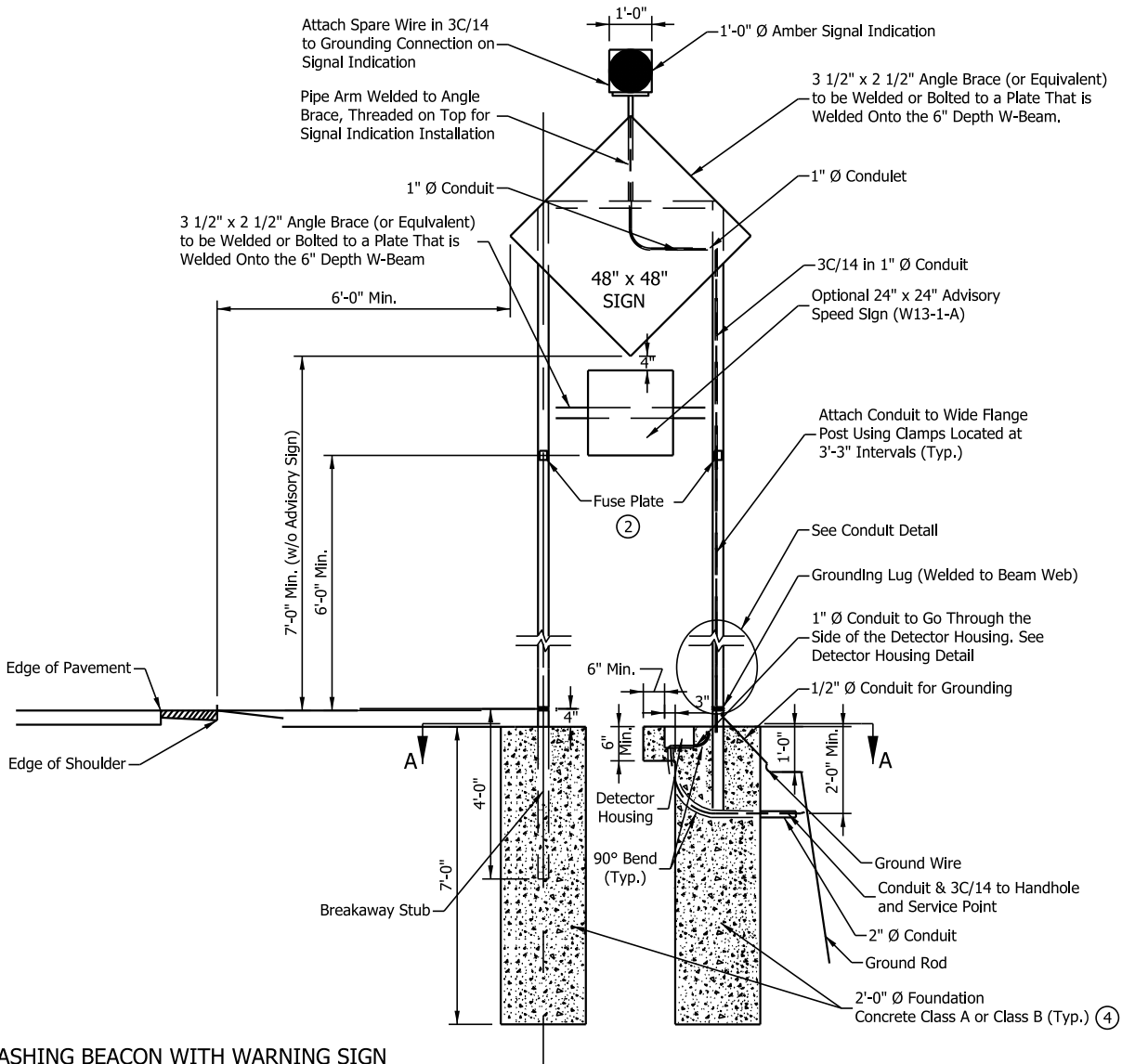
\*Series 2000 Standard Alphabets.

COLORS: LEGEND — BLACK  
 BACKGROUND— YELLOW (RETROREFLECTIVE)

# APPENDIX

## C

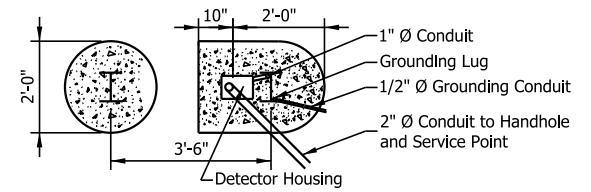
### ALWAYS FLASHING BEACON DETAILS



**FLASHING BEACON WITH WARNING SIGN  
ON W 6 x 9 BEAM**

**NOTES:**

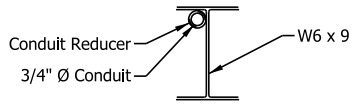
1. See Standard Drawing E 802-SNGP-03 through -05 for breakaway details and dimensions. Use beam size W 6 x 9.
- ② The fuse plate shall be 6 in. below the lowest fastener of the sign. Fuse plate shall be used on both the front and back sides.
3. See Standard Drawing E 805-SGFB-02 for conduit and detector housing details.
- ④ See Standard Drawing E 802-SNGP-16 for foundation details.



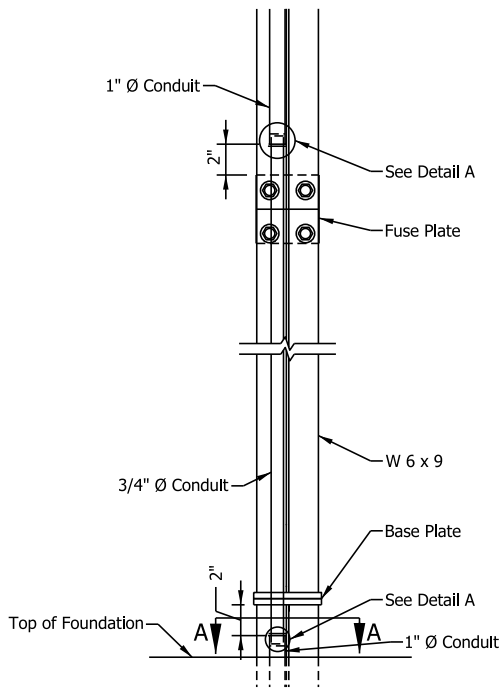
**SECTION A-A**

INDIANA DEPARTMENT OF TRANSPORTATION	
FLASHING BEACON WITH WARNING SIGN	
SEPTEMBER 2017	
STANDARD DRAWING NO. E 805-SGFB-01	
	/s/ <i>David H. Boruff</i> 03/15/17 DESIGN STANDARDS ENGINEER      DATE
	/s/ <i>John Leckie</i> 04/10/17 CHIEF ENGINEER      DATE

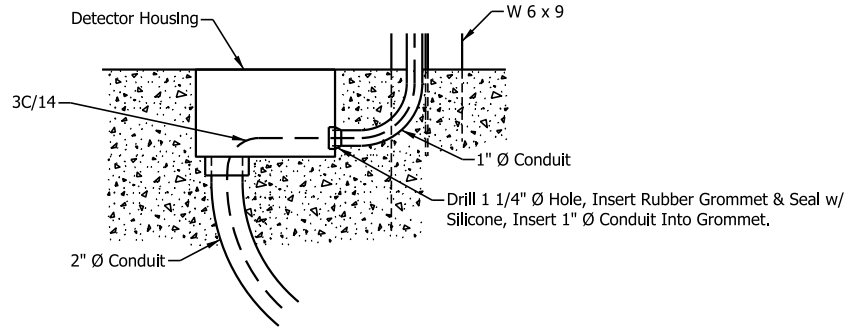




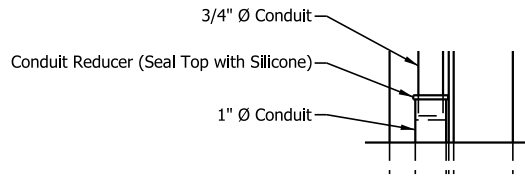
**SECTION A-A**



**CONDUIT DETAIL**

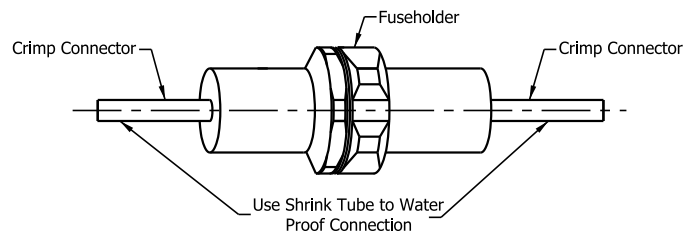


**DETECTOR HOUSING DETAIL**

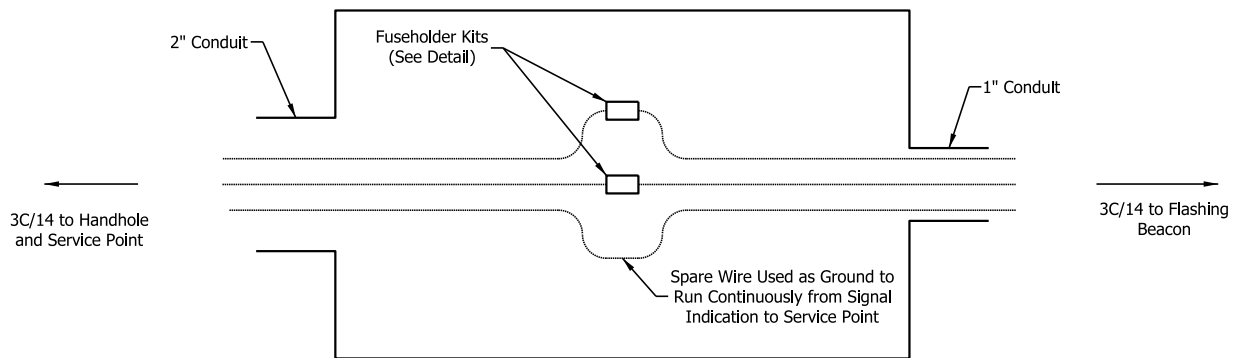


**DETAIL A  
INVERT FOR TOP CONDUIT JOINT**

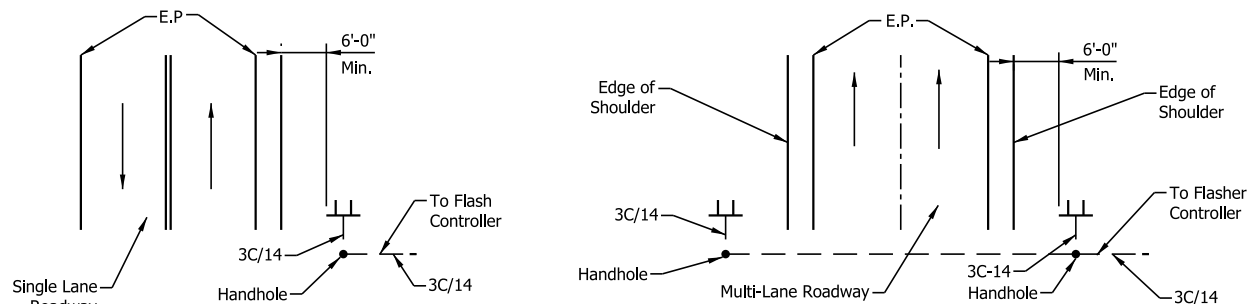
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FLASHING BEACON WITH WARNING SIGN DETAILS	
SEPTEMBER 2017	
STANDARD DRAWING NO. E 805-SGFB-02	
	<i>/s/ David H. Boruff</i> 03/15/17 DESIGN STANDARDS ENGINEER      DATE
	<i>/s/ John Leckie</i> 04/10/17 CHIEF ENGINEER      DATE



**FUSEHOLDER KIT  
TO BE USED IN DETECTOR HOUSING**



**DETECTOR HOUSING CONNECTIONS DETAIL**



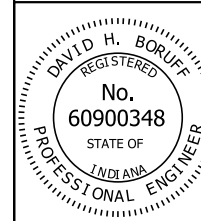
**TYPICAL FLASHING BEACON CONFIGURATION**

INDIANA DEPARTMENT OF TRANSPORTATION

FLASHING BEACON WITH  
WARNING SIGN DETAILS

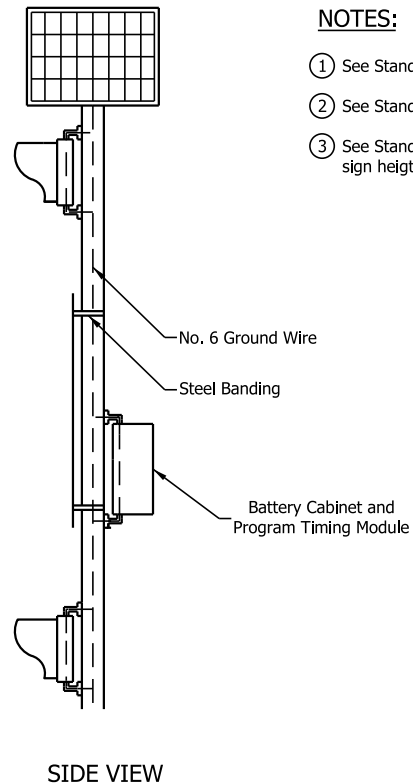
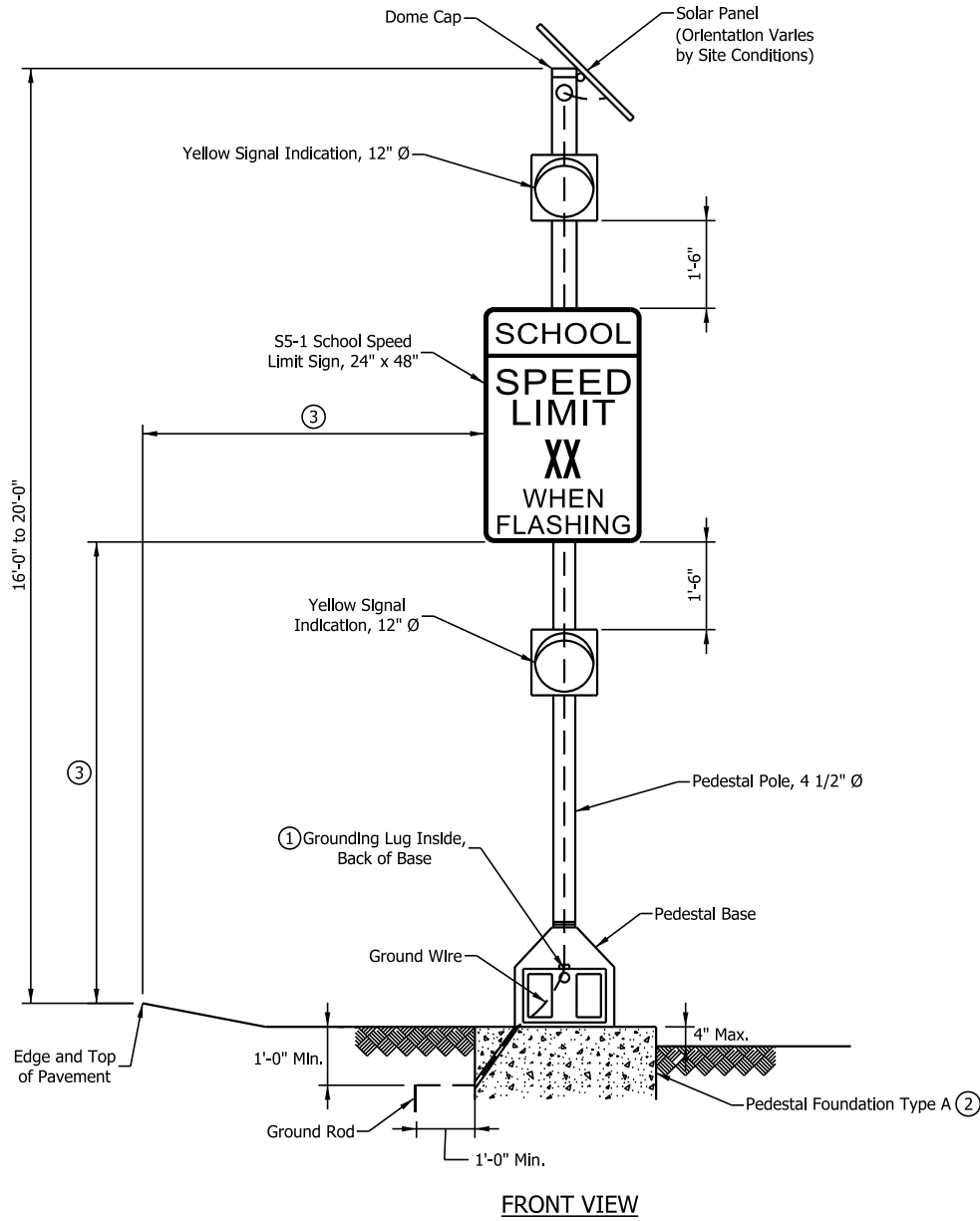
SEPTEMBER 2017

STANDARD DRAWING NO. E 805-SGFB-03



*/s/ David H. Boruff* 03/15/17  
DESIGN STANDARDS ENGINEER DATE

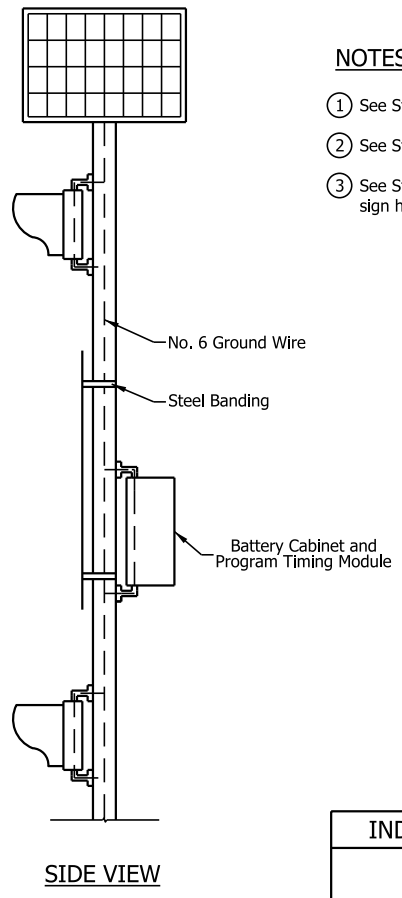
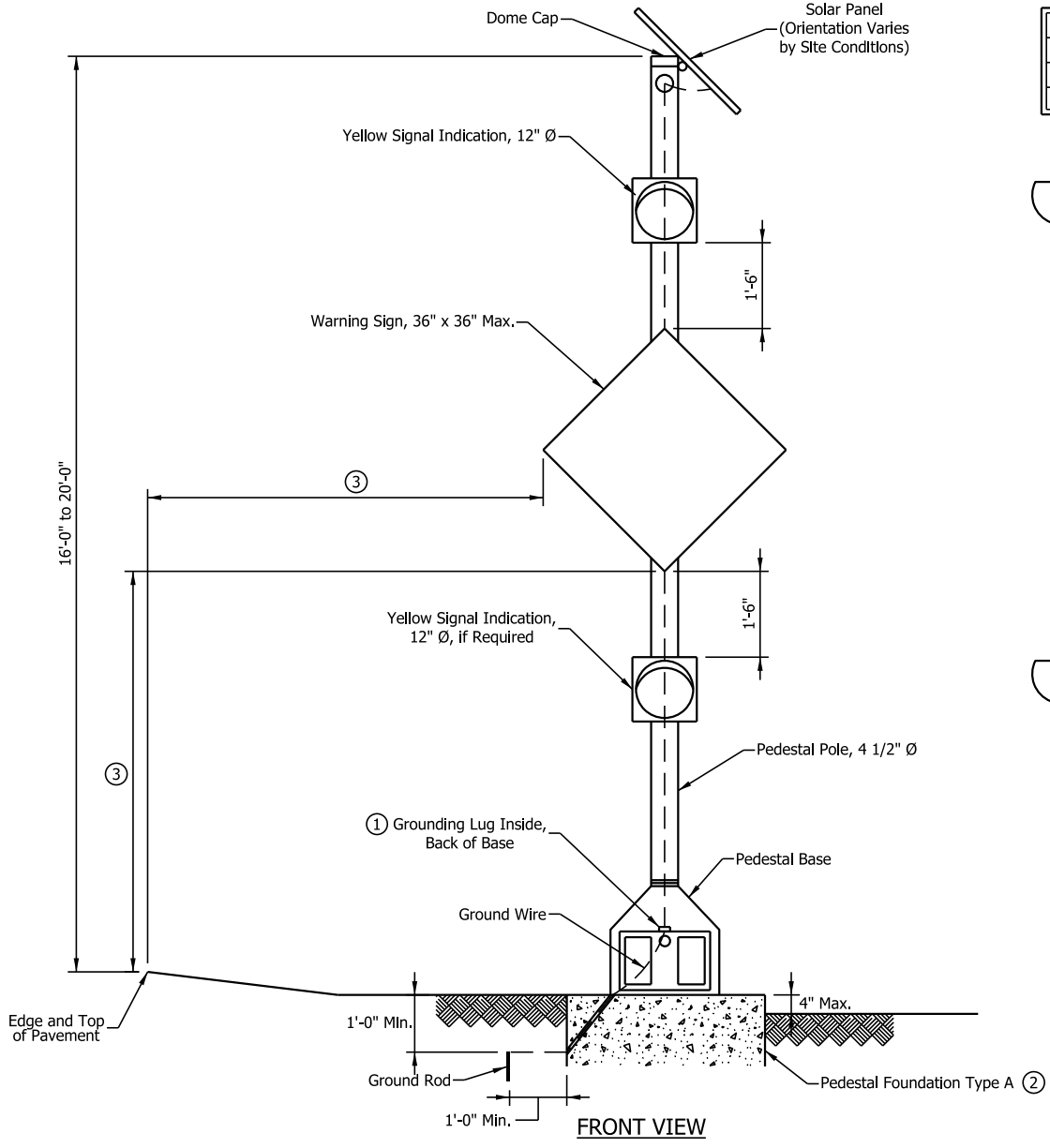
*/s/ John Leckie* 04/10/17  
CHIEF ENGINEER DATE



**NOTES:**

- ① See Standard Drawing E 805-SGGR-03 for grounding lug details.
- ② See Standard Drawing E 805-SGCF-03 for Foundation Type A.
- ③ See Standard Drawing E 802-SNPL-02 for edge of pavement offset and sign height.

INDIANA DEPARTMENT OF TRANSPORTATION									
PEDESTAL MOUNTED SOLAR POWERED SCHOOL SPEED LIMIT FLASHING BEACON ASSEMBLY SEPTEMBER 2017									
STANDARD DRAWING NO. E 805-SGFB-04									
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<i>/s/ David H. Boruff</i>	03/15/17								
DESIGN STANDARDS ENGINEER	DATE								
<i>/s/ John Leckie</i>	04/10/17								
CHIEF ENGINEER	DATE								



**NOTES:**

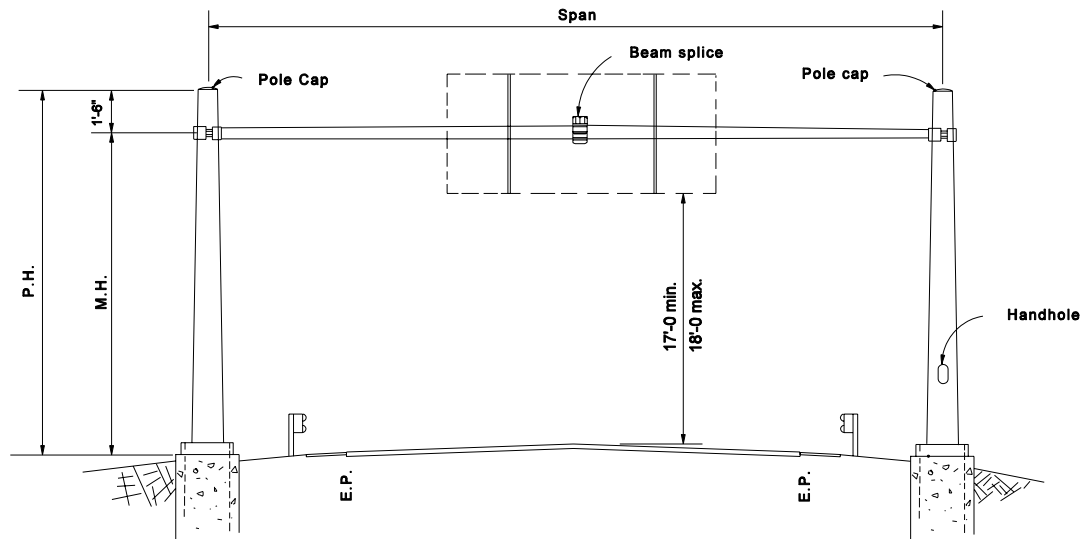
- ① See Standard Drawing E 805-SGGR-03 for grounding lug details.
- ② See Standard Drawing E 805-SGCF-03 for Foundation Type A.
- ③ See Standard Drawing E 802-SNPL-02 for edge of pavement offset and sign height.

INDIANA DEPARTMENT OF TRANSPORTATION									
PEDESTAL MOUNTED SOLAR POWERED WARNING SIGN FLASHING BEACON ASSEMBLY SEPTEMBER 2017									
STANDARD DRAWING NO. E 805-SGFB-05									
	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border-bottom: 1px solid black; width: 70%;"><i>/s/ David H. Boruff</i></td> <td style="border-bottom: 1px solid black; width: 30%; text-align: right;"><i>03/15/17</i></td> </tr> <tr> <td style="font-size: small;">DESIGN STANDARDS ENGINEER</td> <td style="font-size: small; text-align: right;">DATE</td> </tr> <tr> <td style="border-bottom: 1px solid black;"><i>/s/ John Leckie</i></td> <td style="border-bottom: 1px solid black; text-align: right;"><i>04/10/17</i></td> </tr> <tr> <td style="font-size: small;">CHIEF ENGINEER</td> <td style="font-size: small; text-align: right;">DATE</td> </tr> </table>	<i>/s/ David H. Boruff</i>	<i>03/15/17</i>	DESIGN STANDARDS ENGINEER	DATE	<i>/s/ John Leckie</i>	<i>04/10/17</i>	CHIEF ENGINEER	DATE
<i>/s/ David H. Boruff</i>	<i>03/15/17</i>								
DESIGN STANDARDS ENGINEER	DATE								
<i>/s/ John Leckie</i>	<i>04/10/17</i>								
CHIEF ENGINEER	DATE								

# APPENDIX

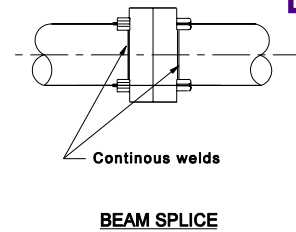
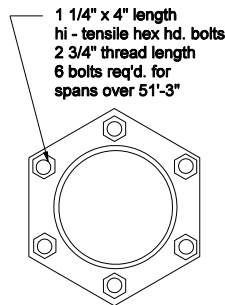
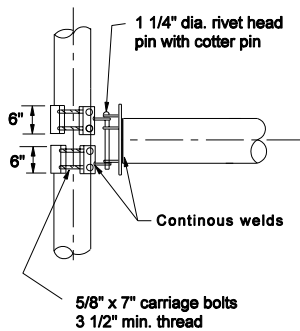
## D

### FLEXIBLE VERTICAL CLEARANCE BAR DETAILS



**OVERHEAD BRIDGE**

**NOTE:**  
 This was not specifically designed for a flexible warning bar, it is used for signs.  
 INDOT does not have a standard for vertical clearance bars.



INDIANA DEPARTMENT OF TRANSPORTATION	
<b>OVERHEAD SIGN BRIDGE SPANS</b>	
MARCH 2004	
STANDARD DRAWING NO. E 802-SNOB-01	
	/s/ Richard L. VarCleave 3-01-04 DESIGN STANDARDS ENGINEER DATE
	/s/ Richard K. Smutzer 3-01-04 CHIEF HIGHWAY ENGINEER DATE
DESIGN STANDARDS ENGINEER	





**Encore Commercial Products, Inc.**  
 37525 Interchange Dr., Farmington Hills, MI 48335  
 Toll Free 1- 866 -737- 8900 Fax 248-354-4095  
 www.postguard.com

Title: Height Guard 96"-120" L

Drawing Number: HG120

**Recommended Use:**

With Chain

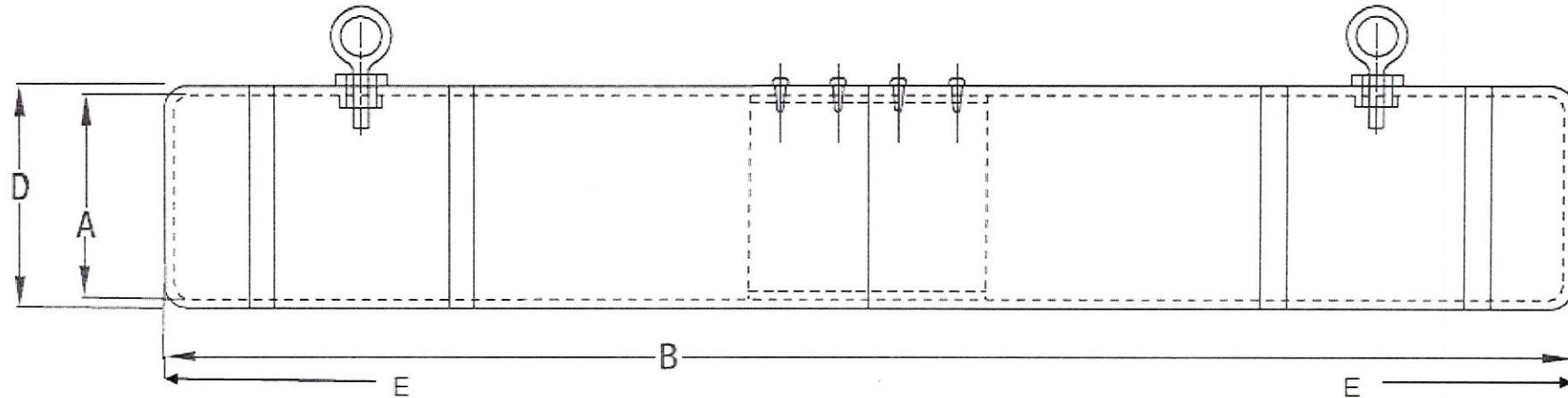
**Specifications:**

See below

Date: 3-15-17

Size: 96"-120" L

Page: 1 of 1



Standard Sizes	A = Actual Inside Diameter	D = Actual Outside Diameter	B = Overall Length	E = Approx. Distance from Rivet to End
4.5" Diameter x 96" Long	4.72 inches	5.00 inches	96.0 inches	16.00 inches
4.5" Diameter x 120" Long	4.72 inches	5.00 inches	120.0 inches	16.00 inches
7.0" Diameter x 96" Long	7.10 inches	7.34 inches	96.0 inches	16.00 inches
7.0" Diameter x 120" Long	7.10 inches	7.34 inches	120.0 inches	16.00 inches

**ASSEMBLY INSTRUCTIONS:**

1. Join both sections and line up pre-drilled holes.
2. Install enclosed zip screws into pre-drilled holes.
3. Install enclosed eye hooks into threaded rivets for attachment to chain.
4. Install Custom Graphics Kit to indicate desired height – "CLEARANCE".

**Eye Bolt Specifications:**

Material: Steel, Zinc Finish	Eye Inside Dia: 1/2 In.
Thread Length: 1 1/2 In.	Wire Dia: 1/4 In.
Length: 2 1/2 In.	Width: 1 In.



PH: 405-340-3434  
 FAX: 405-340-3435  
 Edmond, OK 73013  
 www.pelcoinc.com

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# ASSEMBLY SHEET

REF:

TITLE:

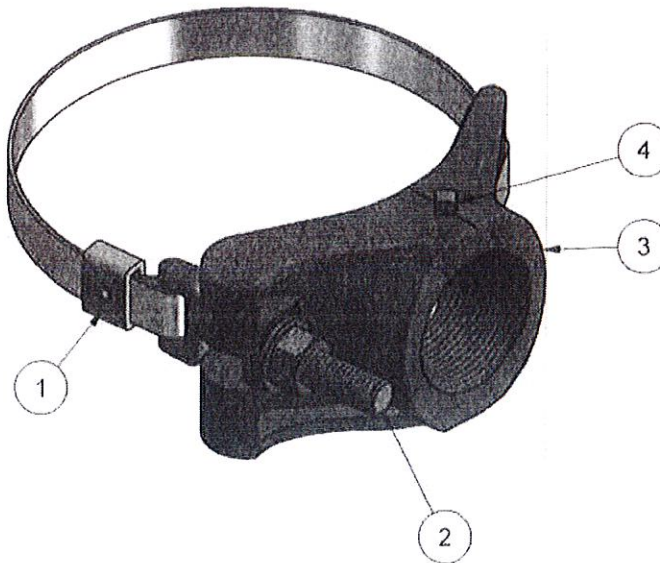
Astro Mini-Brac, 1-1/2" NPS, Band, Alum

PART NO.:

AB-0121

PART NO
AB-0121-29-PXX
AB-0121-29-SS-PXX

Band Length  
 Stainless Upgrade  
 Process No Color=PNC  
 Paint=PXX



Band Length	Max Pole Dia
29	7.3
36	9.6
42	11.5
48	13.4
56	15.9
72	21.0
84	22.0

OPTIONS
Band Length:
Min 4" Pole Dia, Max See Chart
SS=Stainless Upgrade
Paint

**Note:**

- Box 4 per # 2018 Box
- SS=Stainless upgrade of all fasteners.

ITEM	PART NUMBER	DESCRIPTION	QTY
1	AB-0510-L	Band Assy, Set of 2 w/ Clamps, Set Screws & Groove Pins, Stainless	1
2	AB-0303-GLV	Kit, Clamp Screw, Mini-Brac w/ Galv Screw & Stainless Hdwr	1
3	AB-0266-M1	Clamp, Mini-Brac Band Mount, 1-1/2" NPS, Alum	1
4	FS-3205-SS	Set Screw, Square Hd, Cup Point, 1/4"-20 x 5/8", Type 304 Stainless	1
5	Z-2004-2038	Instructions, Astro Mini-Brac, Band & Cable Mount - Tan	1

PelcoVertical.cdw 3/16/15

J ROGERS DRAWN	3/8/1990 DATE	KBM CHECKED	11/15/2016 DATE	KAK MFG ENG	3/29/2016 DATE	RKV DA	3/31/2016 DATE	M REV	09/07/16 SRD DATE	TWO REV CHK'D	9/8/2016 DATE	SHEET 1 OF 1
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www.pelcoinc.com  
 EDMOND, OK 73013  
 405-340-3434  
 FAX: 405-340-3435

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# ASSEMBLY SHEET

REF:

TITLE:

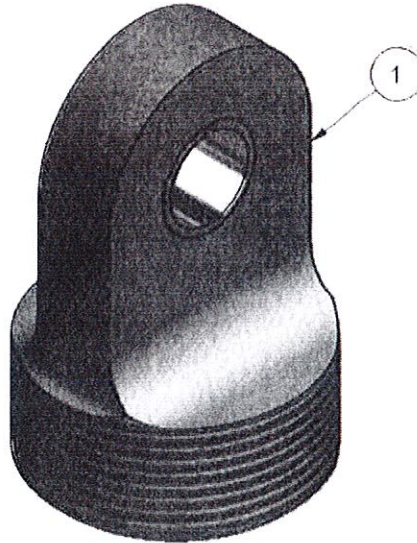
Span Wire Adapter, w/ Stainless Bushing, Alum

PART NO.:

SE-0371

PART NO  
 SE-0371-PXX

Paint=PXX



OPTIONS  
 Paint

ITEM	PART NUMBER	DESCRIPTION	QTY
1	SE-0371-M1	Adapter, Span Wire w/ Stainless Bushing, Alum	1





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 EDMOND, OK 73013  
 405-340-3434  
 FAX: 405-340-3435

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# ASSEMBLY SHEET

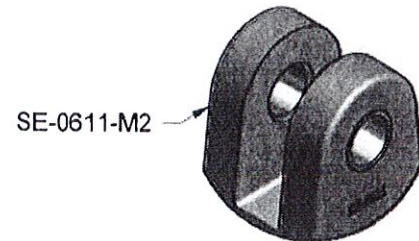
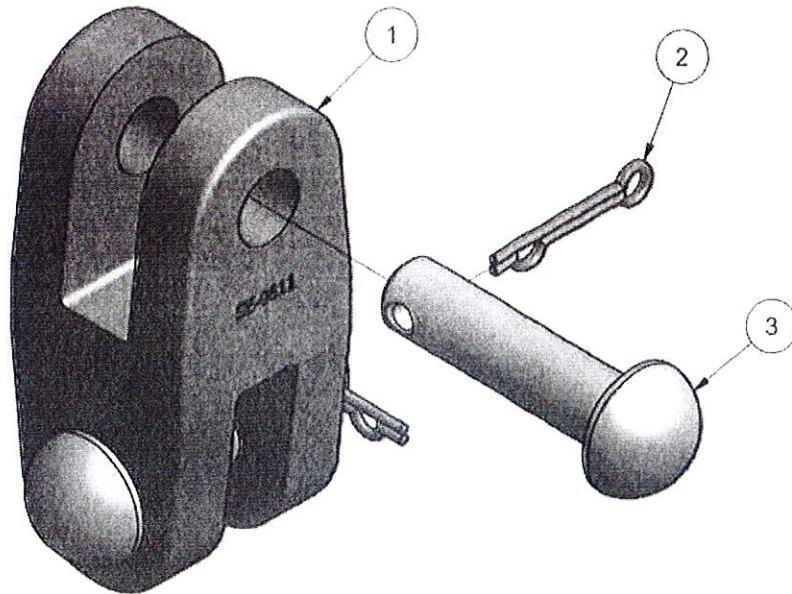
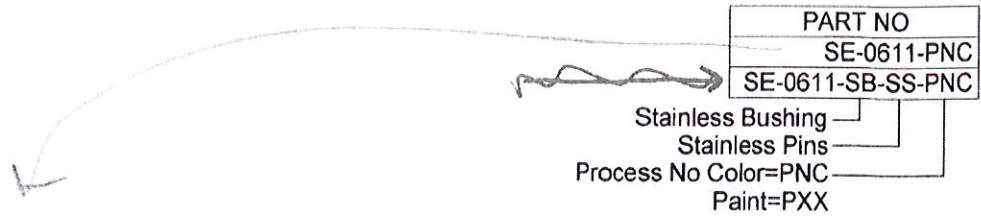
REF:

TITLE:

Hanger, Clevis-Clevis, 3/4" x 1/2", Galv Pins, Alum

PART NO.:

SE-0611



**STAINLESS BUSHING OPTION**

OPTIONS	
SB=Stainless Bushing	
SS=Stainless Pins	
Paint	

ITEM	PART NUMBER	DESCRIPTION	QTY
1	SE-0611-M1	Hanger, Clevis-Clevis 3/4" x 1/2", Alum	1
2	FS-6100-SS	Pin, Cotter, Humped, 5/32" X 1.775", 304 Stainless	2
3	FS-6000-GLV	Pin, Clevis, 5/8" x 2-1/4" EL (.603-.610 Dia) Galv	2



www.pelcoinc.com  
 EDMOND, OK 73013  
 405-340-3434  
 FAX: 405-340-3435

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# ASSEMBLY SHEET

REF:

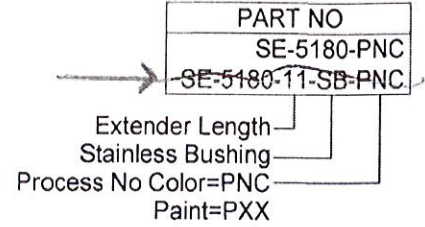
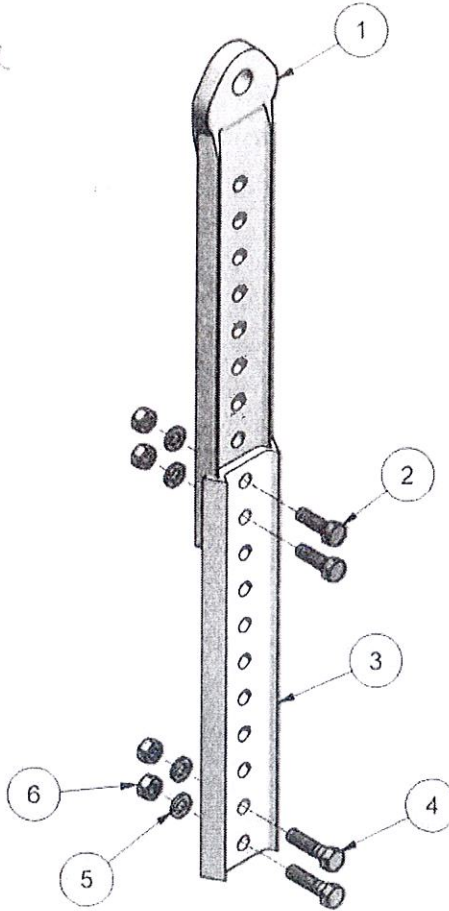
TITLE:

Extender Assy, w/ Extender Connector & Extender, Alum

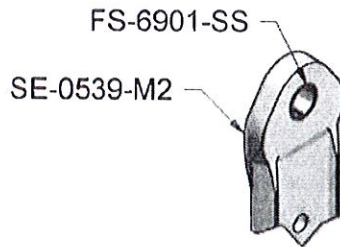
PART NO.:

SE-5180

SE-5180-40-PNC



SE-5180-40-SB PNC



Stainless Bushing Option

OPTIONS	
Stainless Bushing	
Extender Length:	11", 19", 40", 72"

ITEM	PART NUMBER	DESCRIPTION	QTY
1	SE-0539-M1	Hanger, Extender Connector, 10 Hole, Alum	1
2	FS-2006-SS	Bolt, Hex Hd, 5/16"-18 x 1", Type 304 Stainless	2
3	SE-0507-11-PNC	Extender w/ Holes, 11" Long, Alum	1
4	FS-2019-SS	Bolt, Hex Hd, 5/16"-18 x 1-1/4", Type 304 Stainless	2
5	FS-4201-SS	Lock Washer, Split, 5/16", Type 304 Stainless	4
6	FS-1001-SS	Nut, Hex 5/16"-18, Type 304 Stainless	4

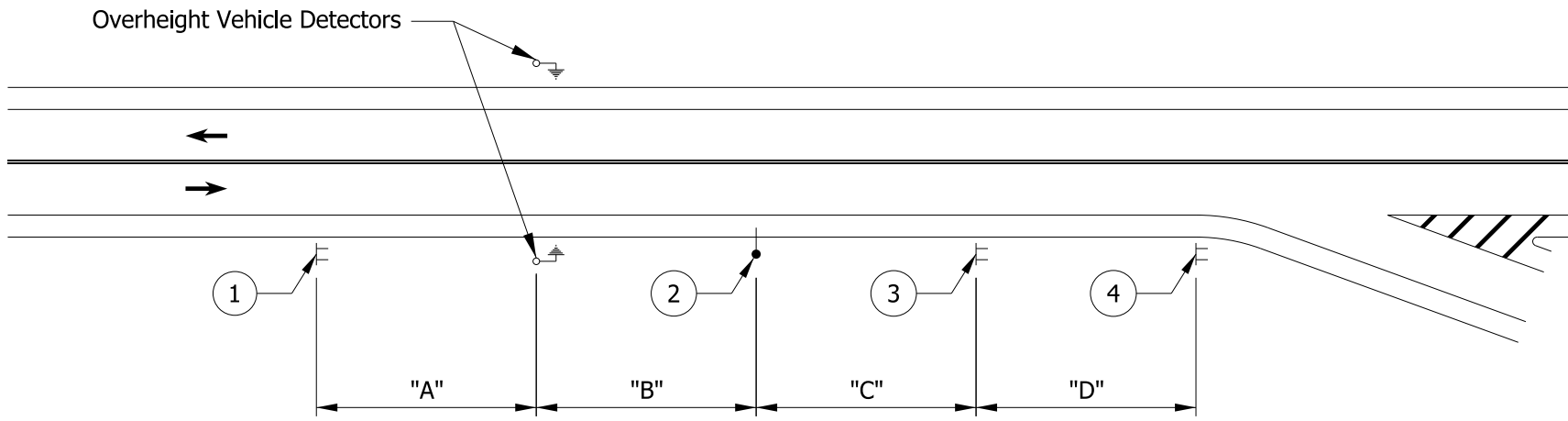
# APPENDIX

## E

CONCEPTUAL  
OVERHEIGHT  
VEHICLE  
DETECTION  
DRAWINGS



# 2-LANE BIDIRECTIONAL ROAD WITH EXIT



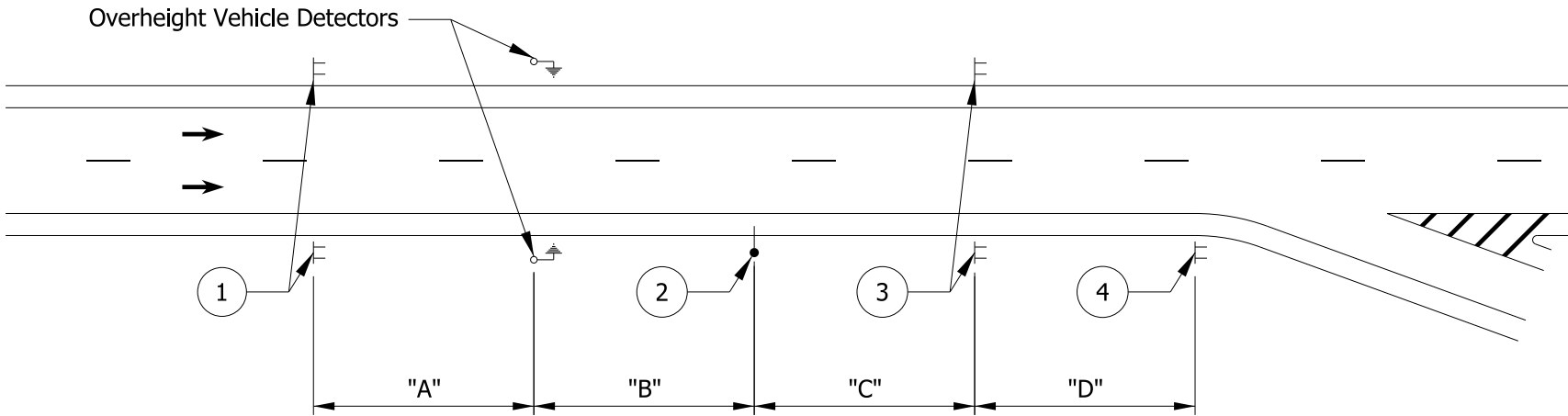
MINIMUM SIGN SPACING			
"A"	"B"	"C"	"D"
100 FT	800 FT	800 FT	800 FT

**NOTE:**  
Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.

**NOTES:**

1. Distances shown are minimum recommended distances only. Each location should be designed based on site-specific roadway geometry and speed.
2. Refer to Table 2C-4 in the MUTCD 2009 Edition for Guidelines for Advance Placement of Warning Signs.
3. Refer to Sht. 4 for Warning Sign Details.

# 2-LANE ONE WAY ROAD WITH EXIT



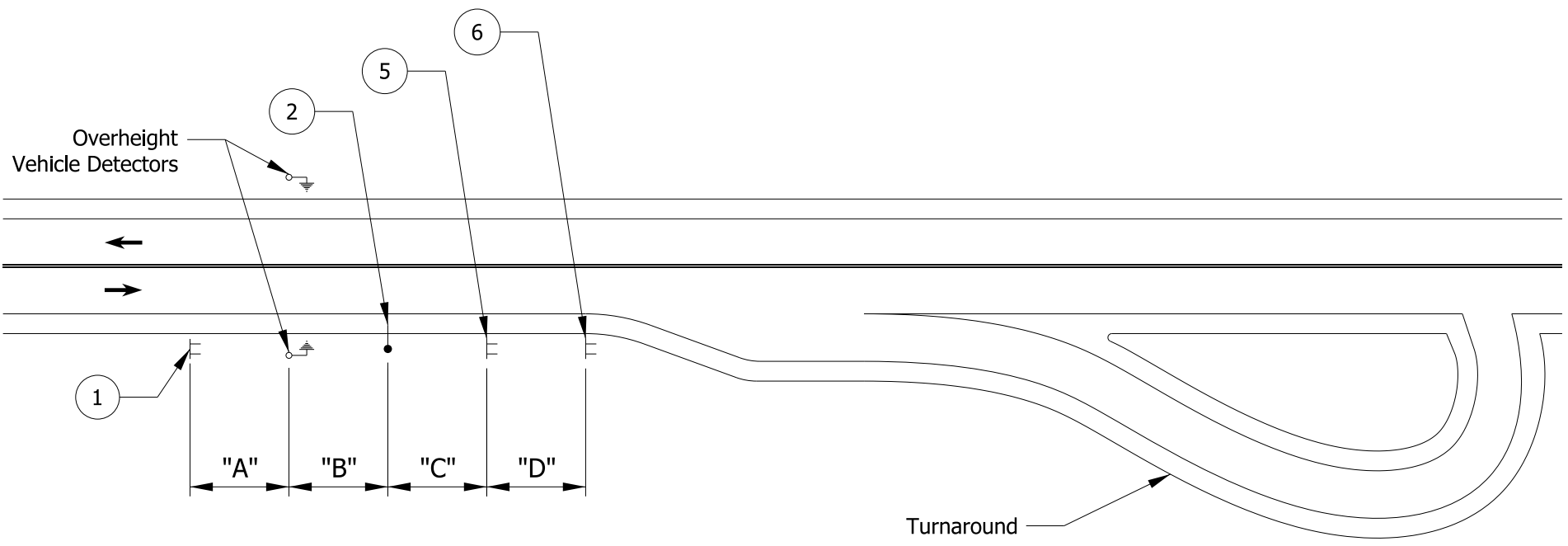
MINIMUM SIGN SPACING			
"A"	"B"	"C"	"D"
100 FT	800 FT	800 FT	800 FT

**NOTE:**  
Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.

**NOTES:**

1. Distances shown are minimum recommended distances only. Each location should be designed based on site-specific roadway geometry and speed.
2. Refer to Table 2C-4 in the MUTCD 2009 Edition for Guidelines for Advance Placement of Warning Signs.
3. Refer to Sht. 4 for Warning Sign Details.

## 2-LANE BIDIRECTIONAL ROAD WITH TURNAROUND



MINIMUM SIGN SPACING			
"A"	"B"	"C"	"D"
100 FT	800 FT	800 FT	800 FT

**NOTE:**  
Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.

**NOTES:**

1. Distances shown are minimum recommended distances only. Each location should be designed based on site-specific roadway geometry and speed.
2. Refer to Table 2C-4 in the MUTCD 2009 Edition for Guidelines for Advance Placement of Warning Signs.
3. Refer to Sht. 4 for Warning Sign Details.

# ADVANCE WARNING SIGNS



500 FT

W12-2  
W16-2aP

1

OVERHEIGHT VEHICLE  
DETECTED

LED Blankout Sign

2

**Overheight  
Vehicles  
Exit Ahead**

Overheight Vehicle  
Exit Ahead

3

**Overheight  
Vehicles  
Exit ↗**

Overheight Vehicles  
Exit

4

**Overheight  
Vehicles  
Use Turnaround**

Overheight Vehicles Use Turnaround

5

**Overheight  
Vehicles  
Turnaround ↗**

Overheight Vehicles  
Turnaround

6

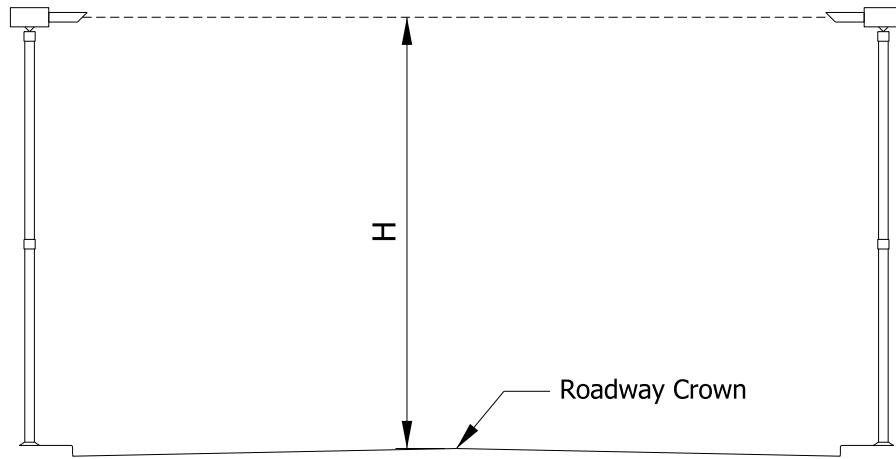
## NOTES:

1. Refer to Table 2C-4 in the MUTCD 2009 Edition for Guidelines for Advance Placement of Warning Signs.
2. Refer to Sht. 1 through 3 for suggested placement of signs.

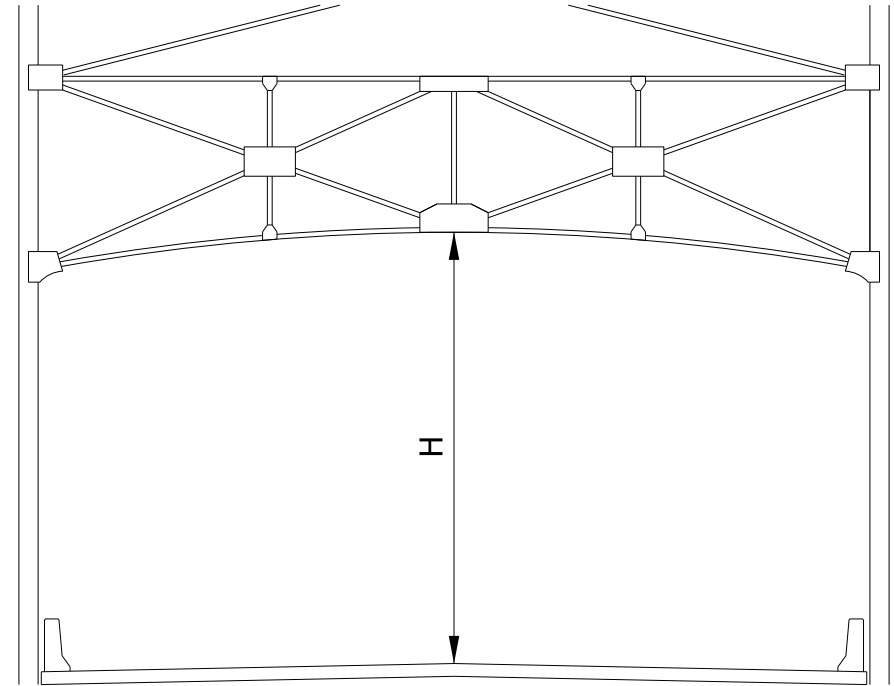
### NOTE:

Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.

# TYPICAL SECTION VIEWS



SECTION VIEW AT OVERHEIGHT VEHICLE  
DETECTOR INSTALLATION



SECTION VIEW AT BRIDGE

H = Minimum Vertical Clearance

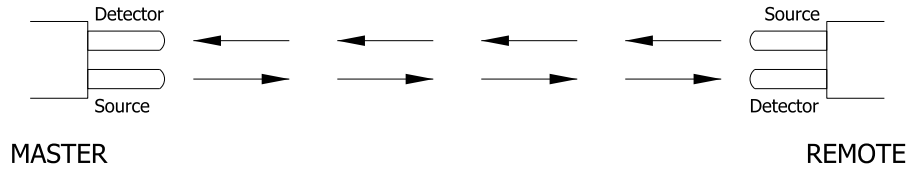
## NOTES:

1. Refer to Sht. 1 through 3 for suggested placement of sensors.

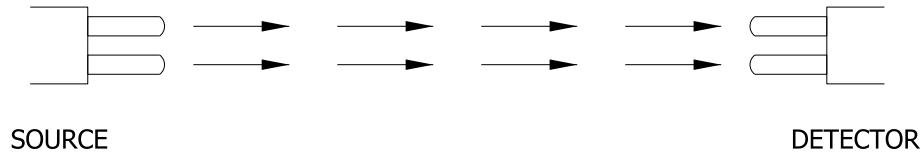
### **NOTE:**

Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.

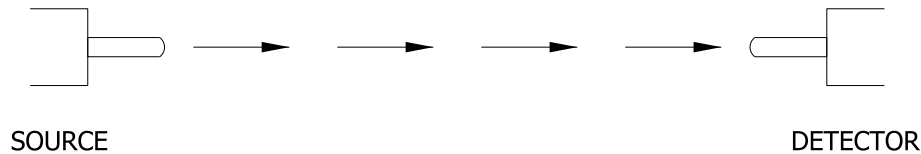
# OVERHEIGHT VEHICLE DETECTOR TYPES



## "Z-PATTERN" OVERHEIGHT VEHICLE DETECTORS



## DUAL BEAM OVERHEIGHT VEHICLE DETECTORS



## SINGLE BEAM OVERHEIGHT VEHICLE DETECTORS

### NOTES:

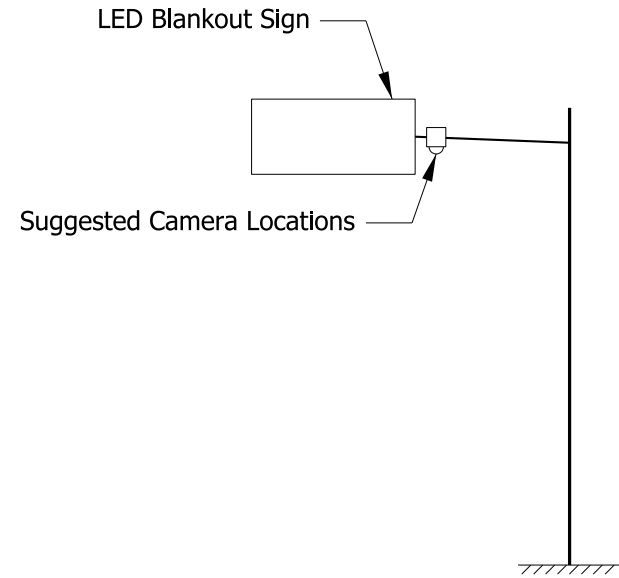
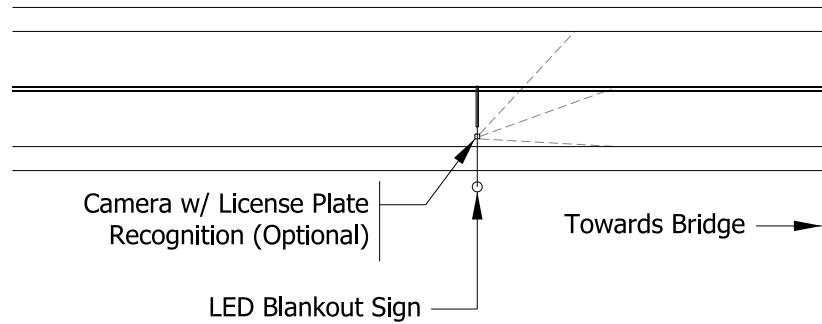
1. Refer to Sht. 1 through 3 for suggested placement of overheight vehicle detectors.

### **NOTE:**

Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.



# CAMERA PLACEMENT



## NOTES:

1. Refer to Sht. 1 through 3 for suggested placement of message sign.
2. Refer to Sht. 4 for LED Blankout Sign Details.

**NOTE:**  
Suggested design drawings were prepared for this report to illustrate possible configurations of OHVDS. These design drawings are for illustration purposes only. The OHVDS shall be designed for individual installation locations.

# APPENDIX

## F

# OVERHEIGHT VEHICLE DETECTION SPECIFICATION SHEETS



Over Height Vehicle Detection System  
12VDC Solar, BlinkerBeacon<sup>®</sup>, Infrared  
detector Activated, CVI capable

## Specification Guide

Ver 1.0, December 21, 2020

## Primary Function:

The primary function of the TAPCO Over Height Vehicle Detection System (OHVDS) is to provide a means of detection and warning of a vehicle that exceeds a maximum clearance height for an upcoming overpass, overhead wire or other low clearance structure. Overheight vehicles traveling away from the low clearance structure will not trigger the warning system.

When equipped with an optional detection and/or confirmation camera(s), cellular modem and BlinkLink™ Cloud-based web service, authorities can be alerted to Over Height detections when they happen with near real-time notifications via email with a time-stamped, location specific picture, and SMS to a mobile device.

## Connected Vehicle:

The Manufacturer shall provide a system with the option to upgrade for integration with connected vehicle infrastructure. An upgraded system shall communicate with Smart City Road Side Units (RSUs) to relay Intelligent Warning System activation data. Upgraded system shall be compatible with Dedicated Short-Range Communication (DSRC) or Cellular V2X RSUs.

## Description of Components:

The Manufacturer shall provide components for a 12VDC Solar powered Over Height Vehicle Detection System. Components include:

Dual Beam Infrared Over Height Vehicle Detector pair, with a 12VDC Solar charged, battery powered Control Cabinet each for each Infrared Source and Detector pair. Hardware for the infrared sensors and associated control cabinets is included for pole mounting. An optional cellular modem with detection and confirmation cameras and BlinkLink software can be provided as required for remote notifications via the BlinkLink Cloud-based web service. To complete a warning system, the wirelessly activated flashing beacons will be provided with their own 12VDC Solar charged, battery powered control cabinet. These are meant to bring attention to correction signage for the driver of the Over Height vehicle.

The Over Height Vehicle Detection System shall consist of two pole assemblies that are placed across the detection zone from each other, with the detectors mounted at the desired minimum detection height. Each pole assembly shall also have a 12VDC Solar powered Control Cabinet and solar panel(s). There are no wires needed between the two pole systems, as the Over Height Vehicle System utilizes a low latency radio to transmit the detection signal from the opposite side of the road. Additional cabinets with solar panels at the warning locations between the detection zone and the low clearance structure shall be activated by radio signal from the detection cabinet and shall flash warning beacons.

## General Requirements:

The Intelligent Warning System Manufacturer shall have a minimum of ten years of relevant intelligent traffic product manufacturing experience, as well as a minimum of three years of BlinkerBeacon® manufacturing experience.

## Specific Functional and Electrical Hardware Requirements:

### System

- Each Over Height Vehicle Detection System shall consist of the following:
  - Dual infrared Sensor pairs consisting of a Source assembly and a Detector assembly, each installed across the roadway from each other
  - Secondary 12VDC Solar charged, battery powered Cabinet with solar charge controller and Wireless Transceiver for Detection trigger
  - Primary 12VDC Solar charged, battery powered Cabinet containing the flash controller with integrated wireless transceiver, logic controller, solar charge controller for Detection Trigger and Overheight Warning Activation
    - Optional cellular router as required for BlinkLink™ alerting and monitoring through a mobile device
  - Directional filtering to ensure over height vehicles traveling away from the low clearance structure do not trigger an event
  - Optional Detection and Confirmation camera(s) for visual verification of Over Height events
  - Warning 12VDC Solar charged, battery powered Cabinets containing the flash controllers with integrated Wireless Transceivers and solar charge controllers for triggering warning beacons upon an Over Height vehicle detection
  - Amber Warning Beacons.
  - Solar Panels
  - Batteries
  - Pole mounting hardware for each assembly
- When an Over Height vehicle breaks the infrared beams as it is traveling towards the low clearance structure, the primary control cabinet shall wirelessly trigger the Warning Beacons. The alert will last for a programmable time period.
- Optional BlinkLink Software Service for remote notification with visual verification via computer or mobile device

### All Control Cabinets

- Shall be NEMA 3R Type
- To promote airflow for internal components, the cabinet shall be vented with screening included on all vents and drains to prevent insects and other foreign matter from entering.
- For security, the cabinet must include two tamper-resistant stainless-steel hinges for the Control Cabinet door.
- Shall have a replaceable Corbin #2 traffic lock installed on the door with two keys.
- To facilitate maintenance or repairs, the cabinet shall include a removable control panel to which all control circuit components either mount or connect.
- For easy installation on a wide range of pole sizes and types, the cabinet shall utilize pairs of 5/16"-18 stainless steel mounting studs for the attachment of mounting brackets.

- Shall adapt to a range of mounting bracket options that are secured to each pair of mounting studs on the back of the cabinet. For installation, banding style brackets that fit poles with a 2-3/8" or larger diameter shall be included as standard equipment. Mounting brackets also available for square pole, wooden post, and wall mount applications.
- Mounting brackets and hardware are included.
- To prevent corrosion, all materials used in the construction or mounting of the control cabinet shall be either aluminum or stainless steel. Anti-vandal mounting hardware shall be available as an option.
- A UV resistant label shall be applied to the exterior of the cabinet and include system specific information including model number, serial number, date of manufacture, as well as any applicable regulatory compliance information.

### Primary and Warning cabinet Flash Controller

The Programmable Flash Controller is housed within the NEMA 3R type Control Cabinet, and shall:

- Include integrated constant-current LED drivers with a minimum of two-channel output for driving one or two LED BlinkerSign or BlinkerBeacon units.
- Flash the LEDs 50 to 60 flashes per minute.
- Run for a programmable time period when activated via an external Infrared Over Height detector or wireless transceiver output
- Provide multiple levels of LED brightness through LED drive current control
- If specified, automatically adjust the LED drive current control to optimize brightness for the ambient lighting conditions.
- Have the LED drive outputs reach the full output current as programmed within the duration of the 100ms on-time.
- Include an integrated Real Time Clock (RTC) with on-board battery backup.
- Have the capability of RS232 communication for programming with Windows-based software.
- Include a minimum of two General Purpose Inputs and Outputs (GPIO).
- Seamlessly integrate with the 900 MHz FHSS wireless transceiver to form a network of connected devices.
- Be internally housed in its own IP67 type enclosure.
- Be independently replaceable of other control panel components
- Be able to monitor internal temperature.
- Operate between the temperatures of -40° to +176°F (-40° to +80°C).

### 900 MHz FHSS Wireless Transceiver

- Shall be housed inside an IP67 enclosure that resides within the NEMA 3R control cabinet
- Shall seamlessly integrate with any of the Flash controllers to ensure simultaneous activation with other radio-equipped warning devices in the system



- Shall include an integrated LCD and two user-interface buttons for setup and troubleshooting, including readouts of flash duration (timeout), and LED testing functionality
- Shall include two LED indicators for status and troubleshooting
- Shall be capable of operating as a Transmitter or Receiver
- Shall be capable of providing site-survey data for verification of signal strength between network devices
- Shall include network-wide modification of sign controller settings and output durations, using programmability from any networked transceiver without the use of additional equipment or software
- Shall synchronize the system components to activate the indications within 120msec of one other and remain synchronized throughout the duration of the flash (timeout) cycle.
- Shall have an antenna connector for easily connecting to multiple antenna options
- Shall operate on the license-free ISM band
- Shall comply with part 15 of FCC rules
- Shall operate from 3.3VDC to 15VDC
- Shall be, in the unlikely event of failure, replaceable independently of other components.

#### Primary and Secondary OHVDS Solar Panels

Each solar panel shall:

- Be IEC61215, TUV, and UL 1703 certified.
- Operate at 12VDC nominal with a maximum individual output rating of either 85W or 130W.
- Include an IP65 rated junction box with terminals sized for 8-16AWG wire.
- Be constructed of an anodized aluminum frame, high-transmission 1/8" tempered glass, with silicon cells encapsulated in double-layer EVA, and with a white polymer backing.
- Be affixed to an aluminum plate and bracket, adjustable at an angle of 45° - 60° to facilitate adjustment for maximum solar collection to optimize battery charging.
- Shall include mounting bracket and hardware for mounting to the support pole. The same mounting bracket can accommodate either one 130W panel or two 85W panels
- Have an overall size of 21" Wide x 47.5" tall (85W) or 26" Wide x 58" tall (130W)
- Have a maximum power voltage 17.8V (85W) or 18.1V (130W)
- Have a maximum power current 4.78A (85W) or 7.38A (130W)
- Have a short circuit current 5.35A (85W) or 7.89A (130W)
- Have an open circuit voltage 22.2V (85W) or 22.0V (130W)
- Operate from -40° to +194°F (-40° to +90°C)

#### Warning Device Solar Panels

The solar panel shall:

- Be IEC61215, TUV, and UL 1703 certified.
- Operate at 6VDC nominal with a maximum output rating of 26W.

- Include an IP65 rated junction box with terminals sized for 8-16AWG wire.
- Be constructed of an anodized aluminum frame, high-transmission 1/8" tempered glass, with silicon cells encapsulated in double-layer EVA, and with a white polymer backing.
- Be attached to a panel, plate and bracket to facilitate mounting and adjustment for maximum solar collection and optimal battery strength.
- Shall include mounting bracket and hardware for mounting to the support pole.
- Have an overall size of 18" x 21"
- Have a maximum power voltage 8.8V
- Have a maximum power current 3.06A
- Have a short circuit current 3.24A
- Have an open circuit voltage 10.4V
- Operate from -40° to +194°F (-40° to +90°C)

#### Infrared Overheight Sensors

- Shall utilize dual beam infrared sensing technology to detect an interruption, indicating an over height occurrence
- Shall consist of a pair of transmitters (sources) and a pair of receivers (detectors.)
- Shall have 150' reliable operable range
- Shall be reliable in all weather conditions
- Shall operate from 12VDC power
- Shall operate from -13° to +131°F (-25° to +55°C)
- Shall have aluminum enclosures with anti-corrosion coating, stainless-steel weather hood, and IP 67 rating for weather protection against snow, rain, and dust clouds
- Shall have built-in lens heaters to prevent condensation or icing
- Shall be provided with all necessary mounting hardware and wiring

#### LED Warning Devices

Each warning pole shall have either a single BlinkerSign or two BlinkerBeacons as required per the specifications functioning to warn the driver of an Over Height event in an effort to stimulate a correction. There are two different options:

- Amber LED BlinkerSigns with an Over Height appropriate legend, such as a W12-2 and additional redirect static or Blinker Signs
- Two Amber LED Wig-Wag BlinkerBeacons – one above and one below, or two side by side above, an Over Height appropriate legend, such as an MUTCD W12-2 legend and additional redirect static or Blinker sign
- BlinkerSign® LED Signs
  - All signs shall conform to 2009 Federal Highway Administration's MUTCD section 2A.07 on retro reflectivity and illumination.
  - Each sign shall have eight quantity Day-Viz® Daylight-Visible, high power 1 watt LEDs.

- Each sign blank material shall be a minimum of 0.080" thick aluminum and sized to meet the requirements.
- Each sign face shall consist of 3M™ Diamond Grade™ DG3 reflective amber sheeting, as required.
- Sign sheeting shall be applied to the sign blank with a 3M™ 1160 Premium Protective Overlay film to provide an additional layer of graffiti protection.
- The BlinkerSign legend shall be a MUTCD approved unless specified otherwise.
- The LEDs shall be embedded individually into 1" diameter holes around the perimeter of the sign and shall be ultrasonically welded to the sign assembly to provide maximum strength and rigidity.
- LED color shall be amber.
- Each LED shall be sealed within a 7/8" diameter, heat-dissipating plastic enclosure to provide resistance to weather and vibration.
- LEDs shall be wired in parallel electrically so that remaining LEDs continue to flash in the unlikely event of the failure of any individual LED.
- Wiring between BlinkerSign® LEDs shall be encapsulated inside 1" x 3/8" aluminum extrusions secured to the back of each sign assembly, to provide weather resistance and protection.
- Each sign shall have adequate holes for mounting to a pole or post. Optional vandal-resistant fasteners to mount the BlinkerSign® LED sign assembly to a pole or post shall be available.
- UV-resistant label(s) shall be applied to the back of each sign assembly and shall include specific information such as the manufacturer, manufacturer phone number, model number, serial number, date of manufacture and any applicable regulatory compliance information.

#### Primary and Secondary Over Height Detection Cabinet Battery Power

- Shall consist of a multitude of 99Ah batteries connected electrically in parallel that have a nominal output voltage of 12VDC and a total capacity rating, based upon a C/100 discharge rate, of from 99Ah to 495Ah as needed to achieve system autonomy requirements
- Shall be valve regulated, Gel type
- Shall be sealed and spill proof
- Shall have terminals that accept screw or bolts for secure wiring connections.
- Shall be replaceable independently of other components.
- Shall be fused for short circuit protection

#### LED BlinkerBeacon Warning Assemblies

- Each of the two warning beacon assemblies shall consist of:
  - A black polycarbonate vehicle traffic signal housing
  - A black polycarbonate door
  - A black poly visor
  - A 12" Amber LED beacon module

- An aluminum mounting arm with black powder coat finish.
- The signal housing shall be a one-piece unit with serrations in 5° increments at each end to allow for positive positioning during mounting and include provisions for attaching back plates if required (Optional Back plates available).
- The housing, door and visor shall be injection molded of ultraviolet stabilized, pre-colored opaque polycarbonate.
- To prevent water entry, a neoprene gasket shall be included between the door and housing.
- A black cut visor shall be included as standard equipment, with other colors and styles available as options.
- To prevent any marring of the finished surface, the arm assembly shall be assembled prior to powder coat application with all internal threads completely masked to prevent paint build-up.
- To prevent corrosion, all materials used in the construction and mounting of the beacon assembly shall be either polycarbonate, powder coated aluminum, aluminum, or stainless steel.
- The beacon assembly will be provided with the bracketry and hardware necessary for mast arm mounting per the requirements.
- The LED beacon module shall provide incandescent-like appearance, be a fully sealed module featuring robust high flux LED technology, include abrasion resistant lens coating and easily install into existing signal enclosures if needed. The LED beacon module shall come pre-installed in the beacon assembly.
- The 12" Amber LED Beacon module shall at a minimum:
  - Utilize Dialight's LED Robust High Flux LED Technology
  - Be driven directly from the constant current DC output of the programmable Flash Controller
  - Include a yellow power wire and white ground wire quick connect spade terminals
  - Meet or exceed Military Standard 883, test method 2007 for vibration resistance
  - Meet or exceed Military Standard 810F, test method 506.4 for moisture resistance to rain and blowing rain
  - Have a dominant wavelength of 625nm (Red)
  - Operate from -40° to +165°F (-40° to +74°C)

#### Optional BlinkLink™ Cloud-based system management and notification service:

- The BlinkLink Cloud-based service shall provide a secure user interface and shall be capable of delivering on-screen notifications with images, e-mail notifications with images, and SMS text messages when the detection hardware has been triggered
- As a Cloud-based service, BlinkLink shall not require any locally installed software applications other than an up-to-date web browser
- Historical alert data and system statistics shall be accessible through easy-to-use user-configurable reports

- BlinkLink shall be capable of displaying detection hardware system status, including but not limited to DC power supply voltage and cabinet temperature.
- BlinkLink is a subscription based service, sold annually per OHVD system

#### Optional Detection and Confirmation Cameras (with BlinkLink):

- Detection area and direction shall be programmable
- Shall be capable of storing images saved in a buffer to capture events that occurred in the recent past
- Shall have programmable event-based logic
- Shall have adjustable image settings, including:
  - Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, and rotation
- Shall have a shutter time of 1/6s to 1/24500s
- Shall utilize a ¼" progressive scan RGB CMOS
- Shall have a minimum of one input and one output
- Shall comply with part 15 of the FCC rules
- Shall operate from -4° to +122°F (-20° to +50°C)
- Shall have a sensor that is IP66 NEMA 4X-rated
- Shall operate from 8VDC to 28VDC
- Shall be programmable from Windows-based software

#### Optional 4G LTE Cellular Gateway (with BlinkLink):

- Shall provide communication to BlinkLink™ Cloud-Based Web Service
- Shall be offered in Verizon and AT&T variants
- Shall include an integrated five-port 10/100 Ethernet switch
- Shall include an integrated RS232 serial port
- Shall include LED indicators for Power, WAN, Signal, RS232, Ethernet Link, and Activity
- Shall comply with part 15 of FCC rules
- Shall operate from -40° to +167°F (-40° to +75°C)
- Shall have a sensor that is IP66 NEMA 4X-rated
- Shall operate on 8VDC to 30VDC
- Shall be capable of Over the Air (OTA) firmware updates and remote management
- Shall be capable of IPSEC VPN
- Shall be programmable from windows-based software

#### Optional Warning Static Sign

- Each static sign face shall be constructed on a 0.080" thick 5052-H32 aluminum and screened onto 3M™ Diamond Grade™ DG<sup>3</sup> Reflective sheeting of specified color.
- Shall have MUTCD compliant sign legend, as dictated by the requirements.
- Shall have two holes for mounting to a post or pole.

- Includes pole mounting hardware.

#### Optional Pole Package

- Pole shall be a standard specified outer diameter aluminum pedestal pole.
- Pole shall be supplied with one end threaded for easy installation into a pedestal base.
- Pole shall be 13' - 20' length Schedule 40 pipe raw aluminum as required
- Pedestal Base shall be TP-358 cast aluminum that mounts on a concrete foundation attached by four internal anchor bolts imbedded in the foundation.
- Pedestal Base shall have a large 8.5" square hand hole cover allowing access to the interior.

#### Warranty

The Manufacturer shall offer a three year warranty on batteries, a five-year unconditional warranty against all defects in material and workmanship, and a ten year warranty on solar panels.



Over Height Vehicle Detection System  
120VAC, BlinkerBeacon<sup>®</sup>, Infrared  
detector Activated, CVI capable

## Specification Guide

Ver 1.0, December 21, 2020



## Primary Function:

The primary function of the TAPCO Over Height Vehicle Detection System (OHVDS) is to provide a means of detection and warning of a vehicle that exceeds a maximum clearance height for an upcoming overpass, overhead wire or other low clearance structure. Overheight vehicles traveling away from the low clearance structure will not trigger the warning system.

When equipped with an optional detection and/or confirmation camera(s), cellular modem and BlinkLink™ Cloud-based web service, authorities can be alerted to Over Height detections when they happen with near real-time notifications via email with a time-stamped, location specific picture, and SMS to a mobile device.

## Connected Vehicle:

The Manufacturer shall provide a system with the option to upgrade for integration with connected vehicle infrastructure. An upgraded system shall communicate with Smart City Road Side Units (RSUs) to relay Intelligent Warning System activation data. Upgraded system shall be compatible with Dedicated Short-Range Communication (DSRC) or Cellular V2X RSUs.

## Description of Components:

The Manufacturer shall provide components for a 120VAC powered Over Height Vehicle Detection System. Components include:

Dual Beam Infrared Over Height Vehicle Detector pair, with a 120VAC powered Control Cabinet each for each Infrared Source and Detector pair. Hardware for the infrared sensors and associated control cabinets is included for pole mounting. An optional cellular modem with detection and confirmation cameras and BlinkLink software can be provided as required for remote notifications via the BlinkLink Cloud-based web service. To complete a warning system, the wirelessly activated flashing beacons will be provided with their own 120VAC powered control cabinet. These are meant to bring attention to correction signage for the driver of the Over Height vehicle.

The Over Height Vehicle Detection System shall consist of two pole assemblies that are placed across the detection zone from each other, with the detectors mounted at the desired minimum detection height. Each pole assembly shall also have a 120VAC powered Control Cabinet. There are no wires needed between the two pole systems, as the Over Height Vehicle System utilizes a low latency radio to transmit the detection signal from the opposite side of the road. Additional 120VAC powered cabinets at the warning locations between the detection zone and the low clearance structure shall be activated by radio signal from the detection cabinet and shall flash warning beacons.

## General Requirements:

The Intelligent Warning System Manufacturer shall have a minimum of ten years of relevant intelligent traffic product manufacturing experience, as well as a minimum of three years of BlinkerBeacon® manufacturing experience.

## Specific Functional and Electrical Hardware Requirements:

### System

- Each Over Height Vehicle Detection System shall consist of the following:
  - Dual infrared Sensor pairs consisting of a Source assembly and a Detector assembly, each installed across the roadway from each other
  - Secondary 120VAC powered Cabinet with universal power supply and Wireless Transceiver for Detection trigger
  - Primary 120VAC powered Cabinet containing the flash controller with integrated wireless transceiver, logic controller, universal power supply for Detection Trigger and Overheight Warning Activation
    - Optional cellular router as required for BlinkLink™ alerting and monitoring through a mobile device
  - Directional filtering to ensure over height vehicles traveling away from the low clearance structure do not trigger an event
  - Optional Detection and Confirmation camera(s) for visual verification of Over Height events
  - Warning 120VAC powered Cabinets containing the flash controllers with integrated Wireless Transceivers universal power supplies for triggering warning beacons upon an Over Height vehicle detection
  - Amber Warning Beacons.
  - Pole mounting hardware for each assembly
- When an Over Height vehicle breaks the infrared beams as it is traveling towards the low clearance structure, the primary control cabinet shall wirelessly trigger the Warning Beacons. The alert will last for a programmable time period.
- Optional BlinkLink Software Service for remote notification with visual verification via computer or mobile device

### All Control Cabinets

- Shall be NEMA 3R Type
- To promote airflow for internal components, the cabinet shall be vented with screening included on all vents and drains to prevent insects and other foreign matter from entering.
- For security, the cabinet must include two tamper-resistant stainless-steel hinges for the Control Cabinet door.
- Shall have a replaceable Corbin #2 traffic lock installed on the door with two keys.
- To facilitate maintenance or repairs, the cabinet shall include a removable control panel to which all control circuit components either mount or connect.
- For easy installation on a wide range of pole sizes and types, the cabinet shall utilize pairs of 5/16"-18 stainless steel mounting studs for the attachment of mounting brackets.
- Shall adapt to a range of mounting bracket options that are secured to each pair of mounting studs on the back of the cabinet. For installation, banding style brackets that fit

poles with a 2-3/8" or larger diameter shall be included as standard equipment. Mounting brackets also available for square pole, wooden post, and wall mount applications.

- Mounting brackets and hardware are included.
- To prevent corrosion, all materials used in the construction or mounting of the control cabinet shall be either aluminum or stainless steel. Anti-vandal mounting hardware shall be available as an option.
- A UV resistant label shall be applied to the exterior of the cabinet and include system specific information including model number, serial number, date of manufacture, as well as any applicable regulatory compliance information.

### Primary and Warning cabinet Flash Controller

The Programmable Flash Controller is housed within the NEMA 3R type Control Cabinet, and shall:

- Include integrated constant-current LED drivers with a minimum of two-channel output for driving one or two LED BlinkerSign or BlinkerBeacon units.
- Flash the LEDs 50 to 60 flashes per minute.
- Run for a programmable time period when activated via an external Infrared Over Height detector or wireless transceiver output
- Provide multiple levels of LED brightness through LED drive current control
- If specified, automatically adjust the LED drive current control to optimize brightness for the ambient lighting conditions.
- Have the LED drive outputs reach the full output current as programmed within the duration of the 100ms on-time.
- Include an integrated Real Time Clock (RTC) with on-board battery backup.
- Have the capability of RS232 communication for programming with Windows-based software.
- Include a minimum of two General Purpose Inputs and Outputs (GPIO).
- Seamlessly integrate with the 900 MHz FHSS wireless transceiver to form a network of connected devices.
- Be internally housed in its own IP67 type enclosure.
- Be independently replaceable of other control panel components
- Be able to monitor internal temperature.
- Operate between the temperatures of -40° to +176°F (-40° to +80°C).

### 900 MHz FHSS Wireless Transceiver

- Shall be housed inside an IP67 enclosure that resides within the NEMA 3R control cabinet
- Shall seamlessly integrate with any of the Flash controllers to ensure simultaneous activation with other radio-equipped warning devices in the system
- Shall include an integrated LCD and two user-interface buttons for setup and troubleshooting, including readouts of flash duration (timeout), and LED testing functionality

- Shall include two LED indicators for status and troubleshooting
- Shall be capable of operating as a Transmitter or Receiver
- Shall be capable of providing site-survey data for verification of signal strength between network devices
- Shall include network-wide modification of sign controller settings and output durations, using programmability from any networked transceiver without the use of additional equipment or software
- Shall synchronize the system components to activate the indications within 120msec of one other and remain synchronized throughout the duration of the flash (timeout) cycle.
- Shall have an antenna connector for easily connecting to multiple antenna options
- Shall operate on the license-free ISM band
- Shall comply with part 15 of FCC rules
- Shall operate from 3.3VDC to 15VDC
- Shall be, in the unlikely event of failure, replaceable independently of other components.

### Universal Switching Power Supplies

The Universal Switching Power Supplies shall:

- Accept a universal AC input, 100-240VAC, 50/60 hz
- Output 12 VDC regulated to +/- 1%
- Have Short Circuit, Overload and Over Voltage protection
- Be convection cooled, DIN rail mount
- Have an LED power on indicator
- Be UL60950-1, TUV EN60950-1, Class I, Div. 2 Group A,B,C,D and Hazardous Locations T4 Approved
- Operate in a relative humidity of 20 to 90% non-condensing
- Operate from -4° to +158°F (-20° to +70°C)

### Infrared Overheight Sensors

- Shall utilize dual beam infrared sensing technology to detect an interruption, indicating an over height occurrence
- Shall consist of a pair of transmitters (sources) and a pair of receivers (detectors.)
- Shall have 150' reliable operable range
- Shall be reliable in all weather conditions
- Shall operate from 12VDC power
- Shall operate from -13° to +131°F (-25° to +55°C)
- Shall have aluminum enclosures with anti-corrosion coating, stainless-steel weather hood, and IP 67 rating for weather protection against snow, rain, and dust clouds
- Shall have built-in lens heaters to prevent condensation or icing
- Shall be provided with all necessary mounting hardware and wiring

## LED Warning Devices

Each warning pole shall have either a single BlinkerSign or two BlinkerBeacons as required per the specifications functioning to warn the driver of an Over Height event in an effort to stimulate a correction. There are two different options:

- Amber LED BlinkerSigns with an Over Height appropriate legend, such as a W12-2 and additional redirect static or Blinker Signs
  - Two Amber LED Wig-Wag BlinkerBeacons – one above and one below, or two side by side above, an Over Height appropriate legend, such as an MUTCD W12-2 legend and additional redirect static or Blinker sign
- BlinkerSign® LED Signs
    - All signs shall conform to 2009 Federal Highway Administration's MUTCD section 2A.07 on retro reflectivity and illumination.
    - Each sign shall have eight quantity Day-Viz® Daylight-Visible, high power 1 watt LEDs.
    - Each sign blank material shall be a minimum of 0.080" thick aluminum and sized to meet the requirements.
    - Each sign face shall consist of 3M™ Diamond Grade™ DG3 reflective amber sheeting, as required.
    - Sign sheeting shall be applied to the sign blank with a 3M™ 1160 Premium Protective Overlay film to provide an additional layer of graffiti protection.
    - The BlinkerSign legend shall be a MUTCD approved unless specified otherwise.
    - The LEDs shall be embedded individually into 1" diameter holes around the perimeter of the sign and shall be ultrasonically welded to the sign assembly to provide maximum strength and rigidity.
    - LED color shall be amber.
    - Each LED shall be sealed within a 7/8" diameter, heat-dissipating plastic enclosure to provide resistance to weather and vibration.
    - LEDs shall be wired in parallel electrically so that remaining LEDs continue to flash in the unlikely event of the failure of any individual LED.
    - Wiring between BlinkerSign® LEDs shall be encapsulated inside 1" x 3/8" aluminum extrusions secured to the back of each sign assembly, to provide weather resistance and protection.
  - Each sign shall have adequate holes for mounting to a pole or post. Optional vandal-resistant fasteners to mount the BlinkerSign® LED sign assembly to a pole or post shall be available.
  - UV-resistant label(s) shall be applied to the back of each sign assembly and shall include specific information such as the manufacturer, manufacturer phone number, model number, serial number, date of manufacture and any applicable regulatory compliance information.

## LED BlinkerBeacon Warning Assemblies

- Each of the two warning beacon assemblies shall consist of:
  - A black polycarbonate vehicle traffic signal housing
  - A black polycarbonate door
  - A black poly visor
  - A 12" Amber LED beacon module
  - An aluminum mounting arm with black powder coat finish.
- The signal housing shall be a one-piece unit with serrations in 5° increments at each end to allow for positive positioning during mounting and include provisions for attaching back plates if required (Optional Back plates available).
- The housing, door and visor shall be injection molded of ultraviolet stabilized, pre-colored opaque polycarbonate.
- To prevent water entry, a neoprene gasket shall be included between the door and housing.
- A black cut visor shall be included as standard equipment, with other colors and styles available as options.
- To prevent any marring of the finished surface, the arm assembly shall be assembled prior to powder coat application with all internal threads completely masked to prevent paint build-up.
- To prevent corrosion, all materials used in the construction and mounting of the beacon assembly shall be either polycarbonate, powder coated aluminum, aluminum, or stainless steel.
- The beacon assembly will be provided with the bracketry and hardware necessary for mast arm mounting per the requirements.
- The LED beacon module shall provide incandescent-like appearance, be a fully sealed module featuring robust high flux LED technology, include abrasion resistant lens coating and easily install into existing signal enclosures if needed. The LED beacon module shall come pre-installed in the beacon assembly.
- The 12" Amber LED Beacon module shall at a minimum:
  - Utilize Dialight's LED Robust High Flux LED Technology
  - Be driven directly from the constant current DC output of the programmable Flash Controller
  - Include a yellow power wire and white ground wire quick connect spade terminals
  - Meet or exceed Military Standard 883, test method 2007 for vibration resistance
  - Meet or exceed Military Standard 810F, test method 506.4 for moisture resistance to rain and blowing rain
  - Have a dominant wavelength of 625nm (Red)
  - Operate from -40° to +165°F (-40° to +74°C)

Optional BlinkLink™ Cloud-based system management and notification service:



- The BlinkLink Cloud-based service shall provide a secure user interface and shall be capable of delivering on-screen notifications with images, e-mail notifications with images, and SMS text messages when the detection hardware has been triggered
- As a Cloud-based service, BlinkLink shall not require any locally installed software applications other than an up-to-date web browser
- Historical alert data and system statistics shall be accessible through easy-to-use user-configurable reports
- BlinkLink shall be capable of displaying detection hardware system status, including but not limited to DC power supply voltage and cabinet temperature.
- BlinkLink is a subscription based service, sold annually per OHVD system

#### Optional Detection and Confirmation Cameras (with BlinkLink):

- Detection area and direction shall be programmable
- Shall be capable of storing images saved in a buffer to capture events that occurred in the recent past
- Shall have programmable event-based logic
- Shall have adjustable image settings, including:
  - Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, and rotation
- Shall have a shutter time of 1/6s to 1/24500s
- Shall utilize a ¼" progressive scan RGB CMOS
- Shall have a minimum of one input and one output
- Shall comply with part 15 of the FCC rules
- Shall operate from -4° to +122°F (-20° to +50°C)
- Shall have a sensor that is IP66 NEMA 4X-rated
- Shall operate from 8VDC to 28VDC
- Shall be programmable from Windows-based software

#### Optional 4G LTE Cellular Gateway (with BlinkLink):

- Shall provide communication to BlinkLink™ Cloud-Based Web Service
- Shall be offered in Verizon and AT&T variants
- Shall include an integrated five-port 10/100 Ethernet switch
- Shall include an integrated RS232 serial port
- Shall include LED indicators for Power, WAN, Signal, RS232, Ethernet Link, and Activity
- Shall comply with part 15 of FCC rules
- Shall operate from -40° to +167°F (-40° to +75°C)
- Shall have a sensor that is IP66 NEMA 4X-rated
- Shall operate on 8VDC to 30VDC
- Shall be capable of Over the Air (OTA) firmware updates and remote management
- Shall be capable of IPSEC VPN

- Shall be programmable from windows-based software

#### Optional Warning Static Sign

- Each static sign face shall be constructed on a 0.080" thick 5052-H32 aluminum and screened onto 3M™ Diamond Grade™ DG<sup>3</sup> Reflective sheeting of specified color.
- Shall have MUTCD compliant sign legend, as dictated by the requirements.
- Shall have two holes for mounting to a post or pole.
- Includes pole mounting hardware.

#### Optional Pole Package

- Pole shall be a standard specified outer diameter aluminum pedestal pole.
- Pole shall be supplied with one end threaded for easy installation into a pedestal base.
- Pole shall be 13' - 20' length Schedule 40 pipe raw aluminum as required
- Pedestal Base shall be TP-358 cast aluminum that mounts on a concrete foundation attached by four internal anchor bolts imbedded in the foundation.
- Pedestal Base shall have a large 8.5" square hand hole cover allowing access to the interior.

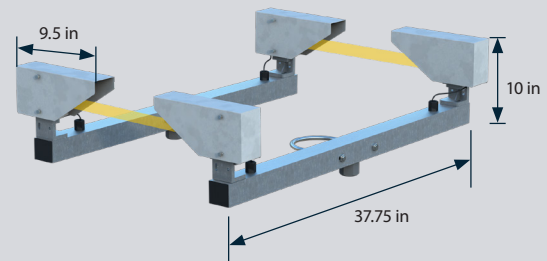
## Warranty

The Manufacturer shall offer a five-year unconditional warranty against all defects in material and workmanship.

# DUAL BEAM OVERHEIGHT SENSORS

## SPECIFICATIONS

<b>POWER</b>	12VDC
<b>DIGITAL OUTPUT</b>	One (short circuit proof)
<b>SENSOR</b>	Dual photoelectric infrared switches with sensitivity adjustment
<b>MAXIMUM SENSOR RANGE</b>	150 feet
<b>ALIGNMENT</b>	Visual LED confirmation
<b>LENS HEATER</b>	Built-in
<b>ENCLOSURE</b>	Aluminum, IP67 rating
<b>INSTALLATION</b>	Dual sensor mounting bracket, banding or U-bolt
<b>WEATHER HOOD</b>	Stainless steel
<b>OPERATING TEMPERATURE RANGE</b>	-13°F to 131°F (-25°C to 55°C)
<b>DIMENSIONS WITH BRACKET</b>	37.8"W x 10"H x 9.5"D



**SPECIFICATIONS**

**MODEL # 3400-Z**  
**Z-PATTERN™ VISIBLE RED / INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**

**Z-Pattern™**



**REMOTE**



**MASTER**

MODEL	3400-Z	3400-Z-230	3400-Z-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>CURRENT - MASTER</b>	0.582A	0.291A	1.450A
<b>CURRENT - REMOTE</b>	0.560A	0.280A	1.150A
<b>ALARM OUTPUT</b>	Two Form C, dry relay contact closures for Over-height Alarm Functions. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	One Form C, dry relay contact opening for Fault Reporting. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT REPORTING</b>	Factory configuration per customer selection of operational mode, loss of source/ detector/power or total failure.		
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated.		
<b>EFFECTS OF AMBIENT LIGHT</b>	Use of Dual Beam RED/IR Z-Pattern™ provides automatic switch to Single Beam Detection Mode of Over height Protection if the sun or other interference saturates one detector.		
<b>MAXIMUM RANGE</b>	500 feet (152 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.		

## SPECIFICATIONS (CONT'D):

MODEL	3400-Z	3400-Z-230	3400-Z-24
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Four LEDs and meter (GO-NOGO functions) provided for ease of alignment and testing.		
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.		
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat with heater and fan controls air flow which reduces moisture and maintains internal temperature during cold weather. Internal heaters in each eye cone to help reduce condensation, snow build up. Lenses to help contain internal heat and provide additional sensor protection.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. NEMA 3R Certified.		
<b>CONNECTORS</b>	Remote Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Master Cabinet: Two 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Remote Cabinet: 12¾ x 16½ x 8½ inches (32 x 42 x 22 cm). Master Cabinet: 12¾ x 18¾ x 8½ inches (32 x 48 x 22 cm).		
<b>SHIPPING WEIGHT</b>	60 lbs (27 kg).		
<b>CERTIFICATIONS</b>	CE Mark		
<b>U.S. PATENT NO.</b>	5,828,320		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

## OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.

**SPECIFICATIONS**

**MODEL # 3401-Z**  
**Z-PATTERN™ INFRARED / INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**

**Z-Pattern™**



**REMOTE**



**MASTER**

MODEL	3401-Z	3401-Z-230	3401-Z-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>CURRENT - MASTER</b>	0.700A	0.350A	1.450A
<b>CURRENT - REMOTE</b>	0.650A	0.325A	1.150A
<b>ALARM OUTPUT</b>	Two Form C, dry relay contact closures for Over-height Alarm Functions. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	One Form C, dry relay contact opening for Fault Reporting. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT REPORTING</b>	Factory configuration per customer selection of operational mode, loss of source/ detector/power or total failure.		
<b>ALARM TIME</b>	Adjustable by customer from 2 to 60 seconds.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated.		
<b>EFFECTS OF AMBIENT LIGHT</b>	Use of Dual Beam IR/IR Z-Pattern™ provides automatic switch to Single Beam Detection Mode of Over height Protection if the sun or other interference saturates one detector.		
<b>MAXIMUM RANGE</b>	500 feet (152 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.		

## SPECIFICATIONS (CONT'D):

MODEL	3401-Z	3401-Z-230	3401-Z-24
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Four LEDs and meter (GO-NOGO functions) provided for ease of alignment and testing.		
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.		
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat with heater and fan controls air flow which reduces moisture and maintains internal temperature during cold weather.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. NEMA 3R Certified.		
<b>CONNECTORS</b>	Remote Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Master Cabinet: Two 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Remote Cabinet: 12¾ x 16½ x 8½ inches (32 x 42 x 22 cm). Master Cabinet: 12¾ x 18¾ x 8½ inches (32 x 48 x 22 cm).		
<b>SHIPPING WEIGHT</b>	60 lbs (27 kg).		
<b>CERTIFICATIONS</b>	CE Mark		
<b>U.S. PATENT NO.</b>	5,828,320		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

## OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.



**SPECIFICATIONS**

**MODEL # 3402-Z**  
**Z-PATTERN™ INFRARED / INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**

**Z-Pattern™**



**REMOTE**



**MASTER**

MODEL	3402-Z	3402-Z-230	3402-Z-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>CURRENT - MASTER</b>	0.700A	0.350A	1.450A
<b>CURRENT - REMOTE</b>	0.650A	0.325A	1.150A
<b>ALARM OUTPUT</b>	Two Form C, dry relay contact closures for Over-height Alarm Functions. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	One Form C, dry relay contact opening for Fault Reporting. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT REPORTING</b>	Factory configuration per customer selection of operational mode, loss of source/ detector/power or total failure.		
<b>ALARM TIME</b>	Adjustable by customer from 2 to 60 seconds.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated.		
<b>EFFECTS OF AMBIENT LIGHT</b>	Use of Dual Beam IR/IR Z-Pattern™ provides automatic switch to Single Beam Detection Mode of Over height Protection if the sun or other interference saturates one detector.		
<b>MAXIMUM RANGE</b>	500 feet (152 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.		

## SPECIFICATIONS (CONT'D):

MODEL	3402-Z	3402-Z-230	3402-Z-24
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Four LEDs and meter (GO-NOGO functions) provided for ease of alignment and testing.		
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.		
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat with heater and fan controls air flow which reduces moisture and maintains internal temperature during cold weather. Internal heaters in each eye cone to help reduce condensation, snow build up. Lenses to help contain internal heat and provide additional sensor protection.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. NEMA 3R Certified.		
<b>CONNECTORS</b>	Remote Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Master Cabinet: Two 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Remote Cabinet: 12¾ x 16½ x 8½ inches (32 x 42 x 22 cm). Master Cabinet: 12¾ x 18¾ x 8½ inches (32 x 48 x 22 cm).		
<b>SHIPPING WEIGHT</b>	60 lbs (27 kg).		
<b>CERTIFICATIONS</b>	CE Mark		
<b>U.S. PATENT NO.</b>	5,828,320		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

## OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

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**SPECIFICATIONS**

**MODEL # 3403-Z**  
**Z-PATTERN™ VISIBLE RED / INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**

**Z-Pattern™**  **CE**



**REMOTE**



**MASTER**

MODEL	3403-Z	3403-Z-230	3403-Z-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>CURRENT - MASTER</b>	0.700A	0.350A	1.450A
<b>CURRENT - REMOTE</b>	0.650A	0.325A	1.150A
<b>ALARM OUTPUT</b>	Two Form C, dry relay contact closures for Over-height Alarm Functions. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	One Form C, dry relay contact opening for Fault Reporting. Contacts rated 240 VAC 10A, protected by 8A circuit breakers.		
<b>FAULT REPORTING</b>	Factory configuration per customer selection of operational mode, loss of source/ detector/power or total failure.		
<b>ALARM TIME</b>	Adjustable by customer from 2 to 60 seconds.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P / IP67 enclosure rated.		
<b>EFFECTS OF AMBIENT LIGHT</b>	Use of Dual Beam Visible Red/IR Z-Pattern™ provides automatic switch to Single Beam Detection Mode of Over height Protection if the sun or other interference saturates one detector.		
<b>MAXIMUM RANGE</b>	500 feet (152 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.		

## SPECIFICATIONS (CONT'D):

MODEL	3403-Z	3403-Z-230	3403-Z-24
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Four LEDs and meter (GO-NOGO functions) provided for ease of alignment and testing.		
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.		
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat with heater and fan controls air flow which reduces moisture and maintains internal temperature during cold weather. Internal heaters in each eye cone to help reduce condensation, snow build up. Lenses to help contain internal heat and provide additional sensor protection.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. NEMA 3R Certified.		
<b>CONNECTORS</b>	Remote Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Master Cabinet: Two 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Remote Cabinet: 12¾ x 16½ x 8½ inches (32 x 42 x 22 cm). Master Cabinet: 12¾ x 18¾ x 8½ inches (32 x 48 x 22 cm).		
<b>SHIPPING WEIGHT</b>	60 lbs (27 kg).		
<b>CERTIFICATIONS</b>	CE Mark		
<b>U.S. PATENT NO.</b>	5,828,320		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

## OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

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**SPECIFICATIONS**

**MODEL # DB-R/IR-3200**

DUAL BEAM VISIBLE RED / INFRARED  
OVER-HEIGHT VEHICLE DETECTION SYSTEM



**SOURCE**



**DETECTOR**

MODEL	DB-R/IR-3200	DB-R/IR-3200-230	DB-R/IR-3200-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>CURRENT - SOURCE</b>	0.121A	0.061A	0.390A
<b>CURRENT - DETECTOR</b>	0.390A	0.195A	0.520A
<b>ALARM OUTPUT</b>	Two dry relay contact closures, Form C, contacts rated 115VAC 10A and protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	Dry relay contact opening, Form C, contacts rated 115VAC 10A and protected by an 8A circuit breaker.		
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Other options available.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Printed circuit board for years of reliable operation.		
<b>EFFECTS OF AMBIENT LIGHT</b>	10,000 Foot Candles for Red Detector.		
<b>MAXIMUM RANGE</b>	800 feet. Suggested maximum range of 200 feet to allow for bad weather and lens contamination.		
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Two Green LEDs and GO-NOGO meter provided for alignment. No special tools required.		
<b>REACTION SPEED</b>	1mph to 75mph for a 2.5 inch diameter object 1 inch above the height of detection.		
<b>COUNTER</b>	Records the number of activations.		

SPECIFICATIONS (CONT'D):

MODEL	DB-R/IR-3200	DB-R/IR-3200-230	DB-R/IR-3200-24
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch thickness) to minimize vandalism and provide for rigid mounting.		
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Source / Detector Cabinet: 16½ x 12½ x 8¾ inches (42 x 32 x 22 cm).		
<b>SHIPPING WEIGHT</b>	45 lbs (20 kg).		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.



**SPECIFICATIONS**

**MODEL # DB-R/IR-3200 WITH HEATER OPTION**

DUAL BEAM VISIBLE RED / INFRARED  
OVER-HEIGHT VEHICLE DETECTION SYSTEM



**SOURCE**



**DETECTOR**

MODEL	DB-R/IR-3200-H	DB-R/IR-3200-230-H	DB-R/IR-3200-24-H
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>ALARM OUTPUT</b>	Two dry relay contact closures, Form C, contacts rated 115VAC 10A and protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	Dry relay contact opening, Form C, contacts rated 115VAC 10A and protected by an 8A circuit breaker.		
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Other options available.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Printed circuit board for years of reliable operation.		
<b>EFFECTS OF AMBIENT LIGHT</b>	10,000 Foot Candles for Red Detector.		
<b>MAXIMUM RANGE</b>	800 feet. Suggested maximum range of 200 feet to allow for bad weather and lens contamination.		
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Two Green LEDs and GO-NOGO meter provided for alignment. No special tools required.		
<b>REACTION SPEED</b>	1mph to 75mph for a 2.5 inch diameter object 1 inch above the height of detection.		
<b>COUNTER</b>	Records the number of activations.		



SPECIFICATIONS (CONT'D):

MODEL	DB-R/IR-3200-H	DB-R/IR-3200-230-H	DB-R/IR-3200-24-H
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch thickness) to minimize vandalism and provide for rigid mounting.		
<b>HEATERS / LENS</b>	Internal heaters in each eye cone to help reduce condensation and snow build up. Lenses to help contain internal heat and provide additional sensor protection.		
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Source / Detector Cabinet: 16½ x 12½ x 8¾ inches (42 x 32 x 22 cm).		
<b>SHIPPING WEIGHT</b>	45 lbs (20 kg).		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.

**SPECIFICATIONS**

**MODEL # DB-IR/IR-3200**

DUAL BEAM INFRARED / INFRARED  
OVER-HEIGHT VEHICLE DETECTION SYSTEM



**SOURCE**



**DETECTOR**

MODEL	DB-IR/IR-3200	DB-IR/IR-3200-230	DB-IR/IR-3200-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>CURRENT - SOURCE</b>	0.121A	0.061A	0.390A
<b>CURRENT - DETECTOR</b>	0.390A	0.195A	0.520A
<b>ALARM OUTPUT</b>	Two dry relay contact closures, Form C, contacts rated 115VAC 10A and protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	Dry relay contact opening, Form C, contacts rated 115VAC 10A and protected by an 8A circuit breaker.		
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Other options available.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Printed circuit board for years of reliable operation.		
<b>EFFECTS OF AMBIENT LIGHT</b>	Very high noise immunity for IR detector.		
<b>MAXIMUM RANGE</b>	500 feet. Suggested maximum range of 200 feet to allow for bad weather and lens contamination.		
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Two Green LEDs and GO-NOGO meter provided for alignment. No special tools required.		
<b>REACTION SPEED</b>	1mph to 75mph for a 2.5 inch diameter object 1 inch above the height of detection.		
<b>COUNTER</b>	Records the number of activations.		

SPECIFICATIONS (CONT'D):

MODEL	DB-IR/IR-3200	DB-IR/IR-3200-230	DB-IR/IR-3200-24
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch thickness) to minimize vandalism and provide for rigid mounting.		
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Source / Detector Cabinet: 16½ x 12½ x 8¾ inches (42 x 32 x 22 cm).		
<b>SHIPPING WEIGHT</b>	45 lbs (20 kg).		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.

**SPECIFICATIONS**

**MODEL # DB-IR/IR-3200 WITH HEATER OPTION**  
**DUAL BEAM INFRARED / INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**



**SOURCE**



**DETECTOR**

MODEL	DB-IR/IR-3200-H	DB-IR/IR-3200-230-H	DB-IR/IR-3200-24-H
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+24 VDC
<b>ALARM OUTPUT</b>	Two dry relay contact closures, Form C, contacts rated 115VAC 10A and protected by 8A circuit breakers.		
<b>FAULT OUTPUT</b>	Dry relay contact opening, Form C, contacts rated 115VAC 10A and protected by an 8A circuit breaker.		
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Other options available.		
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Printed circuit board for years of reliable operation.		
<b>EFFECTS OF AMBIENT LIGHT</b>	Very high noise immunity for IR detector.		
<b>MAXIMUM RANGE</b>	500 feet. Suggested maximum range of 200 feet to allow for bad weather and lens contamination.		
<b>DIRECTION SELECTION</b>	Selection switch. No tools or adjustment required.		
<b>ALIGNMENT</b>	Two Green LEDs and GO-NOGO meter provided for alignment. No special tools required.		
<b>REACTION SPEED</b>	1mph to 75mph for a 2.5 inch diameter object 1 inch above the height of detection.		
<b>COUNTER</b>	Records the number of activations.		

SPECIFICATIONS (CONT'D):

MODEL	DB-IR/IR-3200-H	DB-IR/IR-3200-230-H	DB-IR/IR-3200-24-H
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).		
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.		
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch thickness) to minimize vandalism and provide for rigid mounting.		
<b>HEATERS / LENS</b>	Internal heaters in each eye cone to help reduce condensation and snow build up. Lenses to help contain internal heat and provide additional sensor protection.		
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.		
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.		
<b>DIMENSIONS</b>	Source / Detector Cabinet: 16½ x 12½ x 8¾ inches (42 x 32 x 22 cm).		
<b>SHIPPING WEIGHT</b>	45 lbs (20 kg).		
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.		

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

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**SPECIFICATIONS**

**MODEL # SE-R/3310**  
**SINGLE EYE VISIBLE RED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**



**SOURCE**



**DETECTOR**

MODEL	SE-R/3310	SE-R/3310 -F	SE-R/3310 -230	SE-R/3310 -F-230	SE-R/3310 -24	SE-R/3310 -F-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ		240 VAC, 50/60HZ		+24 VDC	
<b>CURRENT - SOURCE</b>	0.120A	0.120A	0.060A	0.060A	0.290A	0.290A
<b>CURRENT - DETECTOR</b>	0.215A	0.246A	0.108A	0.123A	0.390A	0.545A
<b>ALARM OUTPUT</b>	Form C, dry relay contact closure, contacts rated 240 VAC 10A, protected by 8A circuit breaker.					
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Custom alarm times available.					
<b>FAULT OPTION</b>	Fault reporting relay contact opening upon loss of power, source/detector failure or if beam is blocked for approximately 13 seconds.					
<b>FAULT OUTPUT</b>		X		X		X
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Electronic printed circuits for years of reliable operation.					
<b>EFFECTS OF AMBIENT LIGHT</b>	Sunlight immunity of 10,000 foot-candles.					
<b>MINIMUM RANGE</b>	6 feet (2 m).					
<b>MAXIMUM RANGE</b>	800 feet (244 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.					
<b>ALIGNMENT</b>	Two LEDs and meter (GO-NOGO functions) provided for alignment. No special tools required.					

SPECIFICATIONS (CONT'D):

MODEL	SE-R/3310	SE-R/3310 -F	SE-R/3310 -230	SE-R/3310 -F-230	SE-R/3310 -24	SE-R/3310 -F-24
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.					
<b>COUNTER</b>	Records the number of activations.					
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).					
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.					
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. Meets NEMA 3R intent.					
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.					
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.					
<b>DIMENSIONS</b>	Source Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm). Detector Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm).					
<b>SHIPPING WEIGHT</b>	40 lbs (18 kg).					
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.					

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.



**SPECIFICATIONS**

**MODEL # SE-R/3310 WITH HEATER OPTION**  
**SINGLE EYE VISIBLE RED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**



**SOURCE**



**DETECTOR**

MODEL	SE-R/3310 -H	SE-R/3310 -F-H	SE-R/3310 -230-H	SE-R/3310 -F-230-H	SE-R/3310 -24-H	SE-R/3310 -F-24-H
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ		240 VAC, 50/60HZ		+24 VDC	
<b>ALARM OUTPUT</b>	Form C, dry relay contact closure, contacts rated 240 VAC 10A, protected by 8A circuit breaker.					
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Custom alarm times available.					
<b>FAULT OPTION</b>	Fault reporting relay contact opening upon loss of power, source/detector failure or if beam is blocked for approximately 13 seconds.					
<b>FAULT OUTPUT</b>		X		X		X
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Electronic printed circuits for years of reliable operation.					
<b>EFFECTS OF AMBIENT LIGHT</b>	Sunlight immunity of 10,000 foot-candles.					
<b>MINIMUM RANGE</b>	6 feet (2 m).					
<b>MAXIMUM RANGE</b>	800 feet (244 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.					
<b>ALIGNMENT</b>	Two LEDs and meter (GO-NOGO functions) provided for alignment. No special tools required.					

SPECIFICATIONS (CONT'D):

MODEL	SE-R/3310 -H	SE-R/3310 -F-H	SE-R/3310 -230-H	SE-R/3310 -F-230-H	SE-R/3310 -24-H	SE-R/3310 -F-24-H
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.					
<b>COUNTER</b>	Records the number of activations.					
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).					
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.					
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. Meets NEMA 3R intent.					
<b>HEATERS / LENS</b>	Internal heaters in each eye cone to help reduce condensation and snow build up. Lenses to help contain internal heat and provide additional sensor protection.					
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.					
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.					
<b>DIMENSIONS</b>	Source Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm). Detector Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm).					
<b>SHIPPING WEIGHT</b>	40 lbs (18 kg).					
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.					

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

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**SPECIFICATIONS**

**MODEL # SE-IR/3311**  
**SINGLE EYE INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**



**SOURCE**



**DETECTOR**

MODEL	SE-IR/3311	SE-IR/3311 -F	SE-IR/3311 -230	SE-IR/3311 -F-230	SE-IR/3311 -24	SE-IR/3311 -F-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ		240 VAC, 50/60HZ		+24 VDC	
<b>CURRENT - SOURCE</b>	0.120A	0.120A	0.060A	0.060A	0.290A	0.290A
<b>CURRENT - DETECTOR</b>	0.215A	0.246A	0.108A	0.123A	0.390A	0.545A
<b>ALARM OUTPUT</b>	Form C, dry relay contact closure, contacts rated 240 VAC 10A, protected by 8A circuit breaker.					
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Custom alarm times available.					
<b>FAULT OPTION</b>	Fault reporting relay contact opening upon loss of power, source/detector failure or if beam is blocked for approximately 13 seconds.					
<b>FAULT OUTPUT</b>		X		X		X
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Electronic printed circuits for years of reliable operation.					
<b>EFFECTS OF AMBIENT LIGHT</b>	Very high noise immunity.					
<b>MINIMUM RANGE</b>	6 feet (2 m).					
<b>MAXIMUM RANGE</b>	500 feet (152 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.					
<b>ALIGNMENT</b>	Two LEDs and meter (GO-NOGO functions) provided for alignment. No special tools required.					

SPECIFICATIONS (CONT'D):

MODEL	SE-IR/3311	SE-IR/3311 -F	SE-IR/3311 -230	SE-IR/3311 -F-230	SE-IR/3311 -24	SE-IR/3311 -F-24
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.					
<b>COUNTER</b>	Records the number of activations.					
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).					
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.					
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. Meets NEMA 3R intent.					
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.					
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.					
<b>DIMENSIONS</b>	Source Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm). Detector Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm).					
<b>SHIPPING WEIGHT</b>	40 lbs (18 kg).					
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.					

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

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**SPECIFICATIONS**

**MODEL # SE-IR/3311 WITH HEATER OPTION**  
**SINGLE EYE INFRARED**  
**OVER-HEIGHT VEHICLE DETECTION SYSTEM**



**SOURCE**



**DETECTOR**

MODEL	SE-IR/3311 -H	SE-IR/3311 -F-H	SE-IR/3311 -230-H	SE-IR/3311 -F-230-H	SE-IR/3311 -24-H	SE-IR/3311 -F-24-H
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ		240 VAC, 50/60HZ		+24 VDC	
<b>ALARM OUTPUT</b>	Form C, dry relay contact closure, contacts rated 240 VAC 10A, protected by 8A circuit breaker.					
<b>ALARM TIME</b>	Adjustable by customer from 1 to 30 seconds. Custom alarm times available.					
<b>FAULT OPTION</b>	Fault reporting relay contact opening upon loss of power, source/detector failure or if beam is blocked for approximately 13 seconds.					
<b>FAULT OUTPUT</b>		X		X		X
<b>ELECTRONICS</b>	Sensors are NEMA 6P enclosure rated. Electronic printed circuits for years of reliable operation.					
<b>EFFECTS OF AMBIENT LIGHT</b>	Very high noise immunity.					
<b>MINIMUM RANGE</b>	6 feet (2 m).					
<b>MAXIMUM RANGE</b>	500 feet (152 m). Suggested maximum range 200 feet (61 m) to allow for bad weather and lens contamination.					
<b>ALIGNMENT</b>	Two LEDs and meter (GO-NOGO functions) provided for alignment. No special tools required.					

SPECIFICATIONS (CONT'D):

MODEL	SE-IR/3311 -H	SE-IR/3311 -F-H	SE-IR/3311 -230-H	SE-IR/3311 -F-230-H	SE-IR/3311 -24-H	SE-IR/3311 -F-24-H
<b>REACTION SPEED</b>	1 to 75 MPH (1 to 121 km/h) for a 2.5 inch (6.25 cm) diameter object 1 inch (2.5 cm) above the detection height. Custom speed/size available.					
<b>COUNTER</b>	Records the number of activations.					
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C).					
<b>ENVIRONMENTAL CONTROL</b>	Internal thermostat controls air flow which reduces moisture and maintains internal temperature during cold weather.					
<b>HOUSINGS</b>	External housing is heavy ALMAG casting and sheet aluminum (not less than 1/8 inch or .318 cm thickness) for rugged durability and extended life. Cabinet design minimizes effects of vandalism and provides rigid mounting. Meets NEMA 3R intent.					
<b>HEATERS / LENS</b>	Internal heaters in each eye cone to help reduce condensation and snow build up. Lenses to help contain internal heat and provide additional sensor protection.					
<b>CONNECTORS</b>	Source Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting. Detector Cabinet: One 3/4" NPT hole accepts cord grip or conduit fitting.					
<b>MOUNTING</b>	Pole-mountable using Model # PMB-500 bracket (available separately). Wall-mountable using Model # FSB-500 bracket (available separately). Pole-top mountable when using pole cap on Model # 3701 or 3702 poles. Optional Three-Axis Mount (Model # TGZ-M017) recommended in applications with cross slope or complex road profiles.					
<b>DIMENSIONS</b>	Source Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm). Detector Cabinet: 15½ x 10 x 8¾ inches (39 x 25 x 22 cm).					
<b>SHIPPING WEIGHT</b>	40 lbs (18 kg).					
<b>WARRANTY</b>	Standard 1-Year Full Warranty. Extended Warranty options available.					

OPTIONAL ACCESSORIES:

MODEL #	DESCRIPTION
PMB-500	Pole Mount Bracket
TGZ-M017	Three-Axis Mount
FSB-500	Flat Surface Bracket
USC-1000	Universal System Controller - Provides Logging and Remote Notifications
TG-CAM-1010	Network Camera - Provides Snapshot Images and Video Recordings

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## SPECIFICATIONS

### MODEL # ME-IR/330

### METRO-ECONOMY NON-HIGHWAY SINGLE EYE INFRARED OVER-HEIGHT VEHICLE DETECTION SYSTEM

*Suitable for non-highway applications such as parking structures, garages, and warehouses.*



MODEL	ME-IR/330	ME-IR/330-230	ME-IR/330-12	ME-IR/330-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+12 VDC	+24 VDC
<b>OUTPUTS</b>	Output 1 - (1) Set alternating flash output, 60 FPM, protected by fuse Output 2 - (1) Steady voltage output, protected by fuse Output 3 - (1) Form C, dry relay contacts (NC/NO), protected by fuse			
<b>OUTPUT 1 VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+12 VDC	+24 VDC
<b>OUTPUT 2 VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+12 VDC	+24 VDC
<b>ALARM TIME</b>	6 to 60 seconds, user adjustable			
<b>SENSORS</b>	Infrared (880 nm) opposed source and detector, NEMA 6P, IEC IP67			
<b>EFFECTS OF AMBIENT LIGHT</b>	Field of view 2.4 degrees with 6-inch (152 mm) hood			
<b>MAXIMUM RANGE</b>	200 feet (60 m). Suggested maximum range 125 feet (31.8 m) to allow for bad weather and lens contamination.			
<b>ALIGNMENT</b>	Go/no-go red LED indicator. No special tools required.			
<b>REACTION SPEED</b>	<u>IMPERIAL</u> : 1 MPH to 45 MPH for a 2.5-inch diameter object 1-inch above the established height of detection. <u>METRIC</u> : 1.6 KPH to 72.4 KPH for a 63.5 mm diameter object 25.4 mm above the established height of detection.			
<b>TEMPERATURE RANGE</b>	-13°F to +131°F (-25°C to +55°C)			
<b>SENSOR MOUNTING</b>	Installed on a two-axis mount for ease of alignment. 10 in (254 mm) long mounting bracket can be wall or pole mounted			
<b>CONTROLLER ENCLOSURE</b>	Fiberglass with 304 stainless steel hinge/latch and aluminum back panel. NEMA 4X, IEC IP66, 14 x 12 x 6 in (356 x 305 x 152 mm), pad lockable, wall mountable			



## SPECIFICATIONS

### MODEL # ME-IR/1000

### METRO-ECONOMY NON-HIGHWAY SINGLE EYE INFRARED OVER-HEIGHT VEHICLE DETECTION SYSTEM

*Suitable for non-highway applications such as parking structures, garages, and warehouses.  
Web-enabled for advanced remote monitoring and control.*

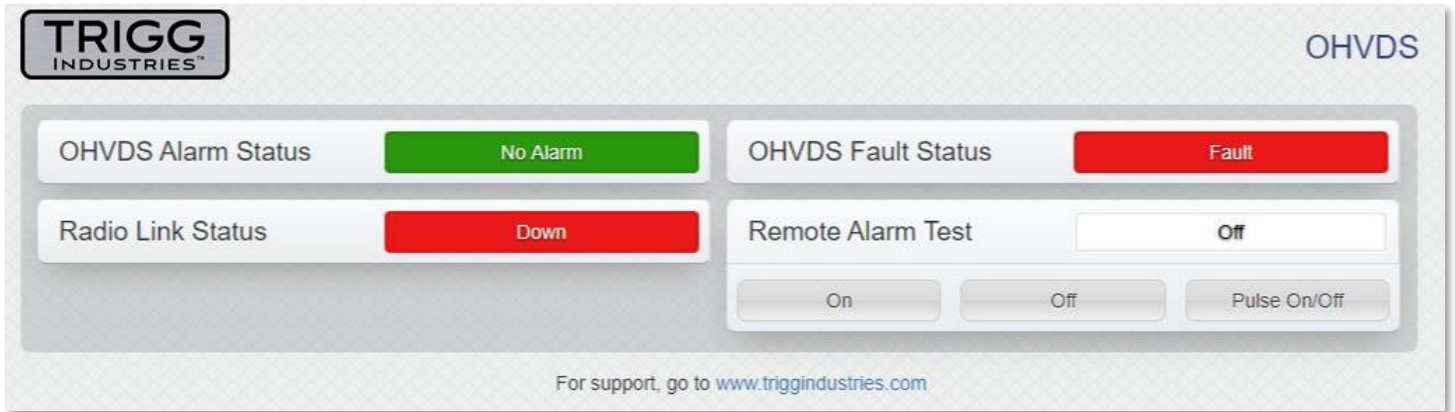


MODEL	ME-IR/1000	ME-IR/1000-230	ME-IR/1000-12	ME-IR/1000-24
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+12 VDC	+24 VDC
<b>OUTPUTS</b>	Output 1 - (1) Set alternating flash output, 60 FPM, protected by fuse Output 2 - (1) Steady voltage output, protected by fuse Output 3 - (1) Form C, dry relay contacts (NC/NO), protected by fuse			
<b>OUTPUT 1 VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+12 VDC	+24 VDC
<b>OUTPUT 2 VOLTAGE</b>	120 VAC, 50/60HZ	240 VAC, 50/60HZ	+12 VDC	+24 VDC
<b>ALARM TIME</b>	0.1 to 86,400 seconds (1-day), software adjustable			
<b>NETWORK</b>	10/100 Ethernet (RJ-45), HTTP, HTTPS, SSL, XML, Modbus TCP/IP, SNMP, SMTP, Remote Services			
<b>REMOTE MONITORING</b>	E-mail notifications on overheight detection, remote monitoring using web-interface			
<b>SENSORS</b>	Infrared (880 nm) opposed source and detector, NEMA 6P, IEC IP67			
<b>EFFECTS OF AMBIENT LIGHT</b>	Field of view 2.4 degrees with 6-inch (152 mm) hood			
<b>MAXIMUM RANGE</b>	200 feet (60 m). Suggested maximum range 125 feet (31.8 m) to allow for bad weather and lens contamination.			
<b>ALIGNMENT</b>	Go/no-go red LED indicator. No special tools required.			
<b>REACTION SPEED</b>	<u>IMPERIAL</u> : 1 MPH to 45 MPH for a 2.5-inch diameter object 1-inch above the established height of detection. <u>METRIC</u> : 1.6 KPH to 72.4 KPH for a 63.5 mm diameter object 25.4 mm above the established height of detection.			

SPECIFICATIONS (CONT'D):

MODEL	ME-IR/1000	ME-IR/1000-230	ME-IR/1000-12	ME-IR/1000-24
TEMPERATURE RANGE	-13°F to +131°F (-25°C to +55°C)			
SENSOR MOUNTING	Installed on a two-axis mount for ease of alignment. 10 in (254 mm) long mounting bracket can be wall or pole mounted			
CONTROLLER ENCLOSURE	Fiberglass with 304 stainless steel hinge/latch and aluminum back panel. NEMA 4X, IEC IP66, 14 x 12 x 6 in (356 x 305 x 152 mm), pad lockable, wall mountable			
ADDITIONAL OPTIONS	Cellular communications, camera interface			

MONITORING WEB-PAGE:



## SPECIFICATIONS

### MODEL # 3600

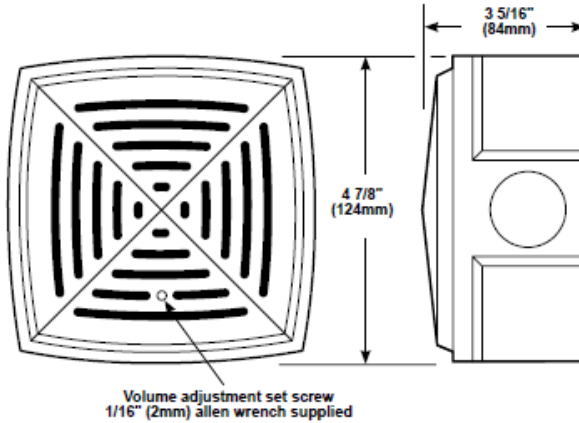
#### DIRECTION ORIENTED ALARM BELL



MODEL	3600	3600-230	3600-12	3600-24
OPERATING VOLTAGE	120 VAC, 50/60Hz	240 VAC, 50/60Hz	+12 VDC	+24 VDC
CURRENT	0.070 A	0.350 A	0.125 A	0.062 A
POWER	8.4 VA	8.4 VA	1.5 VA	1.5 VA
OUTPUT	Directed by parabolic shield. Sound reduced to 50 – 60% at sides and rear of bell by the parabolic shield.			
OUTPUT AT 10 FT (3.05 m)	96 dB		94 dB	
OUTPUT AT 30 FT (9.15 m)	86 dB		84 dB	
OUTPUT AT 70 FT (21.34 m)	79 dB		77 dB	
OUTPUT AT 100 FT (30.48 m)	76 dB		74 dB	
GONG SIZE	10" (254 mm)			
MATERIAL AND FINISH	Parabolic shield: Gel-coated fiberglass, gray. Bell housing: Heat flowed epoxy finish die-cast, gray. Bell mounting box: Baked enamel finish die-cast aluminum, gray. Mounting bracket: Powder-coated machined aluminum, gray. Mounting bracket arm: Powder-coated cast ALMAG, gray.			
ADJUSTMENT	Adjustable pole mounting bracket provided. Other brackets provided as needed.			
PARABOLA DIMENSIONS	38 inches (89 cm) in diameter.			
ENVIRONMENTAL	All-weather, -31° to +151° F (-35° to +66° C).			
CERTIFICATIONS	UL 464, CSA Certified.			
SHIPPING WEIGHT	50 lbs (23 kg).			

**SPECIFICATIONS**

**MODEL # 3601**  
**VIBRATING HORN**



MODEL	3601	3601-230	3601-12	3601-24
OPERATING VOLTAGE	120 VAC, 50/60Hz	240 VAC, 50/60Hz	+12 VDC	+24 VDC
CURRENT	0.13 A	0.07 A	0.27 A	0.16 A
POWER	15.6 VA	16.8 VA	3.2 VA	3.8 VA
OUTPUT AT 10 FT (3.05 m)	78 to 103 dB		78 to 101 dB	
OUTPUT AT 30 FT (9.15 m)	68 to 93 dB		68 to 91 dB	
OUTPUT AT 70 FT (21.34 m)	61 to 86 dB		61 to 84 dB	
OUTPUT AT 100 FT (30.48 m)	58 to 83 dB		58 to 81 dB	
MATERIAL AND FINISH	Horn housing: Heat flowed epoxy finish die-cast, gray. Horn mounting box: Heat flowed epoxy finish die-cast, gray.			
ADJUSTMENT	Volume adjustment using set screw located on grille front			
DIMENSIONS	4-7/8 x 4-7/8" x 3-5/16" (124 mm x 124 mm x 84 mm)			
MOUNTING	Mounts on 3/4" NPT conduit or to any flat surface			
ENVIRONMENTAL	NEMA 4X / 12 / 12K rated enclosure			
CERTIFICATIONS	UL 464, CSA Certified.			
SHIPPING WEIGHT	5 lbs (2 kg).			

## SPECIFICATIONS

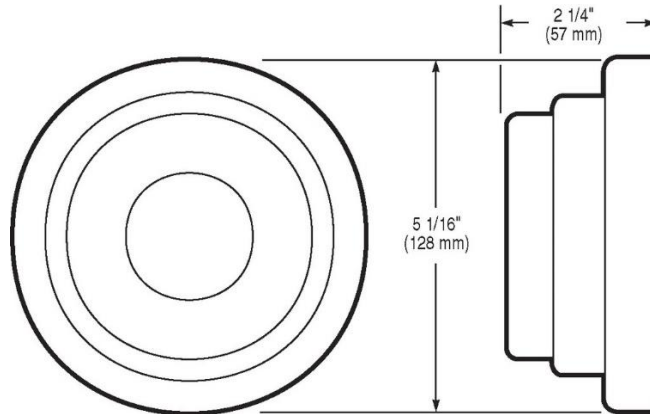
### MODEL # 3602 ELECTRONIC SIREN



MODEL	3602	3602-230	3602-24
OPERATING VOLTAGE	120 VAC, 50/60Hz	240 VAC, 50/60Hz	+24 VDC
CURRENT	0.21 A	0.12 A	0.6 A
POWER	25.2 VA	28.8 VA	14.4 VA
OUTPUT AT 10 FT (3.05 m)	107 to 111 dB		
OUTPUT AT 30 FT (9.15 m)	97 to 101 dB		
OUTPUT AT 70 FT (21.34 m)	90 to 94 dB		
OUTPUT AT 100 FT (30.48 m)	87 to 91 dB		
MATERIAL AND FINISH	Impact and UV resistant plastic		
TONE SELECTION	Three options - wail, yelp, and horn – user selectable		
DIMENSIONS	8.9" H x 12.1" W x 14.5" D (226.1mm x 307.3mm x 368.3 mm) w/o backbox		
MOUNTING	Omni-directional swivel mount		
ENVIRONMENTAL	Indoor and outdoor use. Type 3R enclosure. Operating Temperature: -31° to 151° F (-35° to 66° C)		
CERTIFICATIONS	UL and cUL Listed		
NET WEIGHT	4.4 lbs (2.0 kg) w/o backbox		
SHIPPING WEIGHT	5.2 lbs (2.4 kg) w/o backbox		

**SPECIFICATIONS**

**MODEL # 3603**  
**INDOOR BUZZER**



MODEL	3603	3603-230	3603-12	3603-24
OPERATING VOLTAGE	120 VAC, 50/60Hz	240 VAC, 50/60Hz	+12 VDC	+24 VDC
CURRENT	0.05 A	0.025 A	0.33 A	0.15 A
POWER	6.0 VA	6.0 VA	4.0 VA	3.6 VA
OUTPUT AT 10 FT (3.05 m)	70 dB		62 dB	
OUTPUT AT 30 FT (9.15 m)	60 dB		52 dB	
OUTPUT AT 70 FT (21.34 m)	53 dB		45 dB	
OUTPUT AT 100 FT (30.48 m)	50 dB		42 dB	
MATERIAL AND FINISH	Heat flowed epoxy finish die-cast, gray			
ADJUSTMENT	Volume adjustable		No volume adjustment	
DIMENSIONS	5-1/6" x 2-1/4" (128 mm x 57 mm)			
MOUNTING	Mounts directly on a solid surface or electrical box (single-gang or 4" octagon).			
ENVIRONMENTAL	Indoor installation only			
CERTIFICATIONS	UL and FM Approved			
SHIPPING WEIGHT	5-1/16" x 2-1/4" (128 mm x 57 mm)			

**SPECIFICATIONS**

**MODEL # 3610**  
**LIGHT DUTY STROBE**



MODEL	3610	3610-240	3610-12	3610-24
OPERATING VOLTAGE	120 VAC, 50/60Hz	240 VAC, 50/60Hz	+12 VDC	+24 VDC
CURRENT	0.06 A	0.03 A	0.18 A	0.08 A
POWER	7.2 VA	7.2 VA	2.16 VA	1.92 VA
FLASH RATE	80 FPM			
PEAK OUTPUT	100,000 Candela			
LAMP LIFE	4,000 Hours			
LENS COLORS	Amber, Blue, Green, Red	Amber, Blue, Clear, Green, Red	Amber, Blue, Green, Red	Amber, Blue, Green, Red
DIMENSIONS	5.25" H x 5.5" DIA. (133.4 mm X 139.7 mm)		5.06" H x 5.5" DIA. (128.5 mm X 139.7 mm)	
MOUNTING	1/2" NPT pipe mount		Surface mount	
ENVIRONMENTAL	Indoor/outdoor use. NEMA 3R enclosure Operating Temperature: -31° to 150° F (-35° to 66° C)			
CERTIFICATIONS	UL Listed and CSA Certified			
NET WEIGHT	0.9 LBS (0.4 KG)		0.8 LBS (0.4 KG)	
SHIPPING WEIGHT	1.4 LBS (0.5 KG)		1.3 LBS (0.5 KG)	



## SPECIFICATIONS

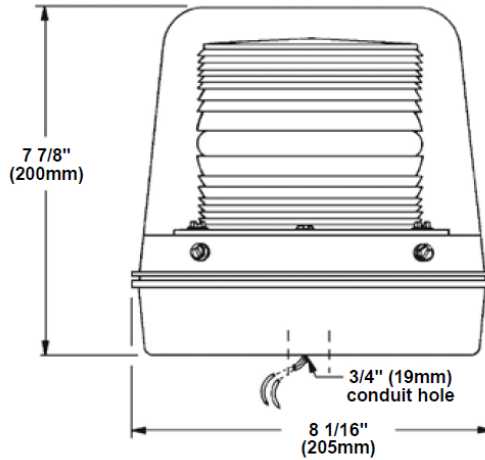
### MODEL # 3611 MEDIUM DUTY STROBE



MODEL	3611	3611-240	3611-12	3611-24
OPERATING VOLTAGE	120 VAC, 50/60Hz	240 VAC, 50/60Hz	+12 VDC	+24 VDC
CURRENT	0.25 A	0.2 A	1.7 A	0.7 A
POWER	30 VA	48 VA	20.4 VA	16.8 VA
FLASH RATE	80 FPM			
PEAK OUTPUT	580,000 Candela			
LAMP LIFE	10,000 Hours			
LENS COLORS	Amber, Blue, Clear, Green, Magenta, Red			
DIMENSIONS	7.5" H x 5.5" DIA. (190.5 mm X 139.7 mm)			
MOUNTING	1/2" NPT pipe mount			
ENVIRONMENTAL	Indoor/outdoor use. NEMA 4X, IP66, IP69K enclosure Operating Temperature: -40° to 104° F (-40° to 40° C)			
CERTIFICATIONS	UL Listed and CSA Certified			
NET WEIGHT	1.5 LBS (0.68 KG)			
SHIPPING WEIGHT	2.0 LBS (0.91 KG)			

**SPECIFICATIONS**

**MODEL # 3612**  
**HEAVY DUTY STROBE**



<b>MODEL</b>	<b>3612</b>	<b>3612-24</b>
<b>OPERATING VOLTAGE</b>	120 VAC, 50/60Hz	+24 VDC
<b>CURRENT</b>	0.1 A	1.2 A
<b>POWER</b>	12.0 VA	28.8 VA
<b>FLASH RATE</b>	65 FPM	
<b>PEAK OUTPUT</b>	800,000 Candela	
<b>LAMP LIFE</b>	3,000 Hours	
<b>LENS COLORS</b>	Amber, Blue, Clear, Green, Magenta, Red	
<b>DIMENSIONS</b>	7-7/8" H x 8-1/16" DIA. (200 mm X 205 mm)	
<b>MOUNTING</b>	3/4" NPT pipe mount	
<b>ENVIRONMENTAL</b>	Indoor/outdoor use. NEMA 4X. Hazardous locations (Class I, Div 2, Groups A, B, C and D; Class II, Div 2, Groups F and G; Class III) Operating Temperature: -13° to +104° F (-25 to +40° C)	
<b>CERTIFICATIONS</b>	UL Listed	
<b>NET WEIGHT</b>	5.53 LBS (2.51 KG)	5.60 LBS (2.54 KG)
<b>SHIPPING WEIGHT</b>	6.10 LBS (2.77 KG)	6.18 LBS (2.80 KG)

**SPECIFICATIONS**

**MODEL # 3613**  
**LED SIGNAL WITH ALUMINUM TRAFFIC HEAD**



<b>HOUSING</b>	1-SECTION ALUMINUM WITH CAP VISOR AND TERMINAL BLOCK OPTIONAL: TUNNEL VISOR, NO VISOR
<b>HOUSING COLORS</b>	STANDARD: FEDERAL YELLOW OPTIONAL: SIGNAL GREEN, BLACK, OR CUSTOM COLORS (OPTIONAL COLORS AT ADDITIONAL COST)
<b>HOUSING DIMENSIONS</b>	8": 10.0"H X 10.0"W X 7.0"D 12": 13.5"H X 13.5"W X 7.0"D
<b>SIGNAL SIZE OPTIONS</b>	8" OR 12"
<b>SIGNAL COLOR OPTIONS</b>	AMBER, RED, OR GREEN
<b>VOLTAGE OPTIONS</b>	120 VAC, 24 VDC, OR 12 VDC
<b>MOUNTING</b>	2.0" HOLE TOP AND BOTTOM FITS STANDARD 1-1/2" NPT FITTINGS (AVAILABLE SEPARATELY)
<b>OPERATING TEMPERATURE</b>	-40° TO +165°F (-40° TO +74°C)
<b>CERTIFICATIONS</b>	AC MODELS: INTERTEK ETL / ITE VTCSH LED CIRCULAR SIGNAL SUPPLEMENT 2005 DC MODELS: MEET ITE 2005 INTENSITY, COLOR, AND UNIFORMITY

120 VAC MODELS:

MODEL	SIGNAL SIZE	SIGNAL COLOR	NOMINAL VOLTAGE (VAC)	OPERATING VOLTAGE (VAC)	POWER (W)	DOMINANT WAVELENGTH (NM)	MAINTAINED INTENSITY (CD) MIN.
3613-8R	8"	RED	120	80-135	6.4	628	240
3613-8A	8"	AMBER	120	80-135	9.9	589	760
3613-8G	8"	GREEN	120	80-135	6.4	499	450
3613-12R	12"	RED	120	80-135	6.3	625	365
3613-12A	12"	AMBER	120	80-135	10.0	589	910
3613-12G	12"	GREEN	120	80-135	9.5	501	475

24 VDC MODELS:

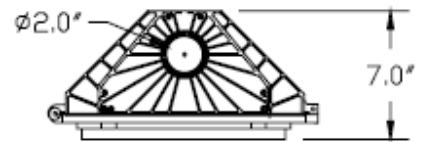
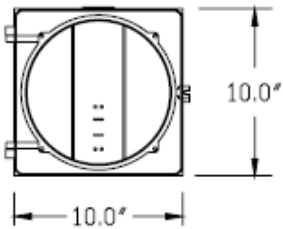
MODEL	SIGNAL SIZE	SIGNAL COLOR	NOMINAL VOLTAGE (VDC)	OPERATING VOLTAGE (VDC)	POWER (W)	DOMINANT WAVELENGTH (NM)	MAINTAINED INTENSITY (CD) MIN.
3613-8R-24	8"	RED	24	10-28	2.4	626	165
3613-8A-24	8"	AMBER	24	10-28	4.3	589	410
3613-8G-24	8"	GREEN	24	10-28	3.4	500	215
3613-12R-24	12"	RED	24	10-28	4.4	626	365
3613-12A-24	12"	AMBER	24	10-28	10	589	910
3613-12G-24	12"	GREEN	24	10-28	6.6	500	475

12 VDC MODELS:

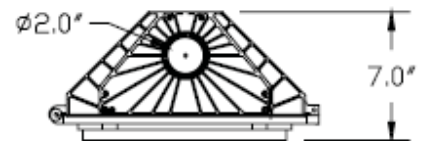
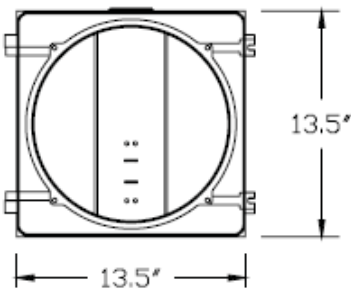
MODEL	SIGNAL SIZE	SIGNAL COLOR	NOMINAL VOLTAGE (VDC)	OPERATING VOLTAGE (VDC)	POWER (W)	DOMINANT WAVELENGTH (NM)	MAINTAINED INTENSITY (CD) MIN.
3613-8R-12	8"	RED	12	10-28	2.4	626	165
3613-8A-12	8"	AMBER	12	10-28	4.3	589	410
3613-8G-12	8"	GREEN	12	10-28	3.4	500	215
3613-12R-12	12"	RED	12	10-28	4.4	626	365
3613-12A-12	12"	AMBER	12	10-28	10	589	910
3613-12G-12	12"	GREEN	12	10-28	6.6	500	475

HOUSING DIMENSIONS:

8-INCH



12-INCH





ORDERING GUIDE:

		Typical product code	<b>3613</b>	<b>-12</b>	<b>A</b>	<b>-24</b>
<b>Model</b>	<b>3613</b>	LED signal with aluminum traffic head				
<b>Size</b>	<b>8</b>	8-inch signal				
	<b>12</b>	12-inch signal				
<b>Signal Color</b>	<b>R</b>	Red				
	<b>A</b>	Amber				
	<b>G</b>	Green				
<b>Input Voltage</b>	<b>24</b>	24VDC				
	<b>12</b>	12VDC				
	<b>(Blank)</b>	120VAC				








INCLUDED ITEMS:

- (1) 1-SECTION ALUMINUM TRAFFIC HEAD
- (1) ALUMINUM CAP VISOR
- (1) LED SIGNAL MODULE
- (1) TERMINAL BLOCK

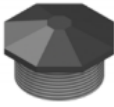


OPTIONAL ITEMS:

MODEL #	DESCRIPTION	
TG-SIG-0443	HEX NIPPLE, 1-1/2" NPS X 1-1/2" LG, ALUM	
TG-SIG-0354	GASKET, NEOPRENE	

OPTIONAL ITEMS (CON'T):

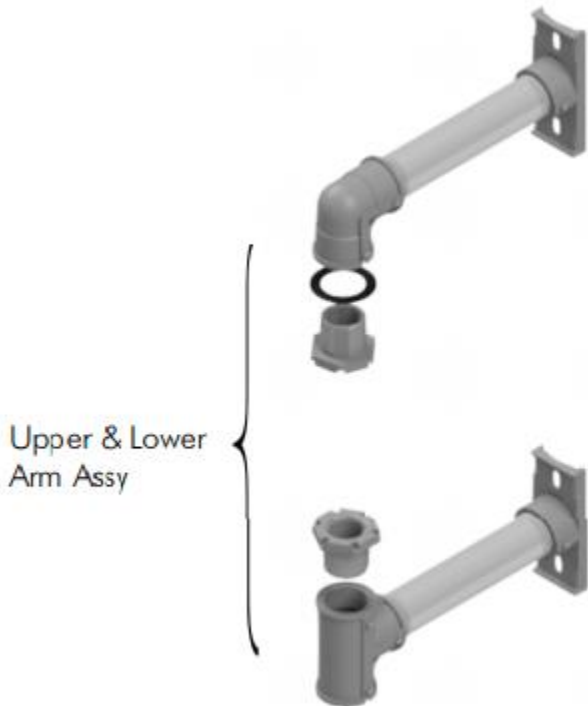
MODEL #	DESCRIPTION	
TG-SIG-0457	ELL, SERRATED, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-0415	HUB PLATE, FLAT BACK, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-0454	HUB PLATE, 4" PIPE, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-0357	HUB PLATE, LARGE POLE, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-4108	HUB PLATE, UNIVERSAL, 1-1/2" NPS, W/ 1-1/2" DIA HOLE IN REAR, ALUM, YELLOW	
TG-SIG-0458	TEE, SERRATED, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-3054	SIGNAL CLOSURE KIT, PLASTIC, YELLOW	

OPTIONAL ITEMS (CON'T):

MODEL #	DESCRIPTION	
TG-SIG-0499	OCTAGONAL CLOSURE CAP, PLASTIC, 1-1/2" NPS X 7/8", YELLOW	
TG-SIG-0436-05	5" NIPPLE, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-0436-07	7" NIPPLE, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-0436-12	12" NIPPLE, 1-1/2" NPS, ALUM, YELLOW	
TG-SIG-0567	1-WAY TRI-STUD FOR 8" & 12" SIGNALS, 4-1/2" OD POLE, ALUM, NO COLOR, W/ HARDWARE KIT	
TG-SIG-1000	TRAFFIC SIGNAL BACKPLATE	



TYPICAL SIDE-OF-POLE MOUNTING:



Additional accessories and warning devices are available from Trigg Industries LLC.  
Contact [sales@triggindustries.com](mailto:sales@triggindustries.com) for details.

## SPECIFICATIONS

### MODEL # 3614 CONFIRMATION LIGHT



<b>OPERATING VOLTAGE</b>	120 VAC, 50/60HZ
<b>CURRENT</b>	0.067 A USING INCLUDED LAMP
<b>POWER</b>	8 VA USING INCLUDED LAMP
<b>LENS COLOR</b>	RED, BLUE, OR CLEAR
<b>LAMP TYPE</b>	INCLUDES HIGH OUTPUT LED TRAFFIC SIGNAL BULB
<b>LAMP COLOR</b>	RED, ORANGE, AMBER, GREEN, BLUE, OR WHITE
<b>ENCLOSURE/MATERIAL</b>	UV STABILIZED IMPACT RESISTANT POLYCARBONATE
<b>DIMENSIONS</b>	APPROXIMATELY 4" DIAMETER X 8.5" H
<b>MOUNTING</b>	POLE MOUNT USING UNIVERSAL ALUMINUM BRACKET WITH 84" SS CABLE AND HARDWARE (22.0" MAX POLE DIAMETER)
<b>NET WEIGHT</b>	3.5 LBS (1.6 KG) W/ INCLUDED LAMP

ORDERING GUIDE:

		Typical product code	<b>3614</b>	<b>-C</b>	<b>-B</b>
<b>Model</b>	<b>3614</b>	Confirmation light			
<b>Lens Color</b>	<b>R</b>	Red			
	<b>B</b>	Blue			
	<b>C</b>	Clear			
<b>Lamp Color</b>	<b>R</b>	Red			
	<b>O</b>	Orange			
	<b>A</b>	Amber			
	<b>G</b>	Green			
	<b>B</b>	Blue			
	<b>W</b>	White			

## SPECIFICATIONS

### MODEL # FLB-102

#### ALARM/FLASHER CONTROL BOX



**POWDER-COATED STEEL  
ENCLOSURE**



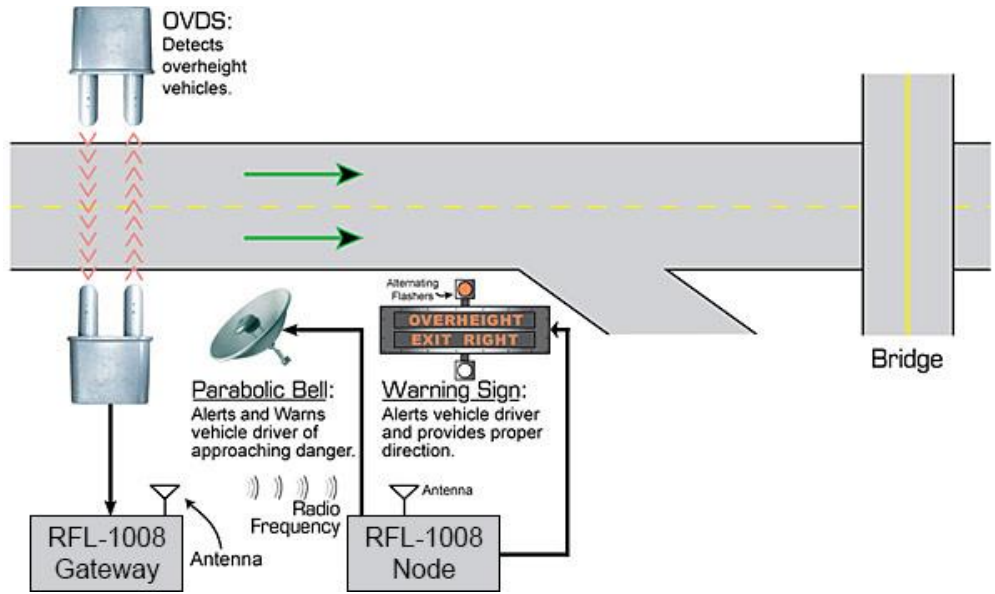
**STAINLESS-STEEL  
ENCLOSURE**

<b>INPUT VOLTAGE</b>	100-240VAC $\pm 10\%$ 50-60Hz $\pm 6\%$ , or 12-24VDC
<b>FEATURES</b>	Activated by over height vehicle detection system (OHVDS) or other equipment dry contact relay closure. Activation time is set by alarm time control in OHVDS (1-30sec) or other equipment.
<b>STANDARD FUNCTIONS</b>	(1) Solid state alternating flash relay to activate warning devices (1) Continuous voltage output to activate warning devices (1) Form C, dry relay contact to activate other devices (PLC, external controller).
<b>ALARM CONFIGURATION</b>	(1) Set alternating flash output, 60 FPM, protected by 5A fuse (1) Steady voltage output, protected by 8A fuse (1) Form C, dry relay contacts (NC/NO), protected by 8A fuse
<b>FAULT CONFIGURATION</b>	(1) Form C, dry relay contacts (NC/NO), protected by 8A fuse
<b>TEMP. RANGE</b>	-29°F to +158°F (-34°C to +70°C)
<b>ENCLOSURE</b>	Pad-lockable, powder-coated carbon steel or 316L stainless-steel, pole and wall mount bracket options. Available without enclosure (back-panel only).
<b>DIMENSIONS</b>	20" H x 16" W x 8" D (enclosure without mounting hardware) 19" H x 14" W x 6" D (back-panel only)

## SPECIFICATIONS

### MODEL # RFL-1008 RADIO FREQUENCY LINK

Activate warning devices using 900 MHz wireless contact closure link between OHVDS and warning devices. Cost effective alternative to wired installation. Includes (1) Gateway and (1) Node unit.



<b>INPUT VOLTAGE</b>	100-240VAC $\pm 10\%$ 50-60Hz $\pm 6\%$ , or 12-24VDC
<b>FEATURES</b>	Activated by over height vehicle detection system (OHVDS) or other equipment dry contact relay closure. Activation time controlled by time delay relay user-adjustable from 0.1 s to 10 days. Gateway unit installed at OHVDS. Node unit installed downstream at warning devices.
<b>STANDARD FUNCTIONS</b>	Provides one solid state flash relay with two independent outputs to activate warning devices (LED signals). Available at Node unit only. Provides one steady state voltage output to activate warning devices (flasher, strobe, blank out sign). Available at Gateway and Node units. Provides one Form C, dry relay contact to activate other devices (PLC, external controller) at Node unit. Available at Gateway and Node units.
<b>ALARM CONFIGURATION (NODE)</b>	(1) Set alternating flash output, 60 FPM, protected by 5A fuse (1) Steady voltage output, protected by 8A fuse (1) Form C, dry relay contacts (NC/NO), protected by 8A fuse

SPECIFICATIONS (CONT'D):

<b>FAULT CONFIGURATION (NODE)</b>	(1) Form C, dry relay contacts (NC/NO), protected by 8A fuse
<b>MAXIMUM RANGE</b>	Approximately 6 miles line-of-sight with Omni antenna.
<b>NETWORK</b>	900 MHz, 1 Watt, Frequency Hopping Spread Spectrum. Point-to-point contact closure using one Gateway and one Node (standard). Point-to-multipoint contact closure using one Gateway and multiple Nodes (optional using additional Nodes).
<b>ANTENNA</b>	Omni antenna mounted to the enclosure. Optional antennas available.
<b>TEMP. RANGE</b>	-29°F to +158°F (-34°C to +70°C)
<b>ENCLOSURE (NODE AND GATEWAY)</b>	Powder-coated carbon steel or 316L stainless-steel, Includes wall mount brackets and pad-lock hasps. Also available without enclosure for mounting in customer provided enclosure or 19" rack.
<b>DIMENSIONS (NODE AND GATEWAY)</b>	20" H x 16" W x 8" D (enclosure without mounting hardware) 19" H x 14" W x 6" D (back-panel only) 16" H x 19" W x 8" D (rack installation)

ENCLOSURES:



**POWDER-COATED STEEL ENCLOSURE**



**STAINLESS-STEEL ENCLOSURE**

**SPECIFICATIONS**

**MODEL # USC-1000**  
**UNIVERSAL SYSTEM CONTROLLER**



**POWDER-COATED STEEL ENCLOSURE**



**STAINLESS-STEEL ENCLOSURE**

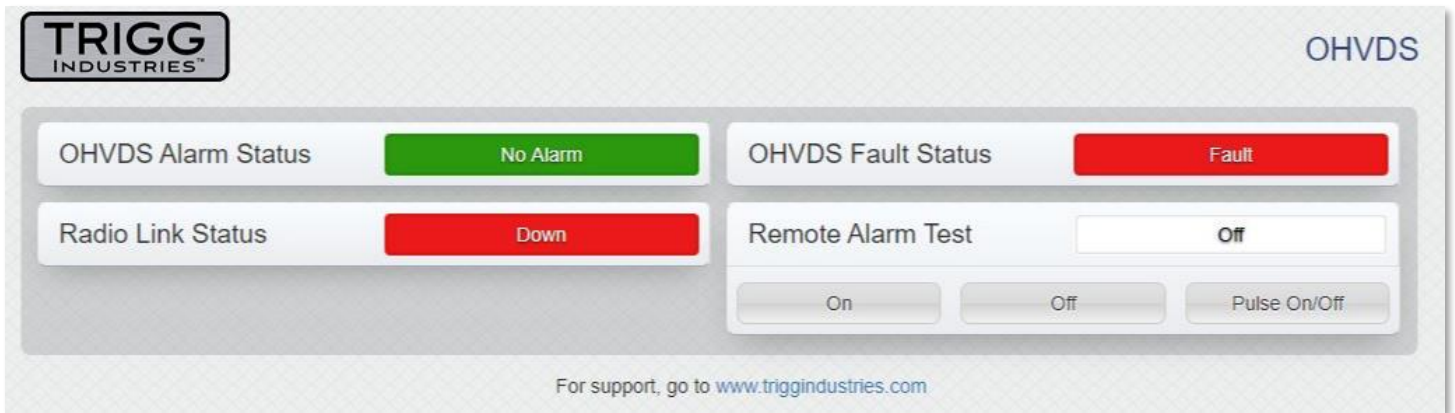
<b>INPUT VOLTAGE</b>	100-240VAC $\pm 10\%$ 50-60Hz $\pm 6\%$ , or 12-24VDC <sup>1</sup>
<b>FEATURES</b>	Activated by over height vehicle detection system (OHVDS) or other equipment dry contact relay closure. Activation time is set by alarm time control in OHVDS (1-30sec) or other equipment.
<b>STANDARD FUNCTIONS</b>	Provides one solid state flash relay with two independent outputs to activate warning devices (LED signals). Provides one steady state voltage output to activate warning devices (flasher, strobe, blank out sign). Provides one Form C, dry relay contact to activate other devices (PLC, external controller).
<b>ADVANCED FUNCTIONS</b>	Provides real-time monitoring, logging, and remote alerting of Alarm and Fault OHVDS events. Accessible using web-browser. <sup>1,2</sup> Compatible with optional network camera accessory. UPS “-120U” ordering option adds real-time power status monitoring and is designed to send “last-gasp” message in the event of loss of commercial power. <sup>4</sup>
<b>ALARM CONFIGURATION</b>	(1) OHVDS Alarm Input - Standard (1) Set alternating flash output, 60 FPM, protected by 5A fuse - Standard (1) Steady voltage output, protected by 8A fuse - Standard (1) Form C, dry relay contacts (NC/NO) output, protected by 8A fuse - Standard Additional OHVDS Alarm Inputs and Output combinations are available.



SPECIFICATIONS (CONT'D):

<b>FAULT CONFIGURATION</b>	(1) OHVDS Fault Input - Standard (1) Form C, dry relay contacts (NC/NO) output, protected by 8A fuse - Standard Additional OHVDS Fault Inputs and Output combinations are available.
<b>CELLULAR MODEM</b> <sup>1,3</sup>	Global HSPA+ and 4G LTE, 2x2 MIMO antenna, (2) 10/100 Ethernet ports, (2) Mini-SIM (2FF) card slots, VPN support, Local and remote management through HTTP/HTTPS, Telnet, SSH, and SMS.
<b>REMOTE I/O MODULE</b> <sup>1,2</sup>	10/100 Base-T Ethernet Port. Supported Protocols: HTTP, HTTPS, SSL, TLS (V1.2), Modbus TCP/IP, SNMP (V1, V2 & V3), NTP, SMTP, FTP. BASIC script support. Supports third-party software integration using XML, JSON, and SNMP. OHVDS application specific Management Information Base (MIB) file can be generated and downloaded directly from device.
<b>TEMP. RANGE</b>	-29°F to +158°F (-34°C to +70°C)
<b>ENCLOSURE</b>	Powder-coated carbon steel or 316L stainless-steel, Includes wall mount brackets and pad-lock hasps. Also available without enclosure for mounting in customer provided enclosure or 19" rack. <sup>1</sup>
<b>STANDARD DIMENSIONS</b>	20" H x 16" W x 8" D (enclosure without mounting hardware) 19" H x 14" W x 6" D (back-panel only) 16" H x 19" W x 8" D (rack installation)
<b>OPTIONAL DIMENSIONS (IF EQUIPPED WITH 120U, 2A, 3A, 2F, OR 3F OPTIONS)</b>	20" H x 20" W x 8" D (enclosure without mounting hardware) 19" H x 18" W x 6" D (back-panel only) 16" H x 19" W x 8" D (rack installation)

MONITORING WEB-PAGE:



(IF EQUIPPED WITH REMOTE I/O MODULE)

ORDERING GUIDE:

		Typical product code	USC-1000	-24	-2A	-2F	-RC2	-SS
<b>Model</b>	<b>USC-1000</b>	Universal system controller, wired connection to warning devices						
<b>Input Voltage</b>	<b>(blank)</b>	120VAC						
	<b>120U</b>	120VAC with +24VDC UPS module						
	<b>240</b>	240VAC						
	<b>24</b>	24VDC						
	<b>12</b>	12VDC						
<b>OHVDS Alarm Inputs</b>	<b>(blank)</b>	1 OHVDS Alarm Input - Standard						
	<b>2A</b>	2 OHVDS Alarm Inputs						
	<b>3A</b>	3 OHVDS Alarm Inputs						
<b>OHVDS Fault Inputs</b>	<b>(blank)</b>	1 OHVDS Fault Input - Standard						
	<b>2F</b>	2 OHVDS Fault Inputs						
	<b>3F</b>	3 OHVDS Fault Inputs						
	<b>NF</b>	No OHVDS Fault Input						
<b>Remote Communication</b>	<b>(blank)</b>	No Remote I/O Module - Standard						
	<b>RC2</b>	Remote I/O Module with Ethernet						
	<b>RC3</b>	Remote I/O Module with Ethernet and Cellular Modem						
<b>Enclosure</b>	<b>(blank)</b>	Carbon steel, powder coated, light gray, pad-lockable - Standard						
	<b>SS</b>	Stainless steel, 316L, pad-lockable						
	<b>BP</b>	No enclosure, components mounted on carbon steel back-panel						
	<b>19</b>	No enclosure, components mounted on 9RU recessed panel for installation in 19" rack						

<sup>1</sup> Refer to Ordering Guide for details.

<sup>2</sup> If equipped with Remote I/O Module and network connection is available.

<sup>3</sup> If equipped with Cellular Modem.

<sup>4</sup> Runtime varies depending on load (typically 5 to 15 mins). UPS supplies power to +24VDC USC-1000 internal devices only, including the Remote I/O module with Ethernet and Cellular Modem.

## SPECIFICATIONS

### MODEL # PMB-407

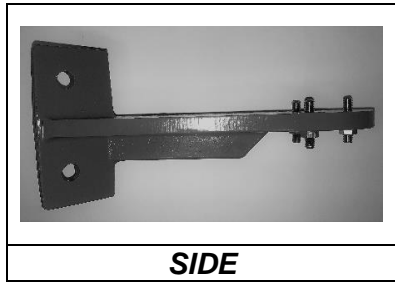
### POLE MOUNT BRACKET WITH VERTICAL ADJUSTMENT



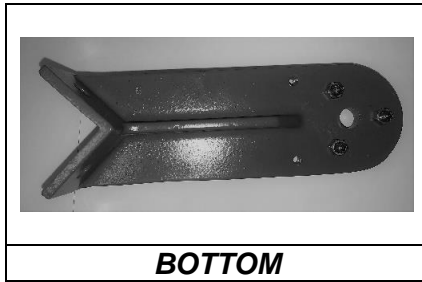
<b>FEATURES</b>	Enables 10 inch (25.4 cm) vertical adjustment in 1 inch (2.54 cm) increments
<b>ADJUSTMENT</b>	Pan $\pm 45^\circ$ . Pitch and roll vary with optional three axis mount.
<b>DIMENSIONS</b>	Angle bracket: 4 x 18 x 3/8 inch (10.16 x 45.72 x 0.95 cm) with 1" (2.54 cm) spaced tapped holes for 3/8" (0.95 cm) diameter bolt. Mounting bracket: 5 x 3.5 x 11 inch (12.7 x 8.89 x 27.94 cm)
<b>CONSTRUCTION</b>	3/8 inch (0.95 cm) aluminum
<b>FINISH</b>	Powder coated light gray (ANSI49). Custom colors available at additional cost.
<b>ATTACHMENT</b>	Stainless steel bands and/or lag bolts. Adapts to any pole $\geq 3$ inches (7.62 cm) in diameter.
<b>SHIPPING WEIGHT</b>	6.5 lbs (2.94 kg) each. Two required per system.

**SPECIFICATIONS**

**MODEL # PMB-500**  
**POLE MOUNT BRACKET**



**SIDE**



**BOTTOM**



**INSTALLED**

<b>ADJUSTMENT</b>	Pan 270°, Pitch ± 15°, Roll ± 25°
<b>DIMENSIONS</b>	5 H X 3.5 W X 11 L inch (13 H X 9 W X 28 L cm)
<b>CONSTRUCTION</b>	Heavy ALMAG casting
<b>FINISH</b>	Light gray enamel
<b>ATTACHMENT</b>	Stainless steel bands or customer provided bolts. Adapts to any pole ≥ 3 inches diameter.
<b>SHIPPING WEIGHT</b>	2.5 lbs (1.2 kg) each. Two required per system.

## SPECIFICATIONS

### MODEL # TGZ-M017

#### THREE-AXIS MOUNT



<b>ADJUSTMENT</b>	Pan $\pm 60^\circ$ , Pitch $\pm 40^\circ$ , Roll $\pm 40^\circ$
<b>DIMENSIONS</b>	9 H X 8-1/2 W X 3-1/2 D inch (23 H x 22 W x 9 D cm).
<b>CONSTRUCTION</b>	Three-piece mount of 9 mm 5052 aluminum with stainless steel hardware.
<b>FINISH</b>	Powder coated light gray (ANSI49). Custom colors available at additional cost.
<b>ATTACHMENT</b>	Designed for pole-top or pole-mount bracket installations via 5/8 inch (1.6 cm) stainless steel bolt.
<b>SHIPPING WEIGHT</b>	4 lbs (2 kg) each. Two required per system.

## SPECIFICATIONS

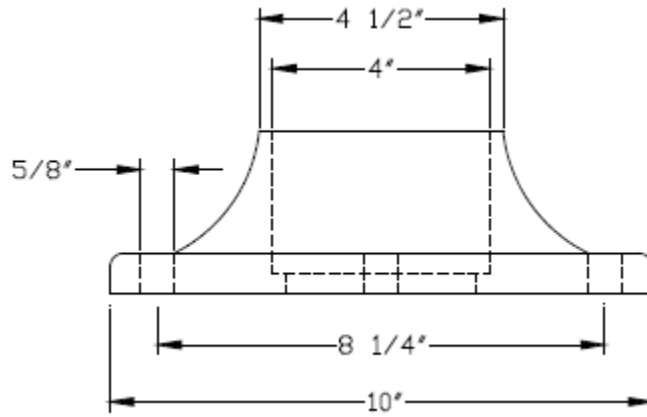
### MODEL # 3701

### TELESCOPING MOUNTING POLE

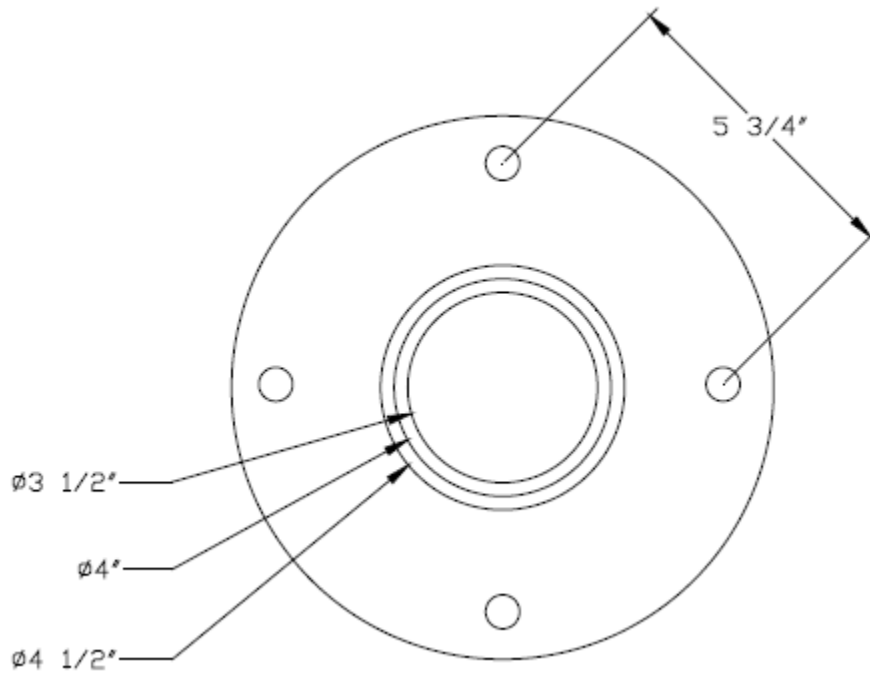


<b>ADJUSTMENT</b>	Telescopes 10.5 to 16.5 ft (3.2 to 5.03 m)
<b>DIMENSIONS</b>	<p><b>Pole Base Flange</b> 10 inches (254 mm) Diameter 2.75 inches (69.85 mm) High</p> <p><b>Pole Height</b> Collapsed – 10.5 feet (3.2 m) Extended – 16.5 feet (5.03 m)</p> <p><b>Pole Diameter</b> Upper Section – 3.5 inches (88.9 mm) OD. Lower Section – 4.0 inches (101.6 mm) OD.</p>
<b>CONSTRUCTION</b>	<p><b>Upper Section / Inside Pole</b> 3.5 inches (88.9 mm) OD. w/.216 inches (5.4864 mm) wall, 6061-T6 extruded seamless aluminum tubing</p> <p><b>Lower Section / Outside Pole</b> 4.0 inches (101.6 mm) OD. w/.188 inches (4.7752 mm) wall, 6061-T6 extruded seamless aluminum tubing Handhole centered 18 inches (457.2 mm) above the bottom of the shaft. Handhole cover secured in place by stainless steel screws.</p> <p><b>Base Flange</b> One-piece cast aluminum with 8.25 inches (209.55 mm) bolt centers between four 5/8 inch (15.875 mm) through-holes.</p>
<b>FINISH</b>	Brushed aluminum.
<b>ATTACHMENT</b>	Via pole base flange. Poles are complete with all hardware except base anchor/mounting bolts and nuts.
<b>SHIPPING WEIGHT</b>	90 lbs (41 kg).

POLE BASE FLANGE DETAILS:



SIDE VIEW



TOP VIEW



## SPECIFICATIONS

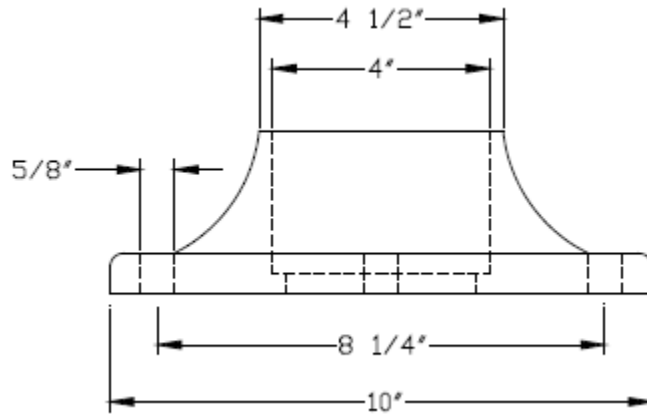
### MODEL # 3702

### FIXED LENGTH MOUNTING POLE

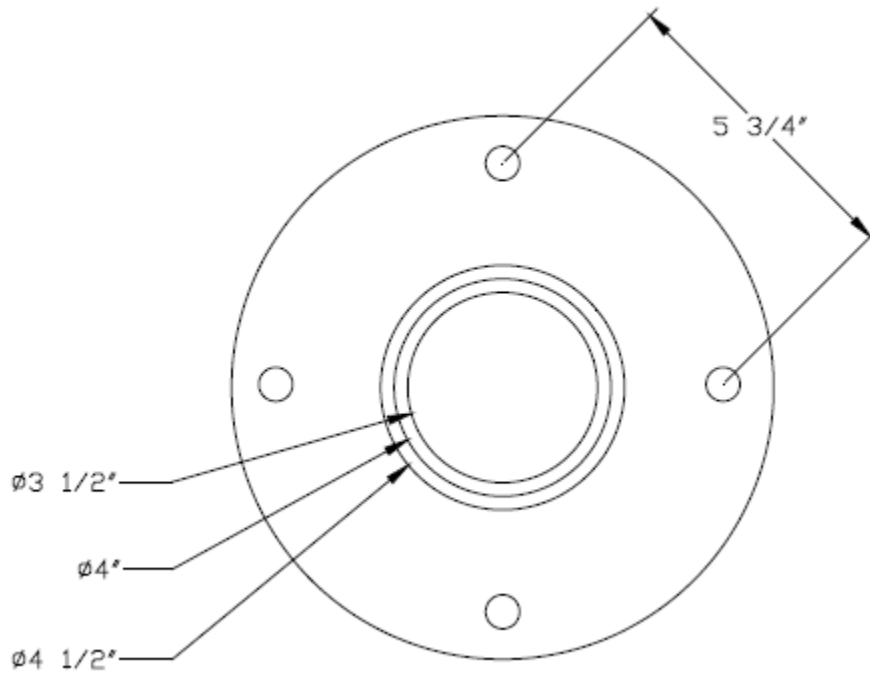


<b>ADJUSTMENT</b>	Fixed length.
<b>DIMENSIONS</b>	<b>Pole Base Flange</b> 10 inches (254 mm) Diameter 2.75 inches (69.85 mm) High <b>Pole Height</b> 10 feet (3.05 m). <b>Pole Diameter</b> 4.0 inches (101.6 mm) OD.
<b>CONSTRUCTION</b>	<b>Pole</b> 4.0 inches (101.6 mm) OD. w/.188 inches (4.7752 mm) wall, 6061-T6 extruded seamless aluminum tubing Handhole centered 18 inches (457.2 mm) above the bottom of the shaft. Handhole cover secured in place by stainless steel screws. <b>Base Flange</b> One-piece cast aluminum with 8.25 inches (209.55 mm) bolt centers between four 5/8 inch (15.875 mm) through-holes.
<b>FINISH</b>	Brushed aluminum.
<b>ATTACHMENT</b>	Via pole base flange. Poles are complete with all hardware except base mounting bolts and nuts.
<b>SHIPPING WEIGHT</b>	60 lbs (27 kg).

POLE BASE FLANGE DETAILS:



SIDE VIEW



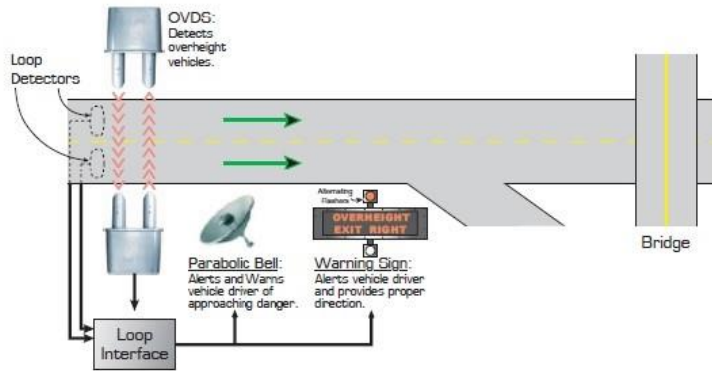
TOP VIEW

**SPECIFICATIONS**

**MODEL # TGL-2001**  
**LOOP DETECTOR INTERFACE**

**Features**

- Reduces False Alarms
- Internal Alarm time adjustment
- Accepts most loop detector outputs
- Easy Installation
- Internal loop hold adjustments



The Trigg Industries Loop Detector Interface ensures that non-vehicular causes do not false-trigger overheight vehicle alarms. A loop detector (or detectors) in the roadway makes it possible to identify overheight vehicle passage so that an overheight alarm is issued only when a vehicle is present. The interface is designed to accept a relay contact opening from a loop detector (or detectors) and a Trigg OVDS relay contact closure. The Model TGL-2001 includes a “Loop Hold” adjustment that allows for slower moving vehicles to be detected.

<b>INPUT POWER</b>	115 VAC +/- 10% Hz. Options include 24 VDC solar or 230 VAC +/- 10%, 50/60 Hz.
<b>OUTPUT</b>	Two Form C Dry relay contacts rated at 10A, protected by 8A fuses.
<b>ALARM TIME</b>	An Alarm Time adjustment is incorporated that allows a double-pole double-throw relay to be energized from 1 to 30 seconds upon receiving a valid alarm. This feature enables the OVDS Alarm Time to be set for a short time (1-2 seconds), which in turn, allows control over time.
<b>THROUGH-PUT</b>	Approximately 1 second.
<b>ELECTRONICS</b>	Heavy duty printed circuit board, terminal strips with Phillips screw connections.
<b>TEMPERATURE RANGE</b>	-40° to +135° F (-40° to +57° C) with required heating or cooling packages per specific site.
<b>HOUSINGS</b>	All electronics are enclosure in a durable fiberglass NEMA 4X rated cabinet. Cord grips/strain relief connectors are included for cable access. The enclosure need not be mounted near either the loop relay(s) or OVDS but we do not suggest more than 500 feet (152 m) of separation due to the possibility of noise pickup in the cabling. Use of shielded cable may be required in some applications.
<b>SHIPPING WEIGHT</b>	20 lbs (9 kg).

## SPECIFICATIONS

### MODEL # TG-CAM-1010

Network Camera Kit – Fixed

*Provides Snapshot Images and Video Recordings of Over-height Vehicles When Using Compatible OHVDS*



<b>IMAGE SENSOR</b>	1/2" progressive scan RGB CMOS
<b>LENS</b>	Varifocal, IR corrected, CS-mount, 3.9–10.0 mm, F1.5, 2 MP (16:9): Horizontal field of view: 92°–42°, Vertical field of view: 50°–23°, i-CS lens, Optional lenses available
<b>DAY AND NIGHT</b>	Automatically removable infrared-cut filter
<b>MINIMUM ILLUMINATION</b>	Color: 0.05 lux, at 50 IRE F1.5, B/W: 0.01 lux, at 50 IRE F1.5 (1080p 30 fps WDR) Color: 0.1 lux, at 50 IRE F1.5, B/W: 0.02 lux, at 50 IRE F1.5 (1080p 60 fps WDR) Color: 0.2 lux, at 50 IRE F1.5, B/W: 0.04 lux, at 50 IRE F1.5 (1080p 120 fps WDR)
<b>SHUTTER TIME</b>	1/100000 to 2 s
<b>PAN / TILT / ZOOM</b>	Digital PTZ, uploadable PTZ driver (Pelco D pre-installed)
<b>VIDEO COMPRESSION</b>	H.264 (MPEG-4 Part 10/AVC), Main, Baseline and High Profile Motion JPEG
<b>RESOLUTION</b>	1920x1080 to 320x180
<b>FRAME RATE</b>	Up to 60 fps (1080p with WDR) Up to 120 fps (1080p without WDR)
<b>VIDEO STREAMING</b>	Multiple, individually configurable streams in H.264 and Motion JPEG Controllable frame rate and bandwidth VBR/ABR/MBR H.264
<b>SECURITY</b>	Password protection, IP address filtering, HTTPS encryption, IEEE 802.1x (EAP-TLS) network access control, digest authentication, user access log, centralized certificate management, brute force delay protection, signed firmware
<b>SUPPORTED PROTOCOLS</b>	IPv4, IPv6 USGv6, HTTP, HTTP/2, HTTPS, SSL/TLS, QoS, Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP/DM, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, SRTP, TCP, UDP, IGMP, RTCP, ICMP, DHCPv4/v6, ARP, SOCKS, SSH, LLDP, CDP, MQTT, Syslog.
<b>SOFTWARE API</b>	ONVIF Profile G, ONVIF Profile S, and ONVIF Profile T

SPECIFICATIONS (CONT'D):

<b>EVENT ACTIONS</b>	File upload: FTP, SFTP, HTTP, HTTPS, network share and email, send video clip Notification: email, HTTP, HTTPS and TCP Overlay text, Send SNMP Trap, Video and audio recording to edge storage, Pre- and post-alarm video buffering
<b>CONSTRUCTION</b>	IP66-, IP67-, NEMA 4X- and IK10-rated Metal (Aluminum)
<b>POWER</b>	Power over Ethernet (PoE) IEEE 802.3at Type 2 Class 4 (Typical 12.3 W, max 25.5 W)
<b>CONNECTORS</b>	Shielded RJ45 10BASE-T/100BASE-TX PoE 6-pin terminal block for four configurable inputs from compatible OHVDS
<b>IR ILLUMINATION</b>	850 nm IR LEDs with range of reach 30 m (98 ft) or more depending on the scene
<b>STORAGE</b>	Support for microSD/microSDHC/microSDXC card Support for SD card encryption Support for recording to network-attached storage (NAS)
<b>OPERATING CONDITIONS</b>	Start-up at -40 °C to 60 °C (-40 °F to 140 °F) Humidity 10-100% RH (condensing)
<b>MOUNTING</b>	Wall or pole mounting using included brackets.
<b>DIMENSIONS</b>	7 x 8.11 x 19.45 in (178 x 206 x 494 mm) Excluding mounting brackets
<b>WEIGHT</b>	13.2 lb (6.35 kg) Excluding mounting brackets
<b>INCLUDED ITEMS</b>	Fixed Network Camera with Built-In IR Illuminator, Wall Mount Bracket, Pole Mount Bracket, 64GB Memory Card, Midspan POE Extender, Bird Control Spikes, 6-pin Terminal Block Connector.

SAMPLE SNAPSHOT IMAGES:



TRAFFIC OVERVIEW CONFIGURATION



SIDEVIEW CONFIGURATION