



Podcast 10:

Lighting the Way to Safety: Warning Lights and Illumination for Vehicles, Traffic Control Devices, and the Work Area

Hello and welcome to the American Traffic Safety Services Association's Work Zone Safety podcast series. This podcast, as well as its companion document titled *Nighttime Lighting Guidelines for Work Zones: A Guide for Developing a Lighting Plan for Nighttime Work Zones*, is based on work supported by the Federal Highway Administration under the 2011 Work Zone Safety Grant. The primary focus of this podcast is nighttime warning lights and work zone illumination, although some guidance is also applicable to daytime work zone warning lights as well.

For a more extensive and detailed discussion on nighttime lighting, please review the companion document, *The ATSSA Nighttime Lighting Guidelines for Work Zones*, which is available at workzonesafety.org. In addition, throughout this podcast we will make reference to additional guidance and information resources, such as Part 6 of the *Manual on Uniform Traffic Control Devices* (or the MUTCD), which is the basis for using vehicle warning lights in work zones and should be consulted by practitioners. Links to other resources are listed in the script that accompanies this podcast.

This podcast is divided into three separate segments on the topic of work zone lighting. Part 1, which includes this introduction, will focus on vehicle warning lights and lighting devices mounted on work vehicles. Part II focuses on traffic control warning lights and devices. And finally, Part III discusses work area lighting. Each segment is about 12 or 13 minutes long.

Part I: Warning Lights for Work Vehicles

You know, I'm a practitioner, and I thought whoever owns the work equipment or work vehicles decided what warning lights to use?

In a way you're right, but there's more to it than that. Stick with us while we explain.

The term "work vehicle" includes those vehicles connected to the work operation that are street-legal motor vehicles. This does not include "work equipment," which is not allowed to operate as a motor vehicle outside the work zone. Work equipment typically operates within the limits of the established work area and behind the traffic control devices. Examples of work equipment



may include paving machines and loaders. Work vehicles, on the other hand, *do* interact with traffic as they enter and exit the work zone and in many cases are a significant element of the traffic control operation and work zone safety. In this section, we're going to focus on the warning light requirements for work vehicles.

In general, any work vehicle operating in the work zone, including those used for traffic control operations, for materials delivery, and by subcontractors must be identified as a work vehicle to minimize driver confusion. That's why we use warning lights on each vehicle. Without those lights, drivers may follow work vehicles into the work zone. The MUTCD requires the use of vehicle warning lights, as do most state and local agencies.

It's easy to see the need for vehicle warning lights, but, as is often the case, it's the specific requirements and work zone applications that sometimes cause confusion. The types of warning lights to be used should be identified both in the applicable standards and specifications, as well as on the temporary traffic control plan, or TCP. This is especially true for mobile work zone operations.

Okay, but, what type of warning light should I use for work vehicles? What are the standards?

Well, as defined in the MUTCD in sections 6F.81 and 1A.13, work vehicle warning lights for construction and maintenance work are yellow in color and must be a high-intensity rotating, flashing, oscillating, or strobe light. You may have heard of Type A, B, C or D warning lights; they play an important role when setting up traffic control devices. We'll cover those in greater detail in Part II. As for work vehicle warning lights, many states also have requirements in place that govern what types will be used and how. For example, the Texas DOT requires that dump trucks use only one center-mounted amber mini-light bar.

Keep in mind that some specialized work vehicles, like police or incident response vehicles for example, may use other light colors that have a regulatory connection to their operational use at traffic crashes and incidents. Examples would be blue lights for police and red and white lights for ambulances. Specialized vehicles could be for any type work application where light type, color or placement is adapted to meet that need or specific requirements by state, agency or local rules.

Can we use the flashing warning lights installed by the original equipment manufacturer on our work vehicles in the work zone?

The short answer is yes, but they must be used *with* MUTCD-compliant yellow flashing warning lights, not *in place of* those lights.



Let's talk about the various types of and uses for vehicle-mounted warning lights and devices. One notable practice is by the Washington State DOT, which developed a "Vehicle and Equipment Warning Light Systems Manual" for addressing the types of warning lights and devices installed on several vehicle classes.

One class is generic work, delivery, or support vehicles. The most basic level of warning light to identify this class of vehicle is a single high-intensity rotating, flashing, oscillating, or strobe light that meets the basic MUTCD requirement. Vehicles that do not primarily operate in work zones but may visit occasionally must still have a single exterior warning light, interior-mounted warning light, or a temporary warning light with a magnetic base. There are many vehicle types and many types of warning lights and lighting devices, and this is where additional agency guidance becomes helpful for consistent application.

Another vehicle class would be vehicles that are commonly used in work zones for construction or maintenance activities that frequently enter and exit the work zone—pick-up or support trucks, for example. These vehicles commonly have a light bar of yellow warning lights mounted to the cab roof of the vehicle for maximum visibility.

A third class of vehicle includes traffic control vehicles like truck-mounted attenuators, which are used in a variety of work zones. These vehicles often have a dual purpose, serving both to protect workers and to control and advise traffic through the use of warning devices like arrow boards and portable changeable message signs (PCMS).

Other specialized work vehicles like snow plows and sweepers may operate independently and use several different MUTCD-compliant warning lights to maximize visibility to drivers.

With so many vehicle classes, how can I be sure that I'm using the correct vehicle-mounted warning lights and that I've applied them appropriately?

First, check whether your agency has standards and specifications for vehicle warning lights and their use in work zones. Next, review MUTCD Part 6G and Part 6H. These sections will provide guidance. For example:

- All work vehicles must display a warning beacon visible from 360 degrees.
- Mobile work operations should have a TCP that indicates the types of warning lights and devices required, such as vehicle warning lights, arrow boards, and PCMS.
- Night work may include specific requirements for minimizing driver confusion or distraction due to too many warning lights and devices.
- Workers and work vehicles must be strategically located so as to be expected by drivers. This is important as the driver's attention will be focused on the direction of the warning light.



Since warning lights are intended to draw drivers' attention, how can I avoid distracting or blinding drivers with warning lights?

Here are some tips for appropriate vehicle and equipment lighting applications in the work zone:

- First, turn off warning lights when vehicles are parked outside the work zone or are working behind traffic control devices in the work zone.
- Second, reduce the overall numbers of active warning lights when several work vehicles are clustered together in a work area. This may mean using only the warning lights of the vehicles being used for actual traffic control or turning off warning lights located close to a PCMS or arrow board.
- Next, be consistent. Consistent use and application of warning lights minimizes driver confusion, which is generally higher at night.
- Lastly, keep in mind that high-intensity warning lights may be required for some work zone operations, especially those that require long-range warning due to high traffic speeds or work zone conditions that are unexpected by drivers. High intensity warning lights and devices have both day and night performance specifications in both the MUTCD and in many agencies' requirements.

Mobile operations at night can be very challenging, so here are a few ideas for making your night time operation safer:

- When conducting shoulder closures, make sure to use PCMS or arrow boards in caution mode and perform a "drive by" inspection to ensure the operation is visible but not confusing.
- When conducting a lane closure, it is advisable to use only one arrow display per lane closed, as with stationary lane closures, although some agencies allow more than one arrow display for a mobile lane closure depending on the length of the convoy and type of work.

To summarize what we've learned so far, vehicle warning lights in work zones are required, must be yellow in color, and must be visible from 360 degrees. That's the easy part. From there many variations of warning light and work zone applications exist. The biggest issues with vehicle warning lights are glare and distraction for drivers, usually due to overuse. Secondary to those issues are the selection of warning lighting devices and proper work zone application. As we discussed, a best practice approach is to apply specific warning light requirements to various classes of work vehicles to achieve consistent warning light application under work zone conditions.

Are your barricades and drums warning lights, and PCMS and arrow boards used properly? Find out in the second part of this podcast – Warning Lights for Traffic Control Devices.



Part II - Warning Lights for Traffic Control Devices

Welcome to Part II of the podcast “Lighting the Way to Safety: Warning Lights and Illumination for Vehicles, Traffic Control Devices, and the Work Area.” In Part I, we talked about vehicle warning lights and lighting devices mounted on work vehicles. In this segment, we will be talking about common warning lights that are used in conjunction with traffic control devices like barricades and drums. We’re also going to explore arrow boards, which use lights to convey warnings to drivers about lane shifts or closures. All of these devices are very common to most work zones, but are not always understood or applied correctly.

What about temporary or portable changeable message signs and portable traffic control signals? You didn’t mention them. Are they considered warning lights?

That’s a good point, and while these devices are like arrow boards in that they use lights to guide traffic movements in a work zone, we can’t cover these topics adequately within the time constraints of this podcast. That said, the Manual on Uniform Traffic Control Devices (or MUTCD), ATSSA, and the National Work Zone Safety Information Clearinghouse, located at workzonesafety.org, have good information available on the proper use of temporary or portable traffic control signals.

Let’s start with warning lights on traffic control devices, then. How do I determine what type of warning lights to use, or where to place them?

I think we can all agree that warning lights are great tools for grabbing drivers’ attention, but, as with all traffic control devices, proper application is critical. Warning lights that are placed indiscriminately or are not well maintained can be worse than no warning lights at all. If you’ve ever observed a work zone with dead lights or mixed steady burn and flashing lights, you are aware of the confusion it creates. Warning lights are classified as Type A, B, C or D and are intended to supplement channelization devices and signs, primarily at night. When applied properly, warning lights can make a significant improvement in alerting drivers to work zone hazards.

Type A is the most common warning light. This is a low intensity light that flashes yellow and is commonly used at spot locations during nighttime hours to warn of hazards and enhance the conspicuity of the signs, drums, or barricades they may be mounted on. Type A lights should not be used to guide traffic as delineation devices, since the random flashing affect could be somewhat confusing.

Type B, a high-intensity yellow flashing warning light, can be used either during the day or for nighttime work. You may have seen type B warning lights mounted on large advance warning



signs. These lights do an excellent job of attracting a driver's attention to the sign information. Type B lights are very bright and are effective in daylight as well as night.

Type C is the steady burn version of the type A flashing warning light. Many Type A lights come with a "steady burn" switch position that turns them into a Type C light when toggled. Type C warning lights provide excellent guidance for drivers at night and are a positive enhancement when mounted on channelization devices intended either to shift traffic laterally or to delineate the outside edge of a curve.

Type D warning lights are a relatively new designation and offer a 360 degree steady burn display. The 360-degree display may offer some guidance advantage for drivers in work zones where the Type C lights have a limited directionality.

The MUTCD also states that warning lights must meet the Institute of Transportation Engineers "Purchase Specification for Flashing and Steady-Burn Warning Lights" guidance document. Manufacturers of warning light devices are typically very familiar with the standards, so acceptance of those devices is rarely an issue. Any inappropriate use of these devices is mostly due to an incorrect TCP or an improper site application, where the device is either placed at the wrong location or the wrong device is used.

So about those flashing and steady burn lights – why do we need both?

Good question. This is an interesting topic and deals with the human factors behind the design of warning lights. Early studies showed that drivers don't respond well to random flashing lights when they're used to delineate the edge of the roadway or work area. So, steady burn lights are best for delineating a vehicle's path. For example, we use them on top of traffic safety drums that are placed along the edge of a travel lane through a work zone. On the other hand, flashing lights are useful for gaining drivers' attention. A simple example would be the flashing lights you may often see above static advance warning signs, like the ones that read "Work Zone Ahead."

That is interesting. But what about arrow boards? Any advice on how to use those?

When it comes to lane closures, arrow boards may be the single most effective device an agency can deploy. Arrow boards, also called "chevron displays" by some agencies, are highly visible and display a simple yet effective message.

One piece of advice when it comes to arrow boards is to "go big"—well, as big as is reasonable. The largest arrow board meets or exceeds the visibility requirements for all classes of roadways, which means it's the most versatile. Naturally, jurisdictions with low speed roads may not need such a large arrow board, or some may have equipment or other limitations. As with warning lights, the MUTCD allows for 4 different types and sizes of arrow boards: Types A, B, C, and D, with A being the smallest (48" X 24"), then B (60" X 30") and finally C (48" X 96"). Type D



has no specific board or panel size, only the arrow size is specified as 48” X 24”. The Type D arrow is intended to be mounted on work vehicles and equipment that may operate independently, such as a road sweeper, which needs design flexibility.

Arrow boards also have a caution mode display for use when there is no lane closure. Many TCPs make reference to the caution mode or caution display, which are shown in the MUTCD. The caution mode is often used for shoulder work. In addition, an arrow board can display a double-headed left and right arrow for a traffic “split,” where a lane merges both left and right to go around a center lane. This function should be avoided because this type of merge isn’t a recommended practice. Other strategies that reduce lanes prior to the split location are preferred.

Arrow boards can be used effectively during day time or at night. They are very bright to be effective in daylight, but are far too bright and glaring at night and may temporarily blind drivers. Therefore, they are required to have a dimming capability down to 50 percent of their daytime setting so they can be used for nighttime operations. Most newer arrow boards have an automatic dimming control.

In conclusion, device-mounted warning lights and arrow boards are important safety-enhancing tools. To use them successfully, the key is to think strategically and integrate each element into the TCP as appropriate. As always, check your state and local standards for detailed specifications and additional guidance.

That concludes part II of this podcast.

Coming up next – Are you in the dark when it comes to work area lighting practices and requirements? We’ll shed some light on that topic in the third and final part of this podcast – work area lighting.



Part III: Work Area Lighting

Welcome to Part III of the podcast “Lighting the Way to Safety: Warning Lights and Illumination for Vehicles, Traffic Control Devices, and the Work Area.” In Part II we talked about warning lights that mount on common traffic control devices. In this segment, we will focus on work area lighting.

Work area lighting is an important subject because of its impact on both safety and work quality. That said, it is sometimes misunderstood, and its requirements can be confusing. It may make more sense to think of work area lighting as three distinct lighting types with separate standards and practices. These include: (1) temporary illumination, (2) work operations lighting and (3) worker safety and task lighting.

This sounds more confusing than it needs to be. Why do we need to have three different types of lighting for nighttime work operations?

That’s a good question and a good place to start. Work area lighting doesn’t have to be confusing, and learning why each type is different makes lighting as a whole much easier to understand.

The first lighting type, “temporary illumination” is sometimes misunderstood as being intended to illuminate the work operation. However, its purpose is to provide safe nighttime roadway light levels for traffic safety. The fact that it can also provide lighting for nighttime work operations is a beneficial side effect. Temporary illumination uses the same general design standards as permanent illumination but may also use temporary fixtures such as wood poles and common light standards and luminaires.

The second lighting type, “work operations lighting” is used to provide light at adequate and safe levels to the work area at night. This includes floodlights and equipment lights. Not all work zones require extensive lighting for night work operations, but some is necessary and could be as simple as mounting lights on equipment and using portable work lights.

Lastly, the third type, “worker safety and task lighting” is necessary for night work so that workers can safely conduct and inspect work, access the work area, and perform specific operations like flagging. Worker safety and task lighting could include any of the lighting devices previously mentioned and is most likely temporary or portable lighting focused on the actual worker task.

From a safety perspective, the subject of work area lighting has become a higher priority as more road work is being performed at night to avoid congestion impacts. These impacts would be much worse in the daytime to the point where delay would become unacceptable to the community. However, working at night can result in safety issues related to limited visibility.



The good news is that many of these safety concerns can be mitigated by using work area lighting properly.

OK, it's starting to make more sense, but how is this actually applied to the work zone?

Let's talk about that in terms of the process. During early work zone strategy development, look at the potential for night work, which will probably be obvious based on the type of work and traffic impacts. If your agency decides to conduct a night operation, how extensive will it be? That is, will the project features be constructed at a long-term stationary work area, or will it be a short duration project, like nighttime paving? This determination will lead you to some fairly straightforward decisions about the type of work area lighting needed. For example, a temporary illumination system with timber poles might be appropriate for a long-term stationary work area while balloon lights might be appropriate for a night paving operation. ATSSA's *Nighttime Lighting Guidelines for Work Zones* is a good resource for determining work area lighting needs.

The first type of lighting - temporary illumination - is a design function that closely parallels that used when developing a design for permanent illumination design. The real differences are in the early assessment of what, if any, temporary illumination is required or desired and then designing and planning the development of a temporary illumination system that includes fixtures, equipment, and installation.

Still speaking in terms of process, the second lighting type – work operations lighting – is usually a work plan item that determines what lighting equipment is needed and may be adjusted as the work progresses. Balloon lights, light plants, and floodlights are all commonly used. Lights mounted on construction equipment are also common.

Generally, the third type of lighting – worker safety and task lighting – is covered as part of a project or as maintenance work safety requirements. Various lighting equipment is used depending on the nature of the work, the level of access or movement required, and the duties of the workers. In many cases the work operations lighting will provide safety and serve the task needs of workers, inspectors, and equipment operators.

I see how the various work areas and activities relate to the type of lighting needed but what are the actual requirements?

Light levels have been developed for the various types of night work we have described. It's important that these light levels be achieved and be consistent with OSHA and local agency standards. Again, ATSSA's *Nighttime Lighting Guidelines for Work Zones* has useful information about light level requirements, but let's summarize it here.

Level I lighting is measured at approximately 5 foot-candles and is appropriate for tasks requiring low accuracy, involving slow-moving equipment, and where large objects are involved,



such as hauling, grading and some drainage work. This would also involve basic access to the work area on foot, an item that is often overlooked. As you can imagine, it's neither wise nor safe to stumble around in the dark trying to get work done or figure out where you're going. Portable floodlights, equipment lights in the form of either spot or flood lights, and existing roadway lighting or temporary illumination may fulfill this need.

Level II lighting, measuring approximately 10 foot-candles, is recommended for areas on or around construction equipment to provide a safe environment for workers operating the equipment, allowing them to perform tasks that require a moderate level of accuracy. These tasks might include asphalt or concrete paving work, some roadway repairs, and many types of construction and maintenance work. Balloon lights, equipment-mounted lights, and portable generator-powered flood lights are common sources for Level II lighting. Flagger station lighting also falls into this category.

Level III lighting, at approximately 20 foot-candles, is appropriate for those tasks that require a greater level of visual acuity or tasks with a high degree of difficulty. These tasks might include bridge repairs, mechanical or electrical work, and detailed inspection. High-intensity light plants, flood lights, and spotlights are often used to achieve Level III lighting.

Remember, these light levels and categories are for general reference and are considered minimums. Your specific work requirements and regulations may differ. Always be aware of your state and local requirements, and keep in mind that inadequate or no lighting at all can open workers and drivers to the risk of injury or death. In addition, absent or inadequate lighting may result in a Labor and Industries or OSHA inspection and citation.

What type of work area lighting works best mounted on equipment like a paving machine?

Balloon lights are relatively new and have been adapted for slow-moving mobile and portable use on equipment or stationary locations. Balloon lights are omni-directional and have very little glare, so their use is quite flexible, plus, they are an excellent source of lighting.

Floodlights, too, are a good source of light, but they must be pointed away from drivers.

Portable generator-powered floodlights or light plants are the mainstay of work area lighting since they are very bright and can be aimed directly at the work area. Some detailed work requires high light levels to provide enough visibility so workers can see specific roadway features. Work on bridges, drainage, and sign installations are examples.

It's important to note that while work equipment and work vehicles usually come equipped with headlights from the original equipment manufacturers so that they can operate legally on the road, those headlights are usually not adequate for work area or task lighting. Often vehicles and



equipment used in work zones have specific lighting units installed on them for the purpose of providing adequate lighting to effectively accomplish the intended work.

What about flagging? How are lighting needs different for those operations?

Flagging at night is a somewhat unique type of work. Flagging stations must be illuminated at night so drivers can see the flagger's instructions and the Stop/Slow paddle. Several flagger lighting solutions have been developed, and many agencies have developed requirements that meet MUTCD standards. The difficulty here is to provide adequate lighting without blinding the flagger or the oncoming drivers. Most solutions involve a floodlight mounted on a portable mast above the flagging station. Any existing roadway lighting needs to be supplemented with flagger station lighting to highlight the flagger. This is a performance requirement, so actual applications vary greatly. The mounting height of the light must be at least 10', and many suppliers offer portable equipment.

Speaking of being blinded, we've had complaints about glare from our work area lights. How can we address this?

Glare is probably the number one offending issue in work area lighting. The usual culprit is powerful flood lights. Sometimes it's tough to light the work area adequately without creating glare. In many cases, however, adjusting the direction or height of lights will help minimize the glare, and in some cases light shields can be helpful.

In conclusion, while there can be a number of challenges in providing adequate work zone lighting with minimal glare, an understanding of the needs of the work to be performed, the workers' lighting needs, and drivers' visibility needs will help you plan and illuminate a safer work zone operation.

This concludes this podcast. Be sure to check out the resources listed at the end of the script, and remember, most DOTs have resources, including manuals and training, that provide much greater detail and can offer solutions to specific problems.



Resources

Aside from your own State and local agency requirements, other specifications and guidance resources include:

- ATSSA, *Quality Guidelines for Temporary Traffic Control Devices and Features*
- ATSSA, *Maintenance Work Zone Safety: Pocket Guide of MUTCD Guidance on Temporary Traffic Control*
- ATSSA, *Guidance for the use of Portable Changeable Message Signs in Work Zones*
- ATSSA, *Nighttime Lighting Guidelines for Work Zones*
- The *Federal Motor Vehicle Safety Standard (FMVSS)*, which is designed to standardize lighting and other aspects of vehicles and equipment.
- ITE, *Traffic Control Devices Handbook* (a supplement to the 2009 MUTCD).
- TRB, *NCHRP 624: Selection and Application of Warning Lights on Roadway Operation Equipment*.
- Washington State Department of Transportation, *Vehicle and Equipment Warning Light Systems Manual*, M53-54.

Also, be sure to refer to the resources published by manufacturers about their equipment or vehicles.