accidents don't have to happen

Road Safety Factsheet

Vehicle Lighting

March 2018

Introduction

Headlights were first introduced during the late 1880s. These original headlamps were fuelled by acetylene or oil, with the first electric headlights being introduced in 1898 by the Electrical Vehicle Company of Hartford, Connecticut as an optional accessory for the Columbia Electric Car. The standardised seven-inch round sealed beam headlight came out in 1940.

It is just as important to be able to see where you are going and for other road users to see you today as it was in the early days of motoring. Technology is evolving rapidly and this factsheet provides a summary of the main type of lighting currently in use and considers some of the issues associated with modern vehicle lighting.

The law

The Highway Code rule 113 says that as a driver you must:

- ensure all sidelights and rear registration plate lights are lit between sunset and sunrise
- use headlights at night, except on a road that has lit street lighting. These roads are generally restricted to a speed limit of 30 mph (48 km/h) unless otherwise specified
- use headlights when visibility is seriously reduced (see Rule 226).

Night time is defined as the period between half an hour after sunset and half an hour before sunrise.

Rule 114 states that as a driver, you must not:

- use any lights in a way which would dazzle or cause discomfort to other road users, including pedestrians, cyclists and horse riders
- use front or rear fog lights unless visibility is seriously reduced. You MUST switch them off when visibility improves to avoid dazzling other road users (see Rule 226).

In stationary queues of traffic, drivers should apply the parking brake and once the following traffic has stopped, take their foot off the footbrake to deactivate the vehicle brake lights. This will minimise the glare to road users behind until the traffic moves again.

Drivers should also (rule 115):

- use dipped headlights, or dim-dip if fitted, at night in built-up areas and in dull daytime weather
- keep headlights dipped when overtaking until level with the other vehicle and then change to main beam if necessary, unless this would dazzle oncoming road users
- slow down, and if necessary stop, if dazzled by oncoming headlights.

Technological advancements

In order to make vehicle lighting more efficient and to minimise the chances of the driver forgetting to switch on lights, manufacturers have been introducing new technologies that are designed to make vehicles safer and reduce the likelihood of dazzle to oncoming drivers, pedestrians and cyclists. The main systems currently being offered either as standard or as an optional extra includes:

Daytime Running Lights (DRL)

Vehicle manufacturers as of February 2011 must fit DRL to new types of passenger cars and light goods vehicles in accordance with European vehicle requirements, which means that many cars now have daytime running lights using LED technology. Similar requirements apply to HGV and buses. DRL are fitted to improve the visibility of the vehicle and as such need to be bright enough to ensure that they are visible in the daytime but not so bright that they will dazzle other road users, hence they must not be used at night.

DRL activate automatically when the engine is switched on and remain on unless the headlamps are switched on. As they work independently from the rear lights this means that drivers must switch on their normal headlights in poor visibility (including tunnels) as the rear of the vehicle will remain unlit from behind.

Research has shown that DRL are likely to reduce multiple vehicle daytime accidents and fatalities by up to 6% once all vehicles are equipped[i]. Therefore, if used correctly, DRL should reduce the number of crashes and/or the severity of crashes by enabling drivers, motorcycle riders, pedestrians and cyclists to see oncoming vehicles sooner and react earlier to attempt to avoid a crash, or begin braking sooner and thus reduce the crash severity.[ii] In contrast, a 2008 study by the National Highway Traffic Safety Administration[iii]concluded that DRL offered no statistical significant reduction in the frequency or severity of the collisions studied (frontal and side on crashes between two vehicles nor on vehicle collisions with pedestrians, cyclists and motorcyclists), except for a reduction in light trucks and van involvement in two vehicle crashes by a statistically significant 5.7%

Automated Lights

Automated lights switch on headlights and rear lights in the dark or low light levels (e.g., in a tunnel or multi story car park), but only if the light switch is set in the automatic position.

Adaptive Front Lighting Systems (AFLS)

These direct the headlight beams to the direction of travel, based on the angle of the steering wheel.

Advanced Adaptive Front Lighting Systems (AFLS)

These turn the headlights to boost visibility through bends; some also adjust the light pattern for different road speeds and visibility (e.g., narrower beam on motorways), a wider angle when turning corners (especially at junctions), and Auto High beam that automatically switches high beam lights on and off to improve vision, but avoid dazzling on coming drivers.

Main types of light source

There are two main types of headlight systems used in mass car production: halogen and Xenon, together with the recent introduction of LED lights. Vehicle lights, including replacement lights if the originals fail, must conform to vehicle lighting regulations (see below) be correctly aligned.

Halogen - Each bulb has a thin tungsten filament and a glass filament capsule filled with halogen gas. The gas is routed back to the tungsten filament so it regenerates the filament each time the headlight is turned on and used. A halogen bulb produces a bright, white light and has a lifetime of about 1,000 hours.

Xenon - Xenon headlights, officially known as high-intensity discharge headlamps (HIDs), emit a clean white light. A HID bulb does not have a filament; instead, it uses a xenon gas-charged, sealed system that generates light through an electrical charge that starts an arc between two electrodes. Xenon headlights are regarded as being much more efficient than halogen when it comes to the amount of produced light, although this can be a major issue in relation to dazzle if the angle of illumination isn't properly configured because a xenon bulb is much brighter than a halogen one. A xenon bulb produces 3000 lumens and 90 mcd/m2, while a halogen light generates 1400 lumens and 30 mcd/m2. A xenon bulb should last for about 2000 hours.

LED (Light Emitting Diode) - gives off 'directional' light, meaning they emit light in a specific direction when voltage is applied to it. LED is a popular display and lighting technology that is used in various kinds of electrical and electronic products and is now increasingly used in vehicle lighting systems. Being a semiconductor with no wear-and-tear parts, the bulb has an extremely long life, whilst also requiring less electricity than the traditional halogen bulb. LED provides focused rays and can be manufactured to create different shapes, such as rear brake light clusters.

Lighting Regulations

To ensure that vehicle lighting is fit for purpose, all components must conform to both UK and European regulations. The lighting system fitted to a modern European vehicle must comply with the requirements of the type approval process. Representative vehicles are assessed and vehicle manufacturers are required to ensure that the mass produced vehicles match the specification of the tested vehicle. Compliance with the required standards is verified before a vehicle can be registered in the UK.

The assessment process is witnessed by an independent approval authority who oversee the testing, certification and production conformity in line with regulatory requirements. The authority is appointed by respective Member States and an approval issued by one Authority will be accepted in all the Member States. The Vehicle Certification Agency (VCA) is the designated UK Approval Authority for all type approvals to automotive EC Directives and most UN Regulations.

In terms of vehicle lighting, the individual lamps are assessed as components to ensure that they meet the required colour, intensity and light distribution. Subsequently the installation of the lamps in the vehicle is also assessed to ensure that the component approvals are valid, the required number is fitted in the correct position and that they meet the required angles of visibility.

The vehicle lighting regulations for vehicles sold in Europe are developed at the United Nations in Geneva. The harmonisation of standards in this way allows vehicles to be sold without restrictions and ensure that vehicles are compatible across borders.

The Road Vehicles Lighting Regulations 1989 (Statutory Instrument 1989, No. 1796), as amended[iv] governs the lighting of all vehicles used on the roads of the United Kingdom. New vehicle lighting regulations are due to come into force in May 2018.

Glare and dazzle

In 2016, there were 5 fatal accidents, 69 serious injury accidents and 209 slight injury accidents in which 'dazzling headlights' were assigned a contributory factor of the accident. RoSPA is often contacted by members of the public who are concerned about oncoming vehicle headlights dazzling them. There is obviously a need for drivers to have good forward visibility without dazzling other drivers, riders or pedestrians.

Vehicle lighting technology is advancing rapidly, and there is a need to ensure that road users do not suffer from increased levels of dazzle and glare as an unintended consequences of these developments. The UN's Working Party on Lighting and Light-Signalling is examining the topic of visibility, glare and levelling and is expected to report its findings in 2018.

There have also been a number of research studies and a synthesis of their key findings is available in the Vehicle Lighting Research Review at the Road Safety Observatory.[v]

Higher intensity headlights offer better illumination during night-time driving which potentially could be associated with casualty savings. However, increased light intensity may also be associated with an increase in the ratio of head light luminance to ambient light levels and a possible increase in the likelihood of glare. Glare can detract from optimal observation and hence vulnerable road users and other obstacles could be detected later or not even observed at all.

Bullough[vi] found that it was the luminance of a light source, rather than the type of source, which was the most important issue with levels of glare disability experienced by an observer. HID glare source resulted in consistently lower (more glaring) light than a halogen source of lighting. However, in terms of disability, whilst luminance and viewing angle are important, the effect of lamp type was not significant in their study. This shows that, "even if one might experience greater discomfort in the presence of HID headlamp glare, it is possible that no deterioration of driving performance would be experienced, as long as the glare luminance is controlled."

Glare can cause discomfort or disability. Discomfort glare is described as not impairing to vision; however, it can be startling or distracting to a driver. It can also lead to blinking, squinting and fatigue. On the other hand, disability glare does impair visual performance. The De Boer 9 point lighting rating is a way of measuring the effect of glare on the individual, from unnoticeable to unbearable. Theeuwes[vii] found that car drivers may frequently experience blinding because of glare from oncoming cars when driving at night on a dark road."

Research by Mainster and Timberlak[viii] indicates that older individuals have increased glare sensitivity, and longer photostress recovery time. Therefore, brighter light sources are likely to present greater potential problems associated for older than for younger drivers.

Research[ix] into LED sources show that they contain more relative energy in the short-wavelength region of the visible spectrum and may provide a benefit over halogen and HID lamps. An LED forward lighting system can

result in at least a 150ms decrease in reaction time over tungsten-halogen systems, though the amount of this visual benefit will depend on the spectral density of the LED.

Reaction times to brake lights with neon and LED light sources are shorter than to incandescent bulb lights. Neon and LEDs are generally more efficient at generating light of the appropriate saturated red colour than filtered incandescent lamps.

When considering the pros and cons of HID lamps it is worth remembering that they offer an enormous increase in visibility but this can also result in a comparable increase in glare as identified by Mace.[x]

Headlight adjustment

A fully laden vehicle can affect the angle at which the headlamps shine, the result being that the lights shine in to the eyes of oncoming vehicle or the car in front. In most vehicles, there is an option within the dashboard controls to adjust the angle of the headlight beam. It is also possible to adjust the angle of the beam by making manual adjustments with a screwdriver to move the beam either up or down. However, this should only be carried out by a competent person who is familiar with the procedure.

To check the alignment of headlights, park by a garage door or wall on flat ground and adjust the knob in accordance with the manufacturer's handbook; the height of the beam will change and will give a rough indication of the adjustment made. Remember to re adjust once the heavy load is removed from the vehicle.

Conclusions

There will be very few drivers who have not at times experienced being dazzled by very bright car lights, however, it is likely that this results from either poor levelling alignment, use of main beam or use of illegal equipment.

The subject of vehicle lighting is under review by an informal UNECE working group. However, until its findings are known, the Department for Transport's position is:

"There is no evidence to suggest there is an underlying road safety issue associated with modern vehicle lighting, understandably there may be occasions where due to road geometry the driver of an oncoming vehicle may experience temporary discomfort. Whilst we acknowledge that the downward trend in Police recorded collision statistics has not continued in very recent years, there is absolutely no proven link to the advances in vehicle lighting technology. Some advances have potential to address the basic lighting problem that has vexed headlamp designers for many years: providing good visibility with a minimum of glare when two vehicles meet. Manufacturers are working on adaptive front lighting systems, which automatically adapt the headlamp beam to varying conditions including oncoming traffic, with the aim of providing the optimum compromise between visibility and glare for a given situation". Department for Transport, February 2016.

Illegal use of non-factory fitted equipment

Only Type-Approved lighting systems can be sold legally in the EU under the UN 1965 Vehicle Regulations. It is possible to purchase HID conversion kits, however, it is **NOT** legal to sell or use aftermarket HID lighting kits, for converting conventional Halogen headlamps to HID Xenon. [xi] A person who converts their vehicle to Xenon HID must purchase completely new Xenon HID headlamps. The reason for this is that the existing lens and reflector are designed around a Halogen filament bulb, working to very precise tolerances. If one places a HID "burner" (bulb) in the headlamp, the beam pattern will not be correct, there will be glare in some places and not enough light in other places within the beam pattern.

Illegal use of fog lights

Fog lights should not be used in good visibility; they have not been designed for daytime running. Rule 236 of the Highway Code states that:

- you must not use front or rear fog lights unless visibility is seriously reduced (see rule 226) as they dazzle other road users and can obscure your brake lights. You MUST switch them off when visibility improves.

Rule 226:

- You MUST use headlights when visibility is seriously reduced, generally when you cannot see for more than 100 metres (328 feet). You may also use front or rear fog lights but you MUST switch them off when visibility improves (rule 236)

Technology will undoubtedly minimise the incidence of dazzle with the introduction of Advanced Adaptive Front Lighting Systems, however, in the meantime drivers and cyclists who use high intensity lights MUST ensure that lights are correctly adjusted and they adhere to rule 115 of the Highway Code, which says that a driver should:

- use dipped headlights, or dim-dip if fitted, at night in built-up areas and in dull daytime weather, to ensure that you can be seen
- keep your headlights dipped when overtaking until you are level with the other vehicle and then change to main beam if necessary, unless this would dazzle oncoming road users
- slow down, and if necessary stop, if you are dazzled by oncoming headlights.

References

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