

Evaluation of After-Market Replacement LED Headlight Bulbs

Although most passenger cars use halogen lamps for headlights, an increasing number of vehicle makes and models are using LED vehicle forward lighting. Among the reasons for this design decision are reduced energy usage and increased longevity and durability of LED technologies compared to filament-based halogen lamps. Many drivers also prefer the brighter, “whiter” illumination from LED headlights, compared to that from halogen headlights.

Taking advantage of the growing consumer interest in LED headlights, an increasing number of after-market LED replacement bulbs are currently available. They are designed to have similar socket shapes and sizes as halogen bulbs, in order to fit into the existing housings. Although none of these LED replacement bulbs conform to present federal headlighting regulations, and some are labeled for “off road use” only, others claim to meet current regulations. Regardless, many different LED bulbs can be easily purchased and installed by vehicle owners, who may or may not be aware of their regulatory status.

The LRC purchased nine different LED replacement bulb kits, each designed to replace a conventional



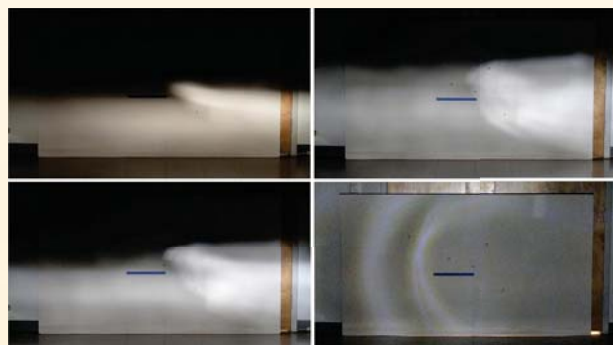
55-W H11 halogen bulb, and tested each in three different low-beam headlight units, two using reflector optics and one using projector optics. Photometric measurements at several critical test points for headlight performance revealed that none of the resulting distributions met all of the test point photometric requirements. Some intensity

values were lower than the allowed minima while others exceeded the allowed maxima.

Photographs of the resulting beam pattern for each combination of LED bulb and headlight unit, when compared to the patterns with the halogen bulb, as shown below, reveal stark differences in performance between the halogen and LED bulbs. The horizontal cut-off pattern typical of low-beam headlights was virtually nonexistent for some combinations, which would drastically increase glare for oncoming drivers. Intensities in the “hot spot” corresponding to locations along the road ahead were often lower, which would result in reduced forward visibility. Even though some bulbs more closely matched halogen performance, performance for different headlights using the same LED bulb could vary widely. These findings suggest that using after-market LEDs to replace halogen bulbs can compromise headlighting performance.



Examples of LED replacement bulbs evaluated



Photographs of the beam patterns from one headlight with the halogen bulb (upper left) and with three different LED replacement bulbs (upper right, lower left, lower right).

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