

(R) Describing and Measuring the Driver's Field of View

TABLE OF CONTENTS

1	Scope	2
2	References	2
2.1	Applicable Publications	2
3.	Definitions.....	2
4.	Measuring Direct Field of View	5
4.1	Direct Field for an Individual Driver	5
4.2	Direct Field for a Group of Drivers.....	7
4.3	Method for Approximating Direct field of View Through Windows.....	10
5	Measuring Indirect Field of View	10
5.1	Field of View for an Individual Driver	10
5.2	Field of View for a Group of Drivers	11
5.3	Field of View Using Neck Pivot Points Defined in SAE J941	12
6	Obstructions	12
6.1	Obstruction in Direct Field as Seen by an Individual Driver	12
6.2	Obstructions in the Direct Field as Seen by a Group of Drivers	13
6.3	Determining the Areas on the Display and Control Surfaces Which are not Obstructed	14
6.4	Obstructions in the Indirect Field.....	14
	Appendix A Developing V and P Points.....	15
	Appendix B Approximating the Indirect Field of View Using "P" Points Defined in SAE J941	17
	Appendix C Approximating the Obstruction Angle from A-Pillars	18
	Appendix D Approximating the Visible Areas on Control and Display Surfaces	19

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1. Scope—This SAE Recommended Practice establishes methods for describing and measuring the driver's field of view. The document describes three methods for measuring the direct and indirect fields of view and the extent of obstructions within those fields. The first method uses any single pair of eye points to determine the fields or obstructions that would be seen by an individual driver. The second method uses the SAE Eyellipses defined in SAE J941 to determine the largest fields or obstructions that would be seen for a given percentage of the driving population. The third method uses specific eye points defined in SAE J941 to measure the extent of a specific field of view or obstruction for which those points were developed.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

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

SAE J264—Vision Glossary

SAE J941—Motor Vehicle Drivers' Eye Locations

SAE J985—Vision Factors Considerations in Rear View Mirror Design

3. Definitions

3.1 Vision Origin Points

3.1.1 EYE POINT (E POINT) (FIGURE 1)—Point representing the location of the eye and from which sight lines may originate. The left and right eye points are 65.0 mm apart.

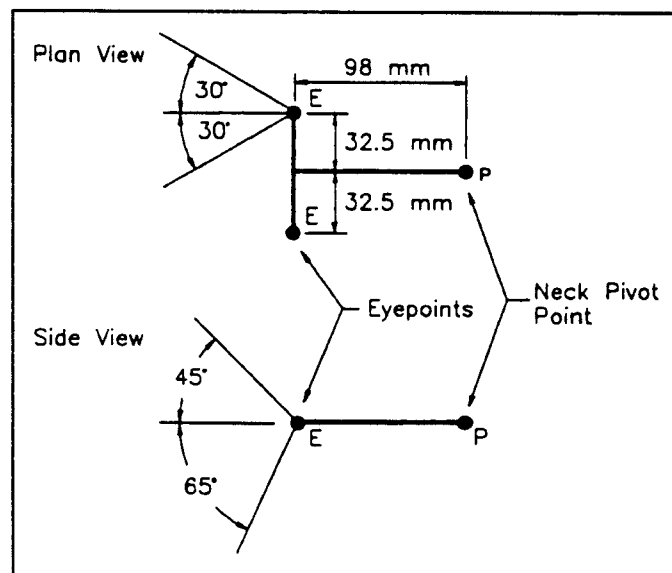


FIGURE 1—EYES MAY ROTATE ABOUT THE EYE POINTS (E POINTS) A MAXIMUM OF 30 DEGREES LEFT AND RIGHT, 45 DEGREES UP AND 65 DEGREES DOWN

- 3.1.2 **NECK PIVOT POINT (P POINT) (FIGURE 1)**—A point about which the driver's head turns on a horizontal plane. It is located 98 mm rearward and midway between the left and right eye points. (Appendix A)
- 3.1.3 **VISION POINT (V POINT)**—A point developed and used for defining and measuring specific direct field of view requirements. (Appendix A)
- 3.2 **Sight Line**—A line representing the driver's line of sight from an eye point or a V Point to a target point or at a given angle.
- 3.3 **Eye Rotation**
- 3.3.1 **MAXIMUM EYE ROTATION (FIGURE 1)**—The eye may rotate a maximum of 30 degrees left, 30 degrees right, 45 degrees up, and 65 degrees down from straight ahead.
- 3.3.2 **EASY EYE ROTATION**—The eye may rotate easily 15 degrees left, 15 degrees right, 15 degrees up, and 15 degrees down from straight ahead.
- 3.4 **Head Turn**
- 3.4.1 **MAXIMUM HEAD TURN (FIGURE 2)**—The driver's head may turn about a vertical axis a maximum of 60 degrees to the left or to the right from the straight ahead position.

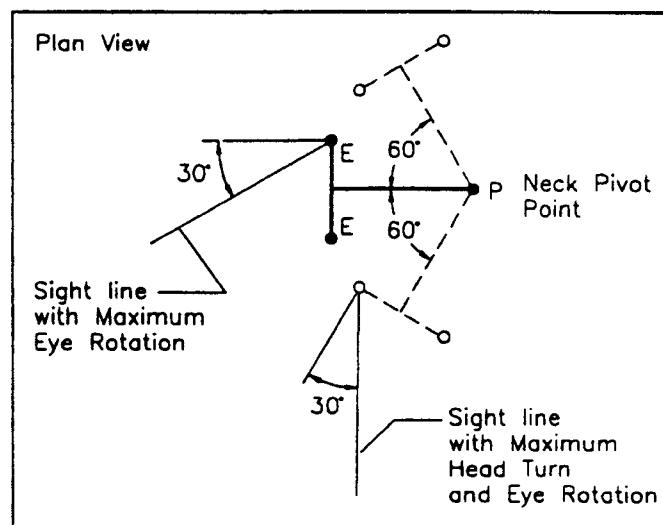


FIGURE 2—THE SIGHT LINES AND EYE POINTS (E POINTS) MAY ROTATE ABOUT THE NECK PIVOT POINT (P POINT) A MAXIMUM OF 60 DEGREES LEFT OR RIGHT

- 3.4.2 **EASY HEAD TURN**—The driver's head may easily turn about a vertical axis 45 degrees to the left or to the right from the straight ahead position.

3.5 Indirect Vision Device—Any device used by a driver to view a field. Examples are mirrors and video systems.

3.6 Field of View—The solid angle defined by sight lines originating from one or more eye points.

3.6.1 DIRECT FIELD OF VIEW—The field of view seen without the aid of any devices.

3.6.2 INDIRECT FIELD OF VIEW—The field of view seen with the use of devices.

3.6.3 MONOCULAR FIELD OF VIEW (FIGURE 3)—The field of view that can be seen by one eye.

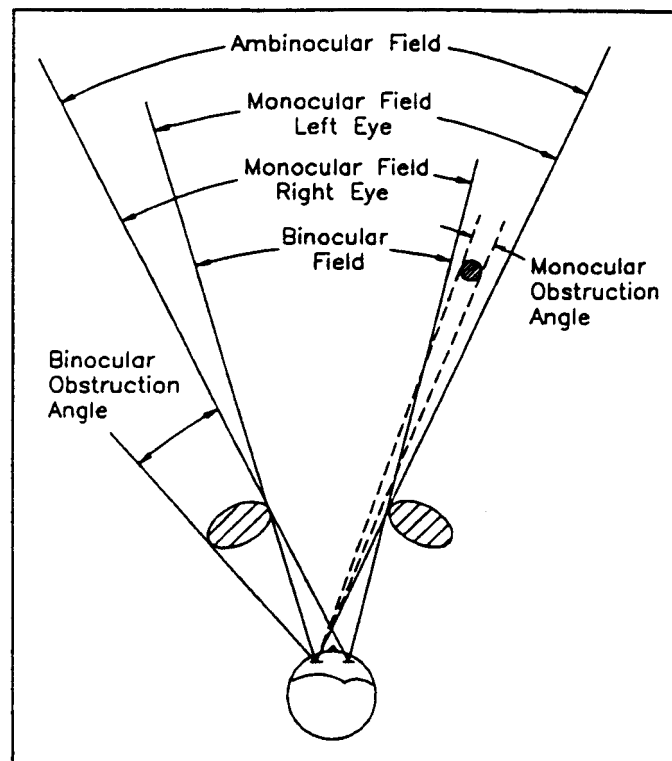


FIGURE 3—DIRECT HORIZONTAL FIELD OF VIEW. THE BINOCULAR OBSTRUCTION IS SEEN BY BOTH EYES. THE MONOCULAR OBSTRUCTION IS SEEN ONLY BY THE LEFT EYE.

3.6.4 BINOCULAR FIELD OF VIEW (FIGURE 3)—The field of view that can be seen by both eyes simultaneously.

3.6.5 AMBINOCULAR FIELD OF VIEW (FIGURE 3)—The total field of view that can be seen by both eyes separately. This includes the binocular field as well as the monocular field visible to the right eye but not the left eye and vice versa.

3.6.6 RANGE OF FIELD OF VIEW (FIGURE 4)—The sum of the angular fields of view to the right and left (or up and down) which can be seen by an individual driver or by the percent of drivers specified by an Eyellipse which is used. Although the same percent of drivers will see the field to the left and the field to the right (or up and down), not all the same drivers will be included in both groups.

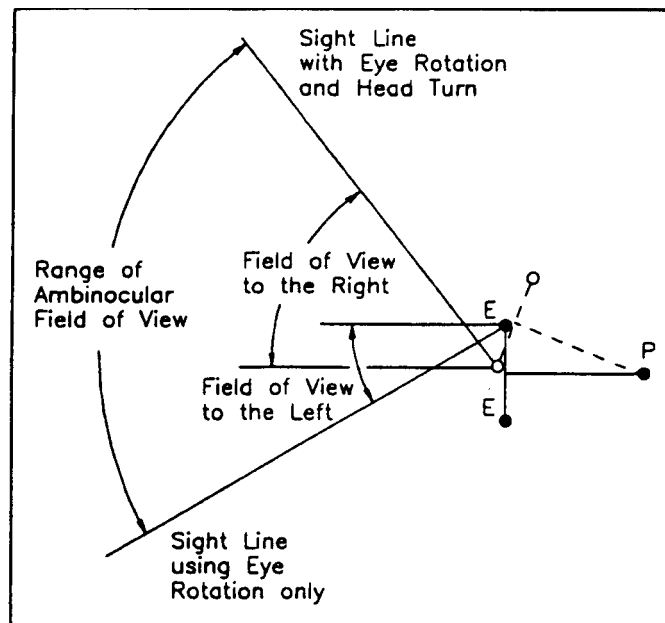


FIGURE 4—RANGE OF DIRECT AMBINOCULAR FIELD OF VIEW IS THE SUM OF THE FIELD TO THE LEFT AND THAT TO THE RIGHT

3.6.7 PERIPHERAL FIELD OF VIEW—The field of view that extends a maximum of 90 degrees in the temporal direction.

3.7 Obstruction

3.7.1 BINOCULAR OBSTRUCTION (FIGURE 3)—Any object within the binocular view which creates an area behind it which cannot be seen simultaneously by the left and right eyes.

3.7.2 MONOCULAR OBSTRUCTION (FIGURE 3)—Any object visible to only one eye which creates an area behind it which cannot be seen by that eye.

4. **Measuring Direct Field of View**—The direct field of view is measured using ambinocular vision, so any point or angle is deemed visible if at least one of the eyes can see it. Therefore, when measuring an angular field limited by an aperture (e.g., through a window), the largest angular field at any point along the aperture is that seen by the eye point farthest from the point on the aperture. The largest field to the left is found using the right eye point and the largest field to the right is found using the left eye point.

When determining whether a specific point or angle can be seen within a field that is not limited by an aperture, the eye point closest to the point or angle will view the point or angle with the smallest head turn and/or eye rotation. Therefore, the right eye point should be used to view a point to the right and the left eye point used to view a point to the left.

4.1 **Direct Field for an Individual Driver**—If the following procedure is performed for points at the left and right limits of the field, the horizontal angle between the two sight lines is the driver's direct ambinocular field of view. The field may be limited by an aperture or by the limits of eye rotation. Likewise, the vertical field of view may be found using the top and bottom field limits.

- 4.1.1 SELECT THE EYE POINT—If the field is limited by an aperture, use the eye point farther from the point on the aperture under consideration. (Figure 5)

If the field is not limited by an aperture, use the eye point closer to the point or angle to be viewed. (Figure 6)

- 4.1.2 ROTATE THE SIGHT LINE ABOUT THE EYE POINT (FIGURES 5 AND 6)—Rotate the sight line about the eye point until it reaches the specified point or angle but not farther than allowed by maximum horizontal and vertical eye rotation. If the sight line does not reach the point or angle, then it is not visible with eye rotation only.

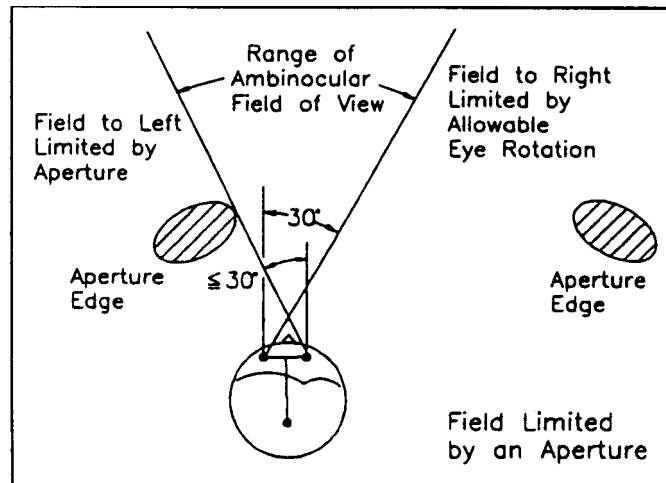


FIGURE 5—RANGE OF HORIZONTAL AMBINOCULAR FIELD OF VIEW FOR AN INDIVIDUAL DRIVER WITH EYE ROTATION ONLY. IN THIS EXAMPLE, THE FIELD TO THE LEFT IS LIMITED BY THE APERTURE AND THE FIELD TO THE RIGHT IS LIMITED BY ALLOWABLE EYE ROTATION.

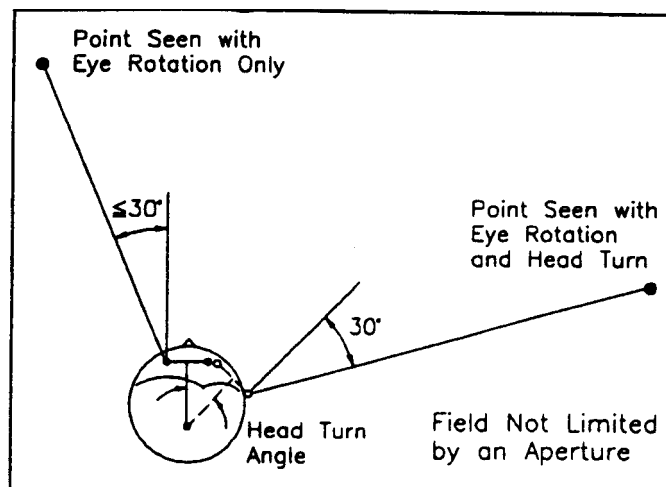


FIGURE 6—INDIVIDUAL DRIVER VIEWING POINTS WITHIN A FIELD WHICH IS NOT LIMITED BY AN APERTURE. IN THIS EXAMPLE, THE POINT ON THE LEFT IS SEEN WITH EYE ROTATION ONLY AND THAT ON THE RIGHT IS SEEN USING EYE ROTATION AND HEAD TURN.

- 4.1.3 **FIELD OF VIEW WITH EYE ROTATION ONLY**—The field of view with eye rotation only is defined using the horizontal and vertical angles of the sight line from 4.1.2 or the point where the sight line intersects a target.
- 4.1.4 **ROTATE THE SIGHT LINE ABOUT THE NECK PIVOT POINT (FIGURES 6 AND 7)**—If the sight line from 4.1.2 does not pass through the specified point or does not reach the specified angle, then rotate it about the neck pivot point until it either reaches the point or angle or reaches maximum head turn. If the sight line does not reach the point or angle, then it is not visible within the limits of maximum eye rotation and head turn.

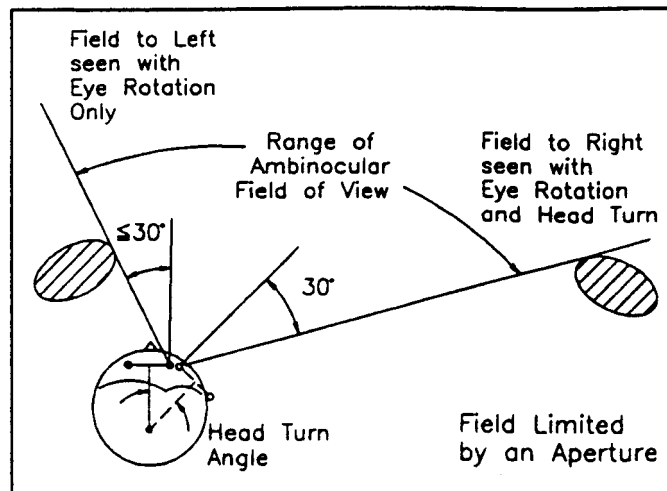


FIGURE 7—RANGE OF HORIZONTAL AMBINOCULAR FIELD OF VIEW THROUGH AN APERTURE FOR AN INDIVIDUAL DRIVER. IN THIS EXAMPLE, THE FIELD TO THE LEFT IS SEEN WITH EYE ROTATION ONLY AND THAT TO THE RIGHT IS SEEN WITH EYE ROTATION AND HEAD TURN.

- 4.1.5 **FIELD OF VIEW WITH EYE ROTATION AND HEAD TURN**—The field of view with eye rotation and head turn is defined using the horizontal and vertical angles of the sight line from 4.1.4 or the point where the sight line intersects a target.
- 4.2 **Direct Field for a Group of Drivers**—The Eyellipses may be used to determine the largest direct field of view which will be seen by everyone within a selected group of drivers. The selected group is determined by the Eyellipse chosen. If the 95th percentile Eyellipse is used in this procedure, 95% of drivers will view at least the calculated field.
- 4.2.1 **FIELD FOR ANY ANGLE OR POINT**—Direct field of view is defined using a plane which is tangent to an Eyellipse and which either goes through the point of interest or is at the desired angle. The plane may be at any orientation relative to the coordinate system within the limits of maximum head turn and eye rotation. Because all the eye points of the selected group are on the ellipse side of that tangent plane, all drivers within the group will view at least the angle on the ellipse side of the plane.

If the tangent plane contains a point on an aperture and is tangent to the side of the Eyellipse closest to the aperture point, all drivers within the group would be able to see through the aperture at the angle of the plane. The largest field through the aperture would be defined using the Eyellipse farthest from the aperture point.

If the tangent plane contains a specified point in space and is tangent to the side of the Eyellipse farthest from the point, all drivers within the group would be able to see that point. The point will be seen with the least head turn and eye rotation if the Eyellipse closest to the specified point is used.

4.2.2 HORIZONTAL FIELD—The horizontal range of direct ambinocular field of view for the selected group of drivers is the horizontal angle between two vertical planes defined when the following procedure is performed for points at the left and right limits of the vision area. The limits may be those imposed by an aperture or by maximum eye rotation and head turn.

4.2.2.1 *Select the Proper Eyellipse*—If the field is limited by an aperture, use the Eyellipse farthest from the point on the aperture and construct the plane to the side of the Eyellipse closest to the point. (Figure 8)

If the field is not limited by an aperture, use the Eyellipse closest to the point or angle and construct the plane to the side of the Eyellipse farthest from the point or angle. (Figure 9)

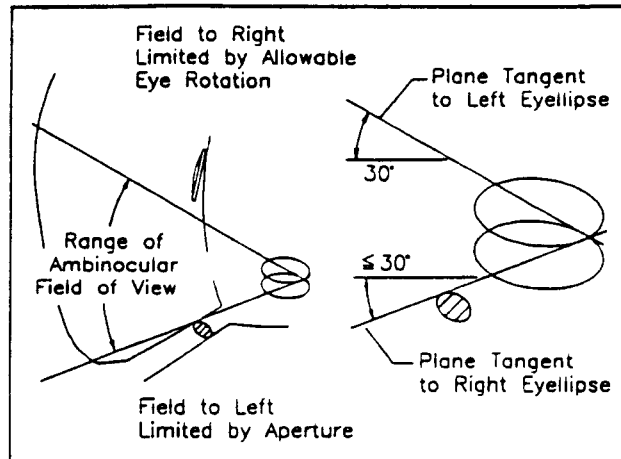


FIGURE 8—THE RANGE OF HORIZONTAL AMBINOCULAR FIELD OF VIEW FOR A GROUP OF DRIVERS WITH EYE ROTATION ONLY IS THE ANGLE BETWEEN A VERTICAL PLANE TANGENT TO THE LEFT SIDE OF THE RIGHT EYELLIPSE AND ONE TANGENT TO THE RIGHT SIDE OF THE LEFT EYELLIPSE IN THIS EXAMPLE, THE FIELD TO LEFT IS LIMITED BY THE APERATURE AND THE FIELD TO THE RIGHT IS LIMITED BY EYE ROTATION.

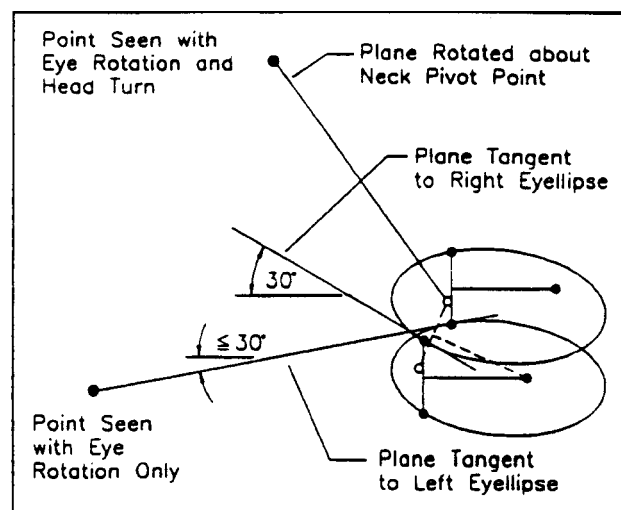


FIGURE 9—POINTS VISIBLE TO A GROUP OF DRIVERS WITHIN A FIELD NOT LIMITED BY AN APERTURE. IN THIS EXAMPLE, THE POINT ON THE LEFT IS SEEN WITH EYE ROTATION ONLY AND THAT TO THE RIGHT IS SEEN USING EYE ROTATION AND HEAD TURN.