UM-HSRI-79-17

CONSIDERATIONS FOR REARVIEW MIRROR SYSTEMS FOR LARGE TRUCKS

Docket No. 71-3a; Notice 4
Department of Transportation
National Highway Traffic Safety Association

Prepared for:

The International Brotherhood of Teamsters
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Introduction

These comments relate to the Proposed Rulemaking in Docket No. 71-3a; Notice 4, which would amend FMVSS No. 111, "Rearview Mirror Systems." The comments deal particularly with those portions of the Proposed Rulemaking which concern large trucks.

The topics to be considered fall under four general headings:

1. Field of View
2. Weather Effects
3. Alignment and Adjustment
4. Convexity

Field of View

A major visibility problem in large trucks is the existence of substantial blind spots near the vehicle, especially on the passenger side. It is possible for one or more passenger cars or even a small truck to be in these areas and not be visible to the operator. Truckers have long been aware of the problem and many have equipped their vehicles with extra mirrors to try to improve visibility. In a survey reported by Commercial Car Journal (August, 1977) seventeen of 20 recipients of the American Trucking Asssociation (ATA) "Truck Driver of the Year" award reported that they had experienced near misses due to blind spots in mirrors. Lack of a convex mirror was cited by 14 of the drivers as contributing to the near miss. The majority of the drivers indicated that lane change maneuvers accounted for most of the near misses. Sixteen of these experienced drivers (average 30 years experience and 2 million accident-free miles) believe that convex mirrors must be provided on both sides of heavy-duty commercial vehicles. Thus, the government's desire to "insure that blind spots would be limited by increasing mirror field of view" is commendable.

The proposed ground and vertical targets for multipurpose passenger vehicles, trucks, and buses which have the R point 45 inches or more above the ground are specified in Figure 1. Not less the 95% of

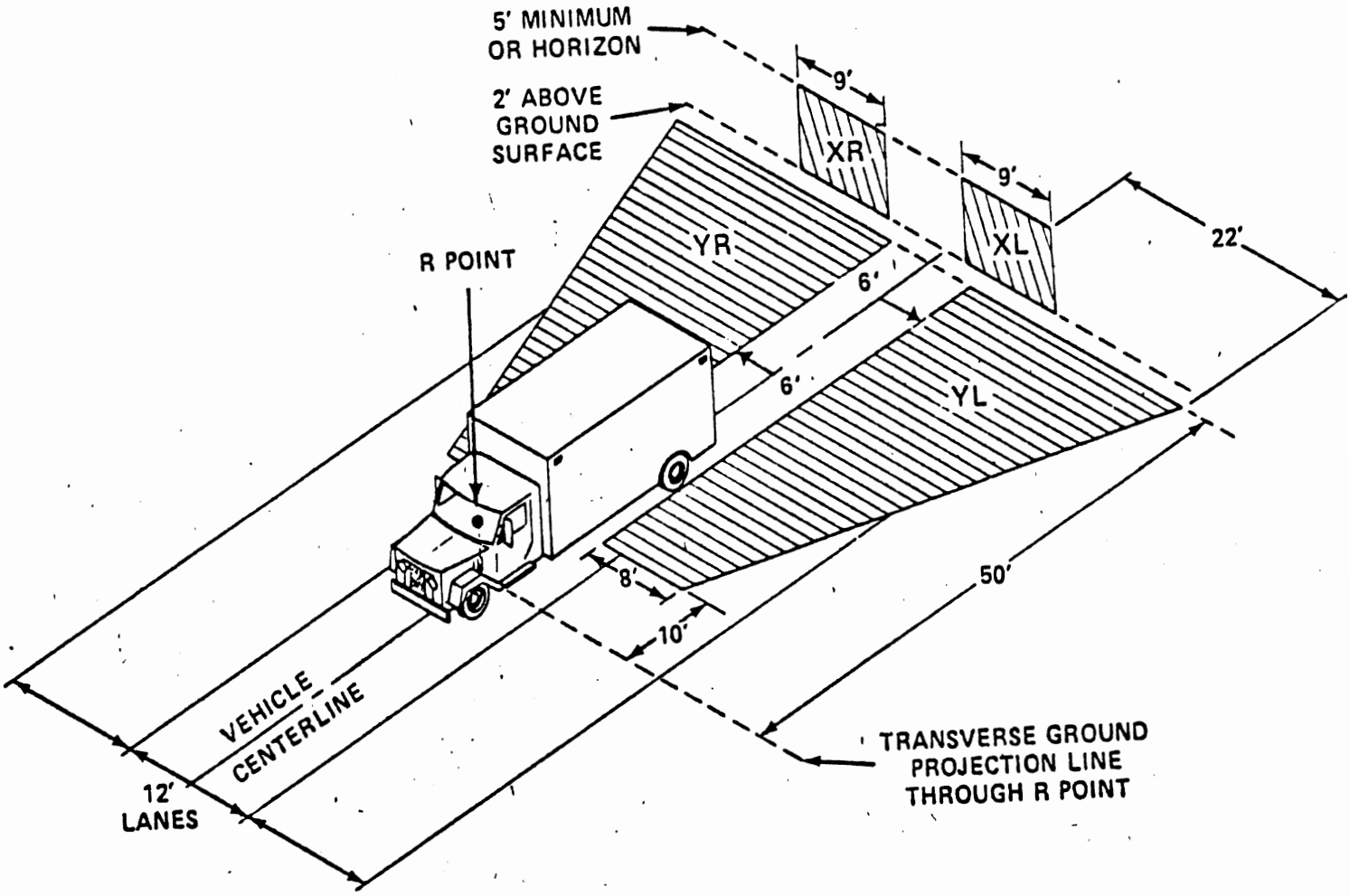

Figure 1. Bus, truck & MPV side & rearward visibility targets. (Taken from Federal Register, Vol. 43, No. 215, Monday, November 6, 1978, page 51675.)

targets YL, YR, and XL and 65% of XR must be viewable from the driver's position when there are no passengers in the vehicle. With all passenger positions occupied, the percentages change to 80% for YL, YR, and XL and 55% for XR.

The blind spot problem exists in the first place because the driving position and the openings through which a truck driver can look are well above the height of a passenger car. Thus, the blind spot extends not just to the rear, but also forward of the driver's position. Its size depends on many factors such as the size of the truck, size and location of window openings, driver eye height, and seat position.

We are concerned that the proposed rule may not address this issue adequately. By only specifying a ten foot distance back of the "R" point for the front boundary of the trapezoidally shaped ground areas YR and YL, the rule allows potentially large blind spots to exist.

Figure 2 is a photograph of a medimum size cab-over tractor. The lower edge of the window (and mirror) on the passenger side is 6' 11" above the ground. For this case the blind spot (assuming adherence to the proposed rules) is approximately defined by the area under the two black lines. This area is large enough to hide a substantial vehicle.

Figure 3 illustrates the problem more specifically. Positioned as shown, the rear roof structure on this large station wagon would have been visible in a mirror adjusted according to the proposed rule. In the brief tests carried out by the authors, a tall (95th percentile seated height) driver could see the end of the hood as well. However, a shorter driver (about 50th percentile seated height) could not see the hood. In any event, at best, only small portions of the vehicle could be seen, in corners of the mirror or windshield. The likelihood that they would be missed by a busy driver glancing in the mirrors is high. It should also be noted that the same make of vehicle, in a sedan model, would have been totally hidden to the shorter driver.

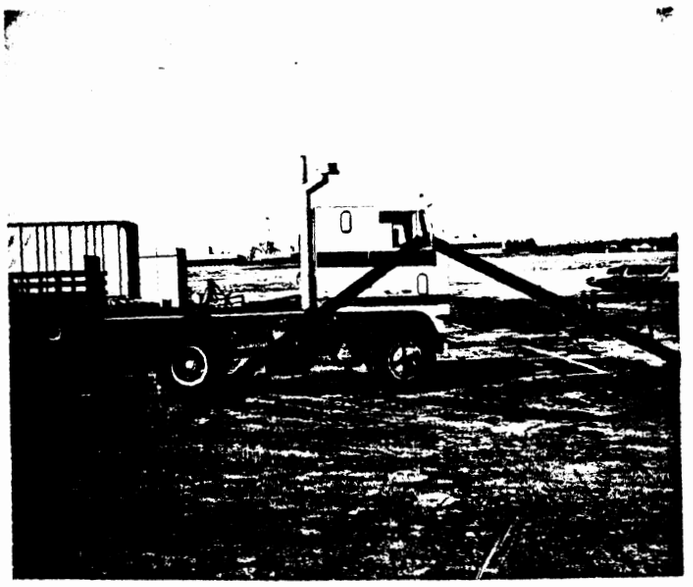

Figure 2. Illustration of the blind spot associated with a particular cab-over tractor assuming conformance to the proposed rulemaking. No object under the heavy black lines in the adjacent lane could be seen by a tall driver.

Figure 3. The large station wagon shown would be almost completely hidden in the blind spot associated with this tractor.

The small station wagon shown in Figure 4 fits the blind spot with about a meter to spare. It would be totally hidden from view even for the tall driver.

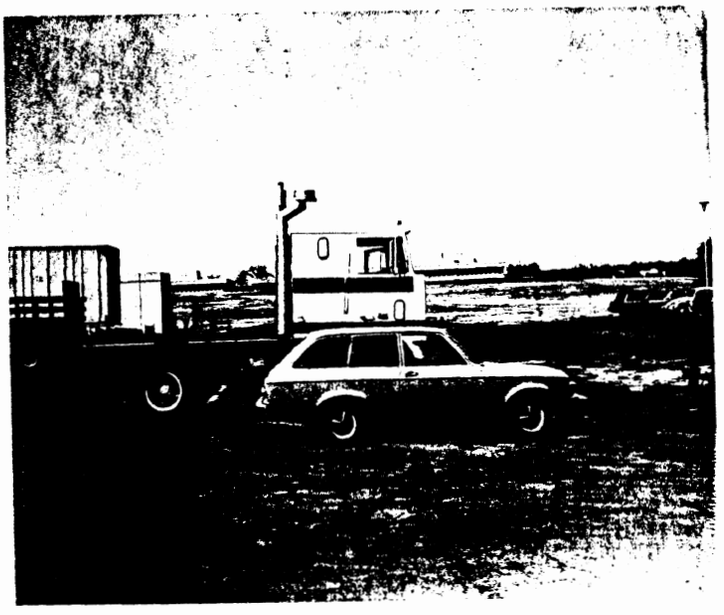

Figure 4. The smaller station wagon shown is completely contained within the blind spot associated with this tractor.

The tractor shown in the photographs was selected solely because it was readily available. Time did not permit a survey of a variety of truck configurations. In general we would expect the blind spot to increase for larger units.

The authors feel that there are practical means for greatly reducing the blind spot on the passenger side of trucks. Thus it should be possible for the government to rewrite the specifications to insure that no car-sized object in an adjacent lane could be outside the driver's field of view.

Low mounted portholes cut through the doors on the passenger side are one possibility. Over one-half of the ATA Drivers of the Year contacted by Commercial Car Journal reported using such a system. All said that this worked well and that they often use a mirror in conjunction with the porthole.

For conventional (engine forward) tractors it may be possible to mount mirrors forward on the passenger side and fill the blind spot. Properly locating convex mirrors on the right side of a cab-over truck can effectively eliminate the right side blind spot according to Commercial Car Journal (August 1977). They show photographs of a small, approximately rectangular convex mirror mounted on the top of the right door frame and visible at the top of the right hand window which is in use on vehicles manufactured by Mack Trucks, Inc. Another method illustrated in the same article involves locating a convex mirror on a long arm such that the mirror is mounted ahead of the plane mirrors and can be seen through the wiper-cleared lower right portion of the windshield; this system is in use on trucks operated by Wycoff Co., Inc.

Weather Effects

If standards are established to provide improved vision to truck drivers, it is important that consideration be given to maintaining the improvement as much as possible under all weather conditions. Frosting or icing of mirrors is a significant problem in northern climates. This may not be so serious for mirrors mounted on the driver's side, which can be reached and scraped easily, but can be quite serious for passenger side mirrors, especially if driving conditions cause the problems to recur often. Over one-half of the ATA drivers in the survey described earlier reported that they had experienced near misses due to iced or fogged mirrors. Five of the drivers had used heated mirrors and found them beneficial. Heated mirrors have been in use for some time by fleets such as the following: Pacific Intermountain Express, IML Freight, Delta Lines, Sears Roebuck and Burlington Industries. Heated mirrors, or some other system for insuring a clear view

under adverse weather conditions seems desirable, especially for vehicles which will be operated in northern climates.

Alignment and Adjustment

Alignment of mirrors is critical to being able to obtain and retain the correct field-of-view. The American Trucking Association manual states "Proper adjustment (of mirrors) is essential in safe driving and must be checked at the start of each trip along with the tightness of brackets." Furthermore, a NHTSA funded study entitled "Studies in Motor Vehicle Rear Vision..." which was conducted by Dunlap and Associates (1974) states that:

> "One design problem of truck rear vision systems became particularly clear during alignment of the large mirrors. Aligning the plane and convex mirror properly requires a very time consuming and meticulous process. Should such systems become misaligned on the road, no method exists by which a lone driver may realign them properly."

Given the problem of alignment and realignment, care should be taken to provide that once mirrors are adjusted the alignment should be retained during vehicle use. In the proposed revision of FMVSS 111 portions dealing with locations of mirrors in zone II, which includes the front right side of a vehicle, differ significantly for passenger cars and multipurpose passenger vehicles, trucks, and buses. S5.3.1.6(b) requires either (1) be adjustable from the driver seated position..., or (2) provide an indirect field of view of not less than 95% of the area of target SR..., or (3) have a locking mechanism that holds the image display in position after adjustment by the driver. The basic requirement for target SR is that not less than 75% of it be viewable (S5.1.1.1(c)). Thus, this provision requies a greater view of SR if the passenger side mirror is neither adjustable from the driver's position nor lockable.

Since truck manufacturers have the option of conforming to the requirements of S5.3.1 for passenger cars or to the requirements of S5.3.2.1 through S5.3.2.6, many trucks may be produced with passenger side mirrors that do not have either an extended view of target SR or

adjustment or locking features. It is not clear why manufacturers of trucks should not be required to meet provisions such as S5.3.1.6(b). Since the problem of passenger side mirror adjustment is greater in larger vehicles, this appears to be a significant omission.

Convexity

NHTSA proposes to allow 40-60 inch convexities on passenger cars via S5.1.1.1(c). The NHTSA states that:

> "To keep the range of convexities (the curvature of convex mirrors) to a minimum so as to not confuse people when they switch vehicles, the NHTSA proposes that the passenger side viewing requirements for cars and small trucks may be met by using convex mirrors with an average radius of curvature of not less than 40 and not more than 60 inches. Wider convexities (20 to 60 inches) would be permitted on multi-purpose passenger vehicles, large trucks, buses..." (underlining added, FR 51659).

However, S5.1.2 allows small trucks with R-points of less than 45 inches above the ground the option of conforming to S5.1.2.1 or S.5.1.2.2. S5.1.2.1 specifies 40-60 inch convexity in subsection 1(c) while S5.1.2.2 specifies 20-60 inch convexity in subsections 1(a) and (b). Thus, small trucks are not restricted to "convex mirrors with an average radius of curvature of not less than 40 and not more than 60 inches." This should be considered since "Small trucks,... have approximately the same visibility requirements and driving pattern as passenger cars" (FR 51659).

Large trucks with R-points of 45 inches or more above the ground must conform to S5.1.2.2 and are thus allowed a convexity range of 20-60 inches. As stated in the docket:

> "Wider convexities (20 to 60 inches) would be permitted on multipurpose passenger vehicles, large trucks, buses, and motorcycles because drivers of these vehicles have been using convex mirrors with a wider range of radii for years and they are used to this wider range. Many commercial vehicle drivers currently use convex mirrors with an average radius of curvature of 20 to 30 inches. The number of truck and multipurpose vehicle configurations is substantially greater than the number of automobile configurations,

consequently, a greater number of mirror configurations is desirable. In addition, many trucks also have both plain (sic) and convex mirrors whereas cars generally use plane mirrors alone" (FR 51659).

The fact that "many commercial vehicle drivers currently use convex mirrors with an average radius of curvature of 20 to 30 inches, does not necessarily imply that they should be used, or that they are safe, or that better alternatives are not available. Of 13 members of the American Trucking Association's Equipment Safety Committee that were polled by Commercial Car Journal (August 1977), only one thought that the small, round stick-on convex mirror was satisfactory. While it is unclear why the other 12 members thought that such a mirror was unsatisfactory, it is likely that image minification, and/or mirror size were contributing factors. Many of these committee members and most of the 20 experienced drivers questioned reported that they preferred bigger hang-on convex mirrors. Their preference may, in part, have been influenced by the fact that the larger convex mirrors generally have a larger radius of curvature, and thus less image minification. Therefore, the boundary of the radius of curvature of convex mirrors should be chosen carefully. A value greater than 20 inches of radius of curvature may be warranted to minimize problems of distortion and image minification. These problems are especially critical to older drivers who may have trouble accommodating to the near distance required by mirrors with short radii of curvature (Seeser, 1974).

Because of distortion and image minification associated with mirrors with small radii of curvature, Liberty Mutual in their Data Sheet No. 77 recommends that convex mirrors on trucks be used "only for near viewing." They recommend restricting convex mirrors to 20-30 inch radius of curvature to provide "just enough overlap to make sure that an object is not lost from sight as it passes from the field of view of one mirror to the other. Thus it avoids over-duplication and confusion which greater overlap produces;" Liberty

Mutual further states that "The most important factor of adjusting the mirrors in any system using a convex mirror is to limit the field of view of the convex mirror to the area where the plane mirror view is inadequate." The present authors feel this is an important point. Convex mirrors should be used as a convenient way of eliminating blind spots. Thus, they provide simple detection information and the problems associated with distance judgments etc. are eliminated, since any object detectable in the convex mirror is close enough to the truck that it should elicit a "no lane change is possible" response. Distance judgments will only have to be made when the adjacent vehicle is far enough back to be visible in the plane mirror.