Nighttime Visibility and Conspicuity

When investigating nighttime collisions, it is critical to determine the distance at which a hazard (e.g., pedestrian, animal, road debris, disabled vehicle, etc.) should have been detected by the striking driver. Establishing the detection distance is critical because a driver cannot reasonably be expected to take evasive action to avoid a collision until they can, at a minimum, detect the presence of the hazard on the roadway.

Visibility vs. Conspicuity

Visibility refers to the ability of the eye to detect an object whereas conspicuity generally refers to the ability of an object to attract an observer's attention. There is not always a clear distinction between visibility and conspicuity, but many of the same factors that affect visibility also affect conspicuity. These include movement, color and color contrast, luminance contrast, object size, and the location of the object in the driver's field of view.

In general, the distance at which a hazard is detectable to a reasonably attentive driver is a function of visibility rather than conspicuity. That is because an object can be conspicuous and not be visible to a driver and an object can be inconspicuous but still be visible to a driver. For example, a bicyclist riding at night while wearing a reflective vest and using a flashing headlight and taillight on their bike would be considered "conspicuous." But, if an approaching driver's view of the bicyclist is obstructed by another vehicle or object, the approaching driver cannot see (i.e., detect) them despite the bicyclist being "conspicuous." Conversely, a pedestrian wearing black clothes and walking on an unlit roadway at night would not be considered "conspicuous." But, the pedestrian will become visible (i.e., detectable) to an approaching driver at some distance. Therefore, the critical factor to address in nighttime visibility investigations is not "was the hazard conspicuous?", but rather "at what distance would the hazard become visible (i.e, detectable) to a reasonably attentive driver?"

Human Factors experts (often referred to as visibility experts or conspicuity experts) have specialized expertise in performing these evaluations, including conducting field investigations of nighttime visibility and calculating visibility level (VL).

Field Investigations

Field investigations of nighttime visibility involve conducting an inspection at the site of the collision for the purpose of observing the distance at which the hazard is detectable under the same lighting, roadway, and environmental conditions as were present at the time of the collision. To obtain equivalent ambient lighting conditions, the inspection must be conducted when the sun is in an equivalent position above or below the horizon. The position of the moon at the time of the inspection is generally of no consequence because the amount of light provided by even a full moon directly overhead is trivial in comparison to the light provided by headlights and other artificial light sources. If the collision occurred on a roadway with artificial light sources such as street lights or lights on nearby buildings, the inspection should be conducted at the collision location so that all ambient light sources that may affect detection distance are adequately accounted for. Exemplar vehicles, surrogate pedestrians, and hazards should be placed in their respective positions on or near the roadway to replicate the roadway conditions at the time of the collision. Lastly, the inspection should be conducted under similar weather conditions. Once the lighting, roadway and environmental conditions have been recreated, investigators then make observations by driving an exemplar vehicle towards the hazard and measuring the distance at which they are first able to detect the hazard in the roadway. Light measurements may be taken at the inspection to validate the investigator's observations.

Adjusting for Expectancy
It is critical to understand, however, that the investigator's observations during the inspection correspond to about the 95th percentile of what would be obtained in a controlled test with multiple trials and multiple participants. Meaning, approximately 95% of drivers under real-world conditions would not detect the hazard until they were closer to it. That is because the investigator knows what the hazard is and where it is located. Therefore, to calculate the distance at which a typical (average) driver would be expected to detect the hazard under real-world conditions, an investigator must approximate the median distance that would be observed under formal test conditions and then reduce that value to correct for expectancy (1).

Visibility Level
Human Factors experts can also evaluate the ability of a driver to readily detect an object at a specified distance under dark conditions by calculating the visibility level (2). Visibility level (VL) is defined as the luminance contrast required at different background luminance levels to achieve visibility under various conditions (3). VL is determined by the object height, viewing distance, ambient lighting conditions, headlight illumination, reflectance of the object and its background, and the age of the driver (4)
If the collision occurred on a roadway with artificial light sources (e.g., street lights), investigators must use light measurements taken during a field investigation to calculate the luminance contrast so that all ambient light sources have been accounted for in the VL calculations. If the collision occurred on an unlit roadway under completely dark conditions, investigators can estimate luminance and reflectivity values using published data on headlamp illumination and the reflectivity of the object and its background (e.g., asphalt, clothing, etc.).

A calculated VL equal to 1 indicates that an object is just barely detectable to an observer. As the visibility level increases, the likelihood that the object will be detected increases. Most reasonably attentive drivers will likely detect an object with a visibility level of at least 6 or 7 (5).

If your case involves a nighttime collision, contact Dr. Nancy Grugle to discuss how visibility and conspicuity may have played a role in the collision.

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