

are benefits to alternative mirrors with expanded fields of view in situations involving immediately adjacent traffic that was nearby (less than one car length behind the driver) when the driver does turn to view the area. Scientex did, however, find some unanswered questions on the effects of speed and distance judgment. Also, it found a need to better understand of the ability of drivers to adjust to non-planar mirrors, and realize their potential benefits.

Discussion of AM General Petition and General Mirror Issues

While the agency agrees that it seems reasonable to allow the Hummer to be equipped with a convex mirror, we believe that it would be shortsighted only to amend Standard No. 111 in the manner requested by AM General. Amending the standard to allow the one known current vehicle model to utilize one widely-available type of technology would have little effect on the overall safety of motor vehicles five years from now. Rather than only allowing the Hummer to have passenger-side convex mirrors, the agency would like to take this opportunity to also explore amending the standard to allow appropriate new mirror and other rearview technology to be utilized by all vehicles. By amending the standard in this manner, not only will AM General be able to equip its Hummers with what it believes are safer mirrors, but new mirror technology will be able to be incorporated on all passenger vehicles.

Research conducted by the agency and other entities, which is outlined above, has led the agency to believe that allowing non-planar mirrors on the driver and passenger side would provide an increased field of view and, thus, eliminate blind spots. Other countries, mostly in Europe, have successfully utilized new technology such as aspheric mirrors to enhance rearward vision.

However, while allowing the use of new mirror technology may be helpful, we are concerned that some drivers may experience difficulties. As the aforementioned TNO and Scientex studies found, there are issues with non-planar mirrors that need to be addressed. Both studies found that some drivers had difficulty making safe lane change decisions using non-planar mirrors. Scientex has recommended that this area be further studied to determine why these problems occur.

One way to account for the drivers who experience problems with the new technology is to include some level of interchangeability. For example, if a driver purchases a vehicle with an aspheric mirror and then determines

that it is unacceptable, a flat or convex mirror would be available to put in its place. If the driver could not easily replace the problematic mirror, there might be a tendency for him or her to simply live with the problem and perhaps not utilize the mirror. Drivers forced to use mirror systems with which they are not comfortable would obviously not benefit from the improved technology; on the contrary, there would be a disbenefit. Not using a mirror could increase the risk of a crash.

An issue that needs to be resolved is how large the radius of curvature of a mirror must be to be perceived as flat. The agency believes that drivers using convex mirrors with a radius of curvature in the 6,350 mm to 12,700 mm range would experience little to no difference when compared to using one that is flat. Future research in this area could lead to an equivalent flatness specification that would set the minimum radius of curvature at which a mirror provides the same safety benefits as a mirror with an infinite radius of curvature.

As the standard is presently written, an aspheric mirror with a flat area of infinite radius that produced the minimum field of view would be allowed. The outer convex area could be considered a supplemental mirror. However, due to technological limitations, this is not currently possible. As stated above, we understand that the largest attainable radius of curvature for an aspheric mirror is about 12,700 mm. If an equivalent flatness specification was determined, perhaps the advantages of aspheric mirrors could be fully utilized while maintaining a large portion of the mirror for speed and distance judgment.

Regarding the cost of such an amendment, allowing an option to replace a flat mirror with a convex mirror should pose no incremental burden since no regulatory requirement mandating a convex mirror is contemplated.

Another issue the agency has been exploring is that of glare produced in a vehicle's mirrors from a following vehicle's headlamps. In the past few years, consumers have registered many complaints with the agency about high-mounted headlamps on some larger light trucks. The headlamps on these vehicles are mounted high enough to place the more intense part of their low beam on a vehicle's mirrors. These high-mounted headlamps are viewed by many drivers as dangerous and intimidating, in addition to being annoying and disabling.

One approach to this problem is to require enhanced mirrors on vehicles.

Automatic electro-mechanical dimming interior mirrors have been available for decades as standard equipment on luxury models and as an option in many vehicles. More recently, the industry has developed electronically dimming mirrors, typically called photochromic and liquid crystal automatic dimming mirrors. The advantage of these mirrors is that they reduce the intensities of incoming light at least as well as manual or electro-mechanical auto-dimming interior mirrors, but they also reduce glare reflected from the outside mirrors as well. The primary disadvantages are that these mirrors can add \$100 or more to the cost of a new vehicle and they can lessen only the glare from following vehicles. There are questions below which attempt to determine whether there should be requirements for such systems.

Below are a number of questions that deal specifically with AM General's petition as well as with the overall philosophy of amending Standard No. 111 to allow new technology to be utilized. To be considered, you must provide a rationale for your answer.

1. Is it reasonable for the agency to permit vehicles like the Hummer to use passenger-side convex mirrors? What are the safety factors that lead to this conclusion?

2. For use of a passenger-side convex mirror on a vehicle that is heavier than 4,536 kg GVWR like the Hummer, should there be a limit of 508 cm on the length of a vehicle as AM General suggested? Is some other maximum vehicle length more appropriate? Should there be requirements based on vehicle height and/or width? What safety factors are involved in these issues?

3. Should Standard No. 111 be amended to permit aspheric mirrors on the passenger side and/or aspheric and convex mirrors on the driver side? What safety rationale is there for such conclusions? At what vehicle dimensions, if any, (length, width, height, and weight) should these mirrors be restricted?

4. If aspheric mirrors were permitted, should a definition of effective flatness be developed? As discussed above, the flatter area of an aspheric mirror that provides the speed and distance judgment is not perfectly flat, but the radius of curvature is usually large enough such that a driver would perceive the area as being flat.

5. At what radius of curvature does the human eye begin to perceive a mirror as flat? At what radius of curvature do depth and closure rate distortion begin to be a safety factor?