

## Lamp Examination to Determine On or Off in a Collision

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In many traffic accident cases, witnesses or other drivers will claim one of the accident vehicles did not have its lights on during a night time accident. This claim supports a contention that another driver, or pedestrian, could not see the approaching vehicle and take reasonable evasive action.

Many attorneys have heard that vehicle headlights and taillights can be examined to determine if they were on or off at the moment of impact. This is true, but there are limitations. Before deciding to invest in such an investigation, or making a quick attempt to recover this type of evidence risking its inadvertent destruction, a little knowledge of the principles and procedures is useful.

First, and most importantly, the subject vehicle must be available to the examiner in the same condition as it was immediately after the accident. Once repaired, the evidence is lost. The reasoning for this will become clear later on. When the questioned lamps have been properly recovered, the necessary photographs of the vehicle taken and the appropriate testing completed, it is no longer necessary to hold the vehicle relieving one of the cost of vehicle storage.

Do not, under any circumstances, turn on a vehicle's lights after an accident in an attempt to determine if they were functional at the time of the collision. This one act may very well destroy the evidence you are seeking.

The rear-ending of one vehicle by another is a common accident situation. If the struck vehicle is parked, stopped, slowing or backing up, the questions of what, if any, lights were on is immediately raised. When the collision occurs on through roadways, it may be necessary to determine whether or not the hazard lights were operating. Examination of the lights on the rear of the struck vehicle may provide the answers to these questions.



Headlights in late model vehicles are called halogens. They are two part arrangements. The front part, the one you see from the front, is a plastic lens that focuses the light from the lamp behind the lens onto the road. The lamp itself, or light bulb, is quite small and behind the lens.

The lamp can usually be removed without tools but care must be used in handling them. Halogen lamps contain an inert pressurized gas, halogen, that will not support a flame. The lamp becomes extremely hot when lit. Any oils from finger tips left on the glass surface will also become hot and a small explosion is possible should the lamp be energized.

Other than this, halogen lamps are remarkably similar in structure to standard, or incandescent lamps, as found on the rest of the vehicle. The majority of lamps used in vehicle tail lights are incandescent. They are the same as household light bulbs.

The filaments, the tightly coiled wire running between two upright support posts, is made from tungsten, a very hard metal. In most lamps this filament runs straight but may be arched. Even when arched, the coils are evenly spaced, have a bright luster and are tightly formed.

A lamp may have one or two filaments. In two filament lamps, the smaller of the two is for the tail lights and the larger is for brake lights, turn signals or a combination of both. The principle of operation for an incandescent lamp is fairly simple. The filament coil carries an electric current when activated. This current is great enough, for the size of the wire, to raise the temperature of the wire to incandescence (4000 degrees fahrenheit) or white heat. The hot wire then produces light. The same basic effect can be



found with an overloaded extension cord that becomes warm to the touch. Overload the extension cord enough and the insulation will melt and a fire may be started.

At normal environmental temperatures, tungsten does not react with oxygen in the air but oxidizes rapidly when at incandescent temperatures and exposed to the air. In standard lamps, the air is removed and replaced with nitrogen, an inert gas, that will not permit oxidization. When the filament reaches incandescence, the nitrogen gas prevents oxidization and the light continues.

In standard lamps, as opposed to halogen lamps, the pressure inside the bulb is slightly less than the outside air, a partial vacuum.

To determine abnormalities in lamps, first consider the normal lamp. This is a lamp that is essentially in the same condition as when it was manufactured. Certain allowances must be made for the use of the lamp over time and manufacturing defects that do not affect the overall performance of the lamp. This may include a darkening of the glass and sagging of the filament coil.

A normal, functional lamp does not present any signs of having been lit or unlit at the time of the crash. The glass bulb is intact, the filament has a bright luster and tight, evenly spaced coils. It has undarkened glass and a bright, corrosion free base.

This is a close-up photo of the (lower) larger, thicker lamp filament. This filament would produce the light for the brakes and/or turn signal. This is a normal filament, not subjected to an impact. A normally burned out lamp, not subjected to an impact, will have a bright filament, probably broken, melted ball ends on the filament at the parted points and the glass may be darkened.

Normal burn out occurs when tungsten leaves the filament when incandescent by evaporation. This produces pitting to such an extreme that the filament is thinner and weaker in certain places. These narrower spots have greater electrical resistance and current through the filament makes them even hotter. The loss of filament material at these points further increases heating at the weakened points.

When the filament temperature at the narrowest point reaches the melting point of tungsten (6100 degrees), the filament parts at that spot. An electrical arc forms across the gap and the lamp flares up brightly for an instant until the gap widens enough to stop the current flow. The lamp is then burned out. The evidence of this is the rounded or ball ends of the filament.

Halogen lamps behave a bit differently. These lamps operate at much higher temperatures than incandescent lamps and produce much brighter light. The tungsten from the filament evaporates in much the same way as an incandescent. As the inert gas is halogen, the evaporated tungsten moves from the hotter part of the lamp to a cooler area and reattaches to the cooler parts of the filament. In essence, it recycles itself. Over time though, even a halogen lamp will develop weak spots on the filament and normal burn out occurs.

The effect of a crash on a filament is quite different when the filament is incandescent, or hot, and when it is off, or cold. This fact gives two bases for judging whether the lamp was on or off at the moment of impact.

First, if the glass envelope breaks, the filament is exposed to the air. This alone will have no effect on a cold filament. A hot filament will quickly blacken and part as the filament oxidizes. Second, impact forces may sharply fracture a cold, brittle filament but stretch out and uncoil an incandescent one which is quite ductile.



A turn signal filament, that has been turned off and is fully exposed to the air, will retain enough heat to oxidize (at least 1250 degrees) when the filament was incandescent for up to one-half second after the current has been removed.

When a hot filament is exposed to the air, the oxide rises from the filament as white smoke. This white dust is deposited on nearby surfaces leaving signs there was an incandescent filament after the glass broke even if the filament is completely gone.

This oxide smoke is typically found on remaining parts of the glass bulb, stems, supports or on an adjacent filament.

This type of filament failure is the same as an old age burn out except that the filament wastes away instantly rather than days. In old age burn out, metallic tungsten vaporized from the filament is deposited on the glass and darkens it, there is no white smoke oxidization.

A hot filament is ductile and will stretch out, uncoil or tangle and may or may not break. Inertia of the filament during the collision makes this happen. The resulting deformation is called "hot shock." For hot shock to occur, the lamp must have been hot, but not necessarily incandescent, and the glass bulb intact during the collision.

Mild deformations, notably irregular spacing of the coils, may be present on lamps that were hot from being incandescent up to four seconds before impact. The larger and stronger a deformed filament, or the greater the degree of deformation, the stronger the indication the lamp was incandescent at impact.

In a lamp with two filaments, if one is incandescent, the hotter of the two will deform more than the other. If both filaments are more or less equally deformed, then both filaments were probably incandescent. In some instances, the heat from one filament will affect the other, cold filament resulting in mild deformation of the second filament and great deformation of the first.

The absence of hot shock does not mean that a lamp was off. The impact may not have been great enough to stretch the filament. A substantial impulse is needed to give hot impact deformation, however, much less than that required for cold impact elongation or fracture.

How much a filament is distorted in an impact depends on four factors: 1) the severity of the impact; 2) filament age; 3) size of the filament; and 4) temperature of the filament. The impact severity that a lamp receives depends not only on the speed of the vehicle when the crash occurs but also how close to the lamp is to the direct contact area.

Lamps in a substantially collapsed area will nearly always show hot impact distortion if they were on at the time of the collision. If they are near the collapsed area they may show impact distortion, but if a lamp is more than several inches from contact damage it is unlikely to show distortion even if it was incandescent. It is for this reason the vehicle from which lamps are recovered must be in the same condition as immediately after the accident. It is critical for the examiner to know if the questioned lamps were close enough to the contact area to exhibit evidence of deformation.

This is a close-up photo of the (lower) larger, thicker lamp filament. This filament produced the light for the brake signal. The upper, thinner filament would produce the light for the rear running light, or taillight. Notice the extreme deformation of the lower filament compared to the normal filament in the previous picture.

Fused glass particles definitely indicate a filament was incandescent when the glass bulb was broken. Flying particles of glass stopped by an incandescent filament will be fused by the filament's heat and will adhere to it.

Glass particles are more likely to fuse to large filaments than smaller ones. Glass particles can be seen under magnification as glass droplets or a fine dust in the form of filament whiskers.

A fractured filament is a definite indication the filament was cold when broken. The ends of a fractured filament are sharp as compared to the rounded ends of a hot filament subjected to an impact shock. The filament will present a bright luster and no oxidization. A cold fracture, with an intact glass bulb, can only occur if the lamp is subjected to considerable impact shock.

A lamp with a cold fracture could not have been incandescent at the time of a collision either because it was off or it had been subjected to an impact shock before the collision and was not functional when the impact occurred.

The absence of cold fracture does not mean a filament was cold, it may not have been subjected to a strong enough force to cause a fracture. Cold fracture may also occur after a collision when the glass bulb is broken and the filament is exposed to the environment and handling. In this instance, consideration must be given to the other possible indications of whether or not the lamp was on or off at impact, such as oxidization. A lamp subjected to sufficient force to cause a cold fracture may also exhibit signs of mild deformation of the filament coil. If the filament has broken into three parts, and the glass is intact, one part will be found loose in the base of the bulb.

The impact forces required to produce a cold fracture are much greater than those required to produce hot shock. For cold shock to occur, the lamp must have been in, or very close to, the contact damage area.

In general, to produce a significant deformation of a hot filament, a force of 400 to 900 times the acceleration of gravity (400 to 900 g's) is required. This is roughly equivalent to an acceleration from 0 to 20 m.p.h. in one-quarter of an inch. This must not be confused with the impact speeds or acceleration changes for an entire vehicle as found in accident reconstructions. The acceleration forces imparted upon a small area of contact between two vehicles does not necessarily translate into high impact speeds. Even low impact speeds can often be sufficient to result in lamp deformation if the contact damage is near the lamp in question.

During the removal of the lamps, the position of each one must be recorded. Comparison of each lamp position to an exemplar vehicle with the same lighting arrangement can be conducted later to determine the function of each lamp or the wiring schematics from the manufacturer can be consulted.

Removing lamps is often complicated by exposed filaments, which are very fragile or the forced placement of the lamp housing due to contact damage making removal difficult. It may be necessary to remove the entire lamp housing assembly to preserve the evidence. Once a lamp has been removed from the vehicle, it must be handled and stored in a manner so as not to alter the condition of the filaments. Unbroken lamps are quite strong and require little special handling. Broken lamps, with exposed filaments are quite fragile and must be stored with care. Macro-photography of the lamps is recommended to preserve the evidence in the event of deterioration or alteration by handling.

A recent development in taillight design is the use of light emitting diodes, or L.E.D., for center point high stop lights. These lights are visibly different from other types of lights. They are notably clear and appear to have more intense color. Their structure is the same as those found in LED watches and on portable computer screens. At this time, a method to determine the functioning of this type of light during a collision has not been found. Lamp evidence is very often absolute. In a fairly severe crash, there is a greater than 80% chance the evidence can be recovered and a determination made.

These are some of the more common aspects of lamp examination. Several aspects and circumstances have not been addressed at all and none in full detail. It is always best to contact a qualified expert in lamp examination to collect and preserve the evidence and perform the analysis.