## C18 Quantifying Discomfort Glare From a Misaimed Headlamp: A Case Study

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The objective of this presentation is to demonstrate, through the example of a case study, how discomfort glare can be quantified to determine its affect on a nighttime visibility accident situation.

The presentation will impact the forensic science community by providing the attendee with insight into how discomfort glare can be considered in nighttime accident visibility reconstruction.

Bright headlamps on vehicles in an opposing lane are a well known cause of visual glare for drivers at night. The commonly recommended practice for drivers encountering excessive glare from oncoming headlamps is to avert their eyes down and toward the right edge of the road until the glare source is passed. The obvious problem with this practice is that the glare source may be hiding an obstacle or hazard in the lane ahead that the driver needs to know about.

The degree to which a glare source is *discomforting* in the visual field of an approaching driver is related to the De Boer rating, W, which is calculated from:

$$W = 5 - 2\log \frac{E}{0.02\left(1+\sqrt{L/0.04}\right)\theta^{0.46}}$$

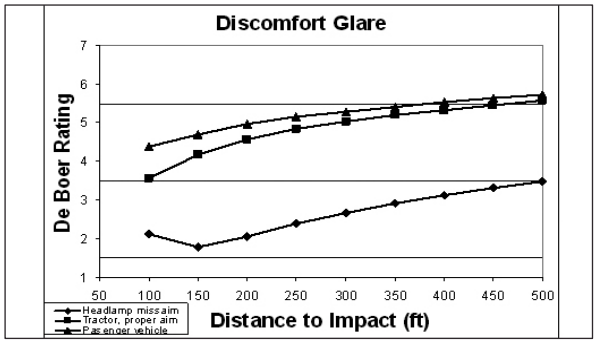
where, $E$ is the illuminance at the eye in Lux, $L$ is the adaptation luminance in cd/m$^2$, and $\theta$ is the angle between the glare source and the line of sight, in degrees [De Boer, 1967]. Glare sources with De Bore ratings of 7 or 6 are considered "satisfactory", 5 or 4 are "just admissible", 3 or 2 are "disturbing", and 1 is "unbearable."

**Subject Case:** The subject case involves a nighttime rear-end collision between an automobile and a stopped silage wagon under nighttime conditions on an unlighted rural two-lane highway. At issue is the ability of the automobile driver to detect and then recognize the stopped wagon as a hazard in his path at a sufficient distance to respond in time to avoid collision. A contributing factor to the visibility aspects of this collision was the presence of a Mack truck, stopped in the opposing lane next to the silage wagon, with its headlamps illuminating in a direction toward the eyes of the approaching automobile driver.

The stopped vehicles were blocking both lanes of traffic; therefore the automobile driver could not have encountered any oncoming vehicle headlamps for at least several minutes prior to encountering the headlamps of the Mack truck stopped alongside the back of the silage wagon. Due to the high mounting height of the truck headlamps and the upward and decreasing grade road geometry on his final approach, the automobile driver's eyes were always in the lower and more intense portion of the Mack's headlamp beam pattern.

During the inspection of the Mack truck it was found that the left (driver's side) headlamp was misaimed in such a way that the highest inten- sity portion of the low-beam intensity profile (the "hot spot") was directed 1.8 degrees to the left of the forward central vertical axis. As a result, the left headlamp of the Mack truck was significantly more intense in the direction of the automobile driver's eyes, as he approached the stopped vehicles, than it would have been had it been aimed properly with it's hot spot slightly to the right of the central vertical axis (in accordance with SAE J599 Standard).

According to output from the event data recorder, the automobile's brakes were engaged at between 1 and 2 seconds before impact. The back of the silage wagon was equipped with a slow-moving vehicle emblem, some reflective tape, and one or two operational flashing lights. The Sheriff's photographs of the crash scene show that some degree of dust reduced the efficiency of the retro-reflective and transmitting surfaces.




The figure above shows the calculated De Boer rating as a function of distance to impact for the condition

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of the subject accident where the opposing glare source is a truck with 4 foot high headlamps with the left (driver's side) headlamp misaimed by 1.8 degrees toward the centerline. For comparison, a similar truck with properly aimed headlamps, and a passenger vehicle with properly aimed headlamps are plotted to show the normally encountered condition of glare for an approaching automobile driver on a flat straight road.

Under conditions of no-glare (had the Mack truck not been there) the back of the wagon should have been sufficiently conspicuous and recogniz- able as a slow-moving (in this case stopped) hazard for the automobile driver to have responded and stopped in time to have avoided collision. Under the conditions that existed for him, as described above with a misaimed left head- lamp, the "disturbing" level of discomfort glare from the stopped truck pre- vented him from detecting and recognizing the stationary silage wagon as a hazard until it was too late for his vehicle to come to a stop in time to avoid collision.

**Reference:**

De Boer, JB. Visual perception in road traffic and the field of vision of the motorist. In JB De Boer (Ed.), *Public lighting*. Eindhoven, the Netherlands: Philips Technical Library, 1967 [cited in numerous sources].

**Glare, Nighttime Visibility, Accident Reconstruction**

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