Dangerous, illegal, blue headlight bulbs

What's All The Fuss?

Various companies and individuals are selling halogen headlamp bulbs with blue or purplish-blue glass. There are lots of spurious claims made for these bulbs. They're falsely advertised as "Xenon bulbs" or "HID bulbs", the blue glass is claimed to "force the bulb to perform at a higher level", and there are seemingly endless amounts of pseudoscience aimed at enticing buyers who want better performance from their headlamps. In fact, these bulbs **reduce** headlamp performance while increasing dangerous glare.

How and why are blue bulbs dangerous?

Many of them degrade roadway safety," both yours and other drivers'. Some of them can be physically hazardous. Here are the nuts and bolts of why blue bulbs are a bad idea:

White light is made up of every color of light mixed together. But the colors are not all present in equal amounts. The output spectrum of filament bulbs, including halogen headlamp bulbs, includes a great deal of red, orange, yellow and green light, but very little blue or violet light. Blue bulbs have colored glass (or a filter coating applied to clear glass) that allows only the blue light through the filter — this is why the bulbs appear blue. Because very little blue light is produced by a halogen bulb in the first place, it is only this very small amount — a tiny fraction of the total amount of light produced by a halogen bulb filament — that ever reaches the road.

Blue and violet are the shortest wavelength/highest frequency colors of visible light, and, as such, they scatter the most readily. This is why the sky is blue rather than any other color from the sun's white output spectrum. Blue light doesn't just scatter most readily in the sky, but also in the eye. To observe this effect, try this informal experiment: Next time you see a dark blue storefront sign or a row of blue airport runway landing lights after dark, notice how blurry the edges of the sign or landing light appears compared to adjacent lights or signs of different colors. Decades ago, hot rodders would install "blue dots" in their cars' taillamps. These small bits of blue glass cause the taillamps to appear not red with a blue dot in the center, but rather pinkish-purple, because the observer's eye easily focuses on the red but has trouble with the blue, which remains out of focus and appears to tint the entire area of the red light.

How can there be more glare if there's less light?

Informal tests by the US Department of Transportation's Office of Crash Avoidance Standards found that a standard-wattage 9004-type blue headlamp bulb reduced the road lighting ability of a standard

headlamp by 67%, and increased glare for oncoming and preceeding trafic by 33%. This apparent contradiction arises because of the way the human eye handles light of different colors. The short-wavelength colors (blue, indigo and violet) are very difficult for our eyes to process and focus on.

Compared to uncolored bulbs, Blue headlight bulbs are able to produce more glare with less light because of the difference between the "signal image", which is what an observer sees when looking at an illuminated headlamp, and the "beam pattern", which is the light viewed from behind the headlamp facing forward, as by the driver of a vehicle. In order for headlamp light to be used by the driver, the light must travel forward from the headlamp to an object, bounce off the object and return to the driver's eyes. As light travels through the atmosphere, it spreads and diffuses according to the Inverse Square Law: The intensity drops as $1/(\text{distance})^2$. That is, a given headlamp will illuminate an object 2 feet away with 1/4 of the intensity found at the front face of the headlamp, an object 3 feet away with 1/9 of the source intensity, an object 10 feet away with 1/100 of the source intensity, and so on — and then this loss is redoubled because the light must travel back to the observer's eyes. Remember that the blue filtration prevents the bulk of the light being produced from reaching the road, so the light "stealing" effect of the Inverse Square law becomes greatly magnified: **Less light by which to see.**

On the other hand, light travels directly from the headlamp to the eyes of the oncoming observer, so the "back to the driver's eyes" redoubling of the Inverse Square law does not take place:**More glare.** Therefore, for any given distance between the headlamps and the observer, there'll be considerably more light to cause glare than there'll be to allow the driver to see **More glare.**

Note that some types of "blue" headlamp bulbs are actually legal and not necessarily unsafe; you can read about them here

Does the scattering tendency of blue light affect headlamp performance and road safety in other ways?

Yes, in two ways:

Because blue light scatters very readily in the human eye, casting a beam that's blue-tinted by any amount in a rainy, foggy or snowy environment causes increased perceived backglare for the driver of a car equipped with blue headlamp bulbs.

Also, blue light *per se*creates increased glare for oncoming traffic. That's because blue light does not trigger a strong pupil-closing response in human eyes. It is **yellow** light that stimulates the human eye most strongly to constrict the pupil. Due to the comparatively weak pupil response to blue light, the human eye is very glare-sensitive to a blue signal image. With the yellow light filtered out by the blue bulb and prevented from reaching the observer's eyes, the pupils remain wider open than they should, and the eyes are hit with a blast of difficult-to-process blue light.

Isn't the same amount of blue light reaching the observer's eyes whether or not the bulb is blue?

Although the same amount of blue is emitted by a halogen bulb whether it's got a blue-filter coating or not, in the "no filter" case, the

remainder of the output spectrum—consisting largely of yellow light—triggers a pupil-closing response in the eyes of oncoming traffic, helping to reduce the short and long term effects of headlamp glare. This glare-protection response is severely compromised when the oncoming signal image is blue.

What about real Xenon headlamps that are blue from the factory?

Genuine arc-discharge (also called metal-halide HID) headlamps run with a very purplish-white character similar to an electronic photoflash, because the same technology is at work—an electrical arc jumping through an atmosphere of Xenon gas. But despite the purplish appearance, this light is actually white with a discrete blue component. That is, most of the light from a Xenon headlamp is white, and there is also blue.

The emerging understanding is that there may be not only a split between the glare-sensitive and non-glare-sensitive amongst the populace, but also among those particularly sensitive to blue, violet and/or near-UV light, and those not particularly sensitive to these wavelengths—with these sensitivities NOT necessarily being linked! This helps explain why some find High Intensity Discharge headlamps menacingly painful and consider them hazardous to share the road with, while others consider them no problem at all.

Researchers are currently working on tweaking the output spectrum of automotive HIDs to eliminate the useless-for-seeing spike in the high blue which causes this reaction in blue-sensitive individuals.

The blue signal images from HID and from blue-tinted halogen lamps arise from two wholly separate phenomena, and therefore can't be directly compared. The main thing is to keep in mind that the blue signal image of an HID headlamp is a throwaway byproduct of a light source that also emits a great deal of white light, while the blue signal image of a blue-tinted halogen lamp is the meager blue ouput left when all the rest of the light has been trapped by the filter.

Are these blue bulbs illegal?

US, Canadian, European and Japanese regulations all call for "white" light. There is no one specific light color that is defined as "white" light; rather, there is a large range of output spectra that are considered "white", and the "white" light is permitted to exhibit visible tints of blue, yellow, green, orange or red. Various regulatory bodies are considering narrowing the "white" standard so that it is less permissive of blue tinting. Such has been the spread of blue headlamp bulbs that many police agencies have purchased in-field beam color testers—they use these on headlamps that look too blue to be legally considered "white".

What about blue-tinted headlight bulbs that I found at a local auto parts store, or on the internet? They're sold as being "DOT Approved". Are these legal?

Probably not. There's no such thing as "DOT approved". DOT does not "approve" products as the European regulatory body does. Rather, the manufacturer of an item of motor vehicle equipment is legally obligated to self-certify that his product complies with all applicable regulations. For some items of equipment, such as headlamp bulbs, the

certification takes the form of a "DOT" marking on the bulb base. However, there is no legal obligation for the manufacturer to submit his product for government testing before applying the marking, and many companies go ahead and apply the marking even to bulbs that do not comply with the law. The relevant regulations (US Federal Motor Vehicle Safety Standard 108, Canadian Motor Vehicle Safety Standards 108 and 108.1, and ECE Regulations 8, 20, 37, 98, 99, 112 and 113 all call for "white" light, defined as discussed above, so the statement of DOT compliance itself is false for a bulb that emits a light color obviously different from "white".

Why is there even a market for bulbs like this, if they're so illegal and unsafe?

Many motorists have been confused by marketing claims for the blue bulbs, which falsely and incorrectly equate the blue bulbs' performance with the very expensive arc-discharge ("Xenon") headlamps found on top-line luxury cars. They have been led to believe that by replacing their car's headlamp bulbs with the blue-coated bulbs, their headlamps' performance will be increased. In fact, quite the opposite is true; their headlamps' performance is decreased by the use of blue bulbs.

There is psychology at work in the marketplace, as well. Many of these blue bulbs are sold at very high prices in extremely attractive packaging. It is well known to marketers that the motorist who pays $35 or $45 or even $85 for a set of "special high performance" bulbs will probably perceive a performance improvement even if there is actually none.

Some motorists believe that the blue light makes their car look "cool". This would fall into the same category as the dark plastic headlamp and taillamp covers that are snapped-up by certain drivers for their appearance "enhancement" value, despite the fact that these covers, like the blue bulbs, are illegal and dangerous.

What about bulbs sold as "Xenon" that have clear glass?

Probably no word is used to refer to so many different automotive lighting products as "Xenon", which is an elemental gas. A "Xenon lamp" is a gas-discharge (or High Intensity Discharge)-sourced lamp without a filament. It produces light by maintaining an electrical arc in a highly pressurized environment containing elements—including Xenon&mdashto make the arc emit a great deal of light.

But, Xenon also has a place in lamps with filaments. The addition of a certain proportion of Xenon to the atmosphere in a halogen bulb allows the use of a filament designed to burn hotter, thereby emitting more light, without the rapid burnout of such a filament that would occur without Xenon. But it's not a case of more being better; beyond a certain percentage, Xenon actually reduces the lifespan of the filament.

Halogen headlamp bulbs containing Xenon, in general, are **not** a gimmick or a scam, if they've got clear glass and are produced by a reputable company. All of the newest bulb designs being produced for new headlamps—such as the H7, H9 and H13 bulb size—include Xenon. Results have been good, with the H7 achieving a higher luminous flux (amount of available usable light) from a given wattage than was achievable with halogen bulbs that didn't include Xenon. So after a few years' experience with H7s, the manufacturers have moved to increase the performance of older, traditional bulb types. One of the

techniques used to get such an improvement is to add Xenon to the bulb's atmosphere. There are other valid techniques as well, and not every bulb containing Xenon (or advertised as containing Xenon) is necessarily a performance upgrade.

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