SURFACE VEHICLE INFORMATION REPORT

J985™ MAR2024

Issued 1967-04
Revised 1995-06
Reaffirmed 2024-03

Superseding J985 NOV2016

Vision Factors Considerations in Rearview Mirror Design

RATIONALE

SAE J985 has been reaffirmed to comply with the SAE Five-Year Review policy.

1. ***Scope***—The design and location of rear-viewing mirrors or systems, and the presentation of the rear view to the driver can best be achieved if the designer and the engineer have adequate references available on the physiological functions of head and eye movements and on the perceptual capabilities of the human visual system. The following information and charts are provided for this purpose. For more complete information of the relationship of vision to forward vision, see SAE SP-279.

2. ***References***

2.1 **Applicable Publications**—The following publications form a part of this specification to the extent specified herein.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE Paper 650464—Automobile Driver Eye Position, Meldrum, James F., SAE Transactions, Vol. 74, (1966)
SAE SP-279—Visual Considerations: Man, the Vehicle, and the Highway, Schmidt, I., and Connolly, Paul L., SAE, March, 1966

2.2 **Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.

Bioastronautics Data Book, Scientific and Technical Information Division, National Aeronautics and Space Administration (Washington, DC, NASA SP-3006), 1964

Design Aspects for Rear Vision in Motor Vehicles, SP-253, SAE, March 1964

The Measure of Man, Dreyfuss, Henry, New York: Whitney Library of Design, 1959

Handbook of Human Engineering Data, Tufts College Institute for Applied Experimental Psychology, Special Devices Center, Office of Nava Research, Project Design, NR 78-3001, 1951

Human Engineering Guide to Equipment Design, Morgan, C.T., Cook, J.S., et al., New York: McGraw-Hill, Inc., 1963

Human Engineering Guide for Equipment Designers, Woodson, W.E., Berkeley: University of California Press, 1960

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J985_202403/

3. Vision Considerations in Rearview Mirror Design

3.1 Introduction—The design and location of rearview mirrors to provide adequate driver rear vision can best be performed when a basic knowledge of the physiological and perceptual capabilities of the driver's visual system are understood.

3.2 Driver's Field of View—The field of view for each eye of the driver extends in a horizontal plane 150 degrees (90 degrees outside and 60 degrees inside from the forward line of sight.) It is assumed that the forward line of sight is directly in line with the longitudinal axis of the vehicle. It can be seen from (see Figure 1) that the fields of view (left eye plus right eye) overlap 120 degrees, thus defining a binocular field of view. The vertical boundary to the binocular field of view is approximately 50 to 55 degrees above and 60 to 70 degrees below the forward line of sight (see Figure 2).

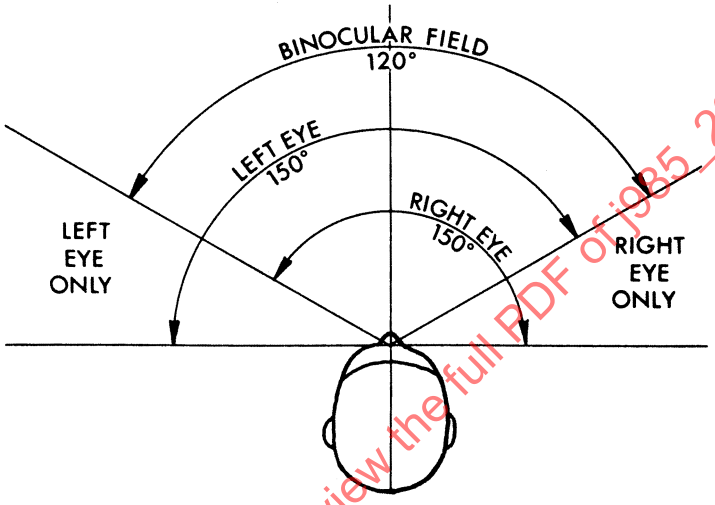

FIGURE 1—HORIZONTAL EXTENT OF THE BINOCULAR VISUAL FIELD

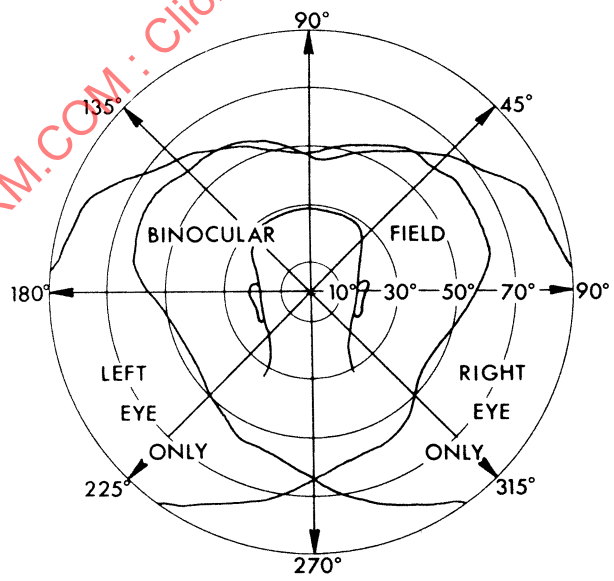

FIGURE 2—BINOCULAR VISUAL FIELD WITH HEAD AND EYES FIXED

3.3 Visual Fields with Head and Eye Movement—In the design and engineering of rearview mirrors and mirror systems, every effort should be made to allow the driver to maintain visual attention to the front of the vehicle. Distracting the driver's attention from viewing the road ahead should be kept to a minimum. Eye and head movement are two factors affected by the placement of rearview mirrors and must be considered (see Figures 3 and 4).

Horizontal eye rotation is optimal at 15 degrees to left and right of the forward line of sight; however, the eyes can turn 30 degrees in one rapid, smooth movement.[1] Vertical eye rotation is optimal at 15 degrees up and down from the forward line of sight, while maximum eye rotation is 45 degrees upward and 65 degrees downward.

Easy horizontal head movement is considered 45 degrees to the left and right of the forward line of sight, while maximum is 50 degrees up and down.

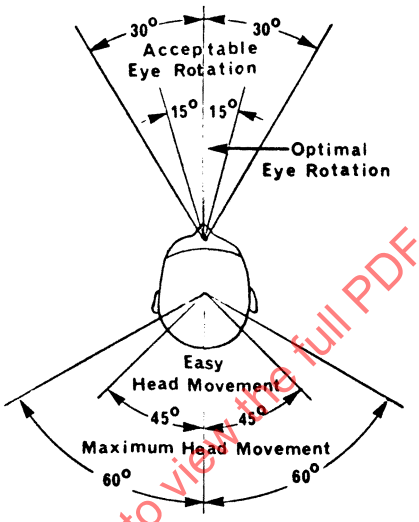

FIGURE 3—HORIZONTAL EXTENT OF HEAD AND EYE MOVEMENT

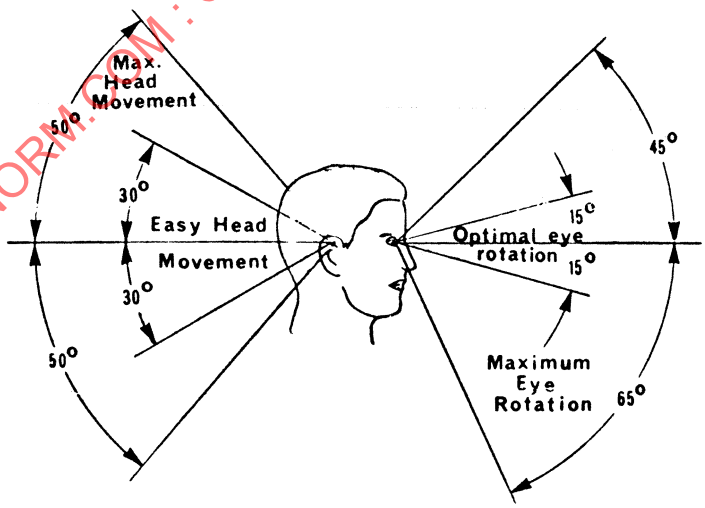

FIGURE 4—VERTICAL EXTENT OF HEAD AND EYE MOVEMENT

1. The human eye does not rotate around a single point. Thus, upon temporal (outward) gaze, the eye moves rearward approximately 0.5 mm and in nasal (inward) gaze, the eye moves forward approximately 0.6 mm.

To reduce driver fatigue and improve visual efficiency, the entire rear vision mirror is best located within the driver's binocular field of view while looking straight ahead. This area extends horizontally 60 degrees to the left and right of the forward line of sight (45 degrees easy head movement plus 15 degrees optimal eye rotation). Vertically, this area extends 45 degrees up and down from the forward line of sight (30 degrees easy head movement plus 15 degrees optimal eye rotation). If necessary, the horizontal limit of head and eye movement may be extended to 75 degrees left and right of the forward line of sight to view a mirror (45 degrees easy head movement and 30 degrees eye rotation). A driver can combine head and eye movement that exceeds the previous limits, but should not be required to do so repeatedly or for long periods of time.

3.4 Perceptual Characteristics of the Eyes—The ability of the eye to perceive detail, form, color, and motion is highest in the area immediately surrounding the forward line of sight. Visual perception reduces as distance from the forward line of sight increases.

The perception of traffic events to the rear is reduced when a mirror is placed away from the forward line of sight. Beyond a given area, a rearview mirror may cease to stimulate the driver's visual system sufficiently to alert the presence of traffic activity to the rear. The farther a mirror is placed away from the forward line of sight, driver perception is reduced from forward traffic events while looking into the rearview mirror.

3.5 Enhancement of Visual Perception—When rear vision mirrors are placed within the driver's binocular field of view (as opposed to outside the binocular field of view), the retina of each eye is stimulated to produce a stronger image to the rear so that: (a) motion perception is increased and (b) reduced reaction time for driver head and eye movement.

Rearview mirrors provide better visual perception when the width allows a driver to view images with both eyes simultaneously. This means the effective aperture (opening or width) of the mirror must be wide enough to allow the line of sight for each eye to view the mirror. Interpupillary distance is the distance between the lines of sight for each eye and is approximately 65 mm. It is desirable that the mirror should be wide enough to allow binocular viewing with reasonable changes in the lateral positioning of the driver's eyes.

The vertical dimension of a rearview mirror or system should adequately provide for changes in the vertical positioning of the driver's eyes. An insufficient vertical mirror dimension can restrict a driver's “eye freedom” and often a physical eye or head adjustment must be made to use the mirror.

3.6 Adjustability of Mirrors—The variation and position in driver eye positions can be ascertained from SAE Paper 650464. However, once a driver has adjusted the mirror, the eye positions may change considerably throughout the duration of a single trip. The vertical dimension is most critical. It must allow the driver's eyes to move up or down without having the line of sight encroach upon the upper or lower edge of the mirror. The driver should not be required to make unnecessary physical or psychological adjustments in order to use the mirror once it is adjusted.

3.7 Illumination and Visual Perception

3.7.1 TWILIGHT AND DAWN—When illumination falls to levels experienced at twilight and dawn, visual perception suffers. Contrast of vehicles and objects on the highway is greatly reduced. Contrast approaches zero (no contrast) shortly before dark. For best visual perception of rear traffic events during low sunlight hours, a rearview mirror should have as high (bright) of a reflection as possible to provide the driver with a rear view that is close to the brightness of the front view. A rearview mirror that provides a lower light transmittance (for the rear environment) than the front environment provides can cause difficulty for the eyes to adjust to the contrast, increasing viewing time into the mirror—a condition to be avoided. A 60-year-old driver may require three times more light to see than a 20-year-old driver.