INTERNATIONAL STANDARD 4513

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Road vehicles — Visibility — Method for establishment of eyellipses for driver's eye location

Véhicules routiers — Visibilité — Méthode de détermination des ellipses oculaires correspondant à l'emplacement des yeux des conducteurs

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4513 was developed by Technical Committee ISO/TC 22, *Road vehicles,* and was circulated to the member bodies in December 1976.

It has been approved by the member bodies of the following countries :

Australia	Iran	Spain
Austria	Italy	Sweden
Belgium	Japan	Switzerland
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Bulgaria	Mexico	United Kingdom
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No member body expressed disapproval of the document.

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Road vehicles — Visibility — Method for establishment of eyellipses for driver's eye location

0 INTRODUCTION

In order to provide a better understanding of this International Standard, a background to the development of the eyellipse is contained in annex A.

1 SCOPE

This International Standard establishes two-dimensional eyellipses representative of driver eye locations corresponding to the 90th, 95th and 99th percentiles.

2 FIELD OF APPLICATION

The statistical representation of the driver's eye location contained in this International Standard applies as a design tool to those road vehicles referred to in sub-clause 3.1.1 of ISO 3833.[1)]

3 REFERENCES

ISO 3409, *Passenger cars — Lateral spacing of foot controls.*

ISO 3833, *Road vehicles — Types — Terms and definitions.*

ISO 4130, *Road vehicles — Three-dimensional reference system and fiducial marks — Definitions.*[2)]

ISO 4131, *Road vehicles — Dimensional code for passenger cars.*[2)]

ISO 4514, *Road vehicles — Method for describing the driver's field of view.*[3)4)]

ISO . . ., *Road vehicles — Devices for use in defining and measuring seating accommodation.*[3)]

ISO . . ., *Road vehicles — Definition of points H and R.*[3)]

4 DEFINITIONS

For the purposes of this International Standard the following definitions apply :

4.1 driver's eye range : A statistical representation of the driver's eye location in a road vehicle.

4.2 eyellipse : The contraction of the words "eye" and "ellipse", describing the elliptical shape of the driver's eye range.

The term "eyellipse" should be used solely in this application.

4.3 eyellipse template : A two-dimensional design tool consisting of a plan view and a side view of the driver's left and right eye ranges (see figure 1 and annex B) from which sight lines may be constructed for the purpose of describing the location of objects in the field of view of the seated driver.

NOTE — The co-ordinates of eyellipse tangent points can be located in the actual vehicle three-dimensional reference system to determine design verification.

4.4 eyellipse locator line — adjustable seat : The side view locator of the eyellipse for horizontally adjustable seats with back angles between 5 and 40° (see figure 2 and annex B).

4.5 sight line : A line which extends from the eyellipse centroid, the left or right eye ellipse centroid, or a tangent point on the eyellipse contour and directed towards a target point or at a given angle from a line drawn parallel to the zero Y plane or ground.

1) V-points may be used in lieu of the complete eyellipse to standardize the driver's field of view for regulation purposes.

2) At present at the stage of draft.

3) In preparation.

4) This proposed International Standard establishes a uniform method of describing the driver's field of view, a method for measuring vehicle window opening for comparison purposes, and a procedure for establishing vision origin points (V-points, P-points and E-points). V-points are points on a sight line constructed from a specific target and tangent to the eyellipse contour.

In the side view, the plane is seen as a line and is constructed to the upper or lower edge; in the plan view, the plane is seen as a line and is constructed to the left or right edge of either ellipse.

The selection of the sight lines relative to the eyellipse is made by the user depending on his design problem.

4.6 three-dimensional reference system : The relationship of three orthogonal planes established by the manufacturer in the initial design stages of the vehicle and remaining permanent.

The planes are used to determine dimensional relationships within the vehicle and are defined below :

4.6.1 zero "Y" plane : A vertical plane which passes through the longitudinal centreline of the vehicle.

4.6.2 zero "X" plane : A vertical plane normal to the "Y" plane.

4.6.3 zero "Z" plane : A plane normal to the "X" and "Y" planes.

4.6.4 negative co-ordinate : A co-ordinate in a direction forward of the "X" plane, left of the "Y" plane when facing forward, or below the "Z" plane.

4.6.5 co-ordinate dimensioning : A system of describing the positions of points with reference to the intersection of the zero planes in the three-dimensional reference system. *X*, *Y*, *Z* co-ordinates are dimensioned to their respective planes.

4.7 H-point [see ISO . . .] : The pivot centre of the torso and thigh on the two- or three-dimensional devices used in defining and measuring vehicle seating accommodation.

4.7.1 design H-point [see ISO . . .] : The point located on a drawing by the H-point on the two-dimensional drafting template placed in any designated seating position.

If the designated position can be adjusted, the path of the design H-point through the full seat adjustment establishes the design H-point travel line and can be dimensionally described by co-ordinates relative to the three-dimensional reference system.

4.7.2 R-point (being the seating reference point) : The manufacturer's design reference point is a unique design H-point which :

- establishes the rearmost and lowest normal design driving or riding position of each designated seating position in a vehicle, which includes consideration of all modes of adjustment, horizontal, vertical and tilt, in a vehicle;
- has *X*, *Y*, *Z* co-ordinates established relative to the designed vehicle structure;
- simulates the position of the pivot centre of the human torso and thigh; and
- is the reference point employed to position the two-dimensional drafting template with the 95th percentile leg described in ISO . . .

1) See ISO 3409.

4.8 Vehicle interior dimensions used (with their symbols in parentheses)

4.8.1 normal driving and riding seat track travel (ISO-L23) : The distance between two planes, parallel to the zero "X" plane, one passing through the R-point–front, the other passing through the design H-point of the front seat moved to the foremost position.

4.8.2 back angle–front (ISO-L40) : The angle between the zero "X" plane and the torso line passing through the R-point–front.

NOTE – The torso line is defined by the manufacturer.

4.8.3 horizontal distance from R-point–front to heel (ISO-L53) : The distance from the R-point–front to the plane parallel to the zero "X" plane and passing through the heel point–front B.[1)]

NOTE – The heel point–front B is defined by the manufacturer.

4.8.4 vertical distance from R-point–front to heel (ISO-H30) : The distance from the R-point–front to the plane parallel to the zero "Z" plane and passing through the heel point–front B.

4.8.5 seat travel rise (ISO-H59) : The vertical distance from the R-point–front to the design H-point at the foremost position within the normal driving and riding seat track travel.

4.8.6 shoulder room–front (ISO-W1) : The minimum distance between the trimmed surfaces, measured in the plane parallel to the zero "X" plane and passing through the R-point–front and at not less than 254 mm above this R-point.

4.8.7 position of the steering wheel centre with respect to zero "Y" plane (ISO-W7) : The distance from the steering wheel centre to the zero "Y" plane.

NOTE – The steering wheel centre is located on the upper surface of the steering wheel rim.

4.8.8 "*Y*" co-ordinate of R-point–front (ISO-W20) : The distance from the zero "Y" plane to the R-points of the front seats.

NOTE – If the values of the left and right R-point co-ordinate are different (asymmetrical dispositions of the R-points), both values shall be stated, separated by a dash, with the first value corresponding to the left seat.

5 EYELLIPSE TEMPLATE APPLICATION

5.1 Eyellipse templates shall be applicable to the type of vehicle stated in clause 2, with either bench or bucket-type seats.

5.2 Eyellipse templates shall be applicable to the limits of driving compartment dimensions shown in table 1.

TABLE 1 – **Driving compartment dimensional range**

Dimension	min.	max.
Back angle – front (ISO-L40)	5°	40°
Vertical distance from R-point–front to heel (ISO-H30)	127 mm	457 mm
Vertical seat travel rise (ISO-H59)	0 mm	38 mm
Normal driving and riding seat track travel (ISO-L23)	102 mm	165 mm
Horizontal distance from R-point–front to heel (ISO-L53)	508 mm	

6 PROCEDURE FOR EYELLIPSE LOCATION

6.1 Datum lines

The eyellipse is located in the vehicle interior by longitudinal (X-X), lateral (Y-Y), and vertical (Z-Z) datum lines which are shown on the eyellipse templates (see figure 1). The datum lines relative to the eyellipse centroid vary between the different seat track travel templates. These datum lines are not the geometric axes of the tool; they are reference lines to establish the position of the tool in the vehicle with respect to seated drivers.

6.2 Eyellipse template – Side view (see figure 5)

6.2.1 Determine the length of the normal driving and riding seat track travel (ISO-L23).

6.2.2 Select the side view eyellipse template which comes closest to matching the normal driving and riding seat track travel (ISO-L23).

6.2.3 Construct a vertical reference line through the R-point.

6.2.4 Construct a horizontal reference line 635 mm above the R-point.

6.2.5 Position the eyellipse locator line (see figure 2 and annex B) at the intersection of the lines constructed in 6.2.3 and 6.2.4.

6.2.6 Position the side view eyellipse template on the eyellipse locator line at the intersection of the eyellipse datum lines X-X and Z-Z at the manufacturer's designed back angle–front (ISO-L40), so that the eyellipse datum lines and the reference lines constructed in 6.2.3 and 6.2.4 are parallel and trace the outline on the layout.

6.3 Eyellipse template – Plan view (see figure 5)

6.3.1 Construct a lateral reference line (Y-Y) perpendicular to the vehicle centreline through the line Z-Z projected from the side view.

6.3.2 Construct a longitudinal reference line (X-X) parallel to the vehicle centreline and at a distance from the vehicle centreline equal to the following :

a) 0,85 (ISO-W7) + 0,075 (ISO-W1) or

b) "Y" co-ordinate of R-point–front + 28 mm (the 28 mm dimension is added in a direction towards the driver's side of the vehicle).

The dimensions ISO-W7, ISO-W1 and "Y" co-ordinate (ISO-W20) are defined in 4.8.7, 4.8.6 and 4.8.8. In the case of a) above, the reference line (X-X) shall not be closer to the vehicle centreline than given by b) above.

6.3.3 Position the plan view eyellipse template datum lines X-X and Y-Y on the constructed reference lines (X-X) and (Y-Y) and trace the outline on the layout.

ANNEX A

BACKGROUND TO THE DEVELOPMENT OF THE EYELLIPSE

A.1 The eyellipse contours were developed by the statistical analysis of photogrammetric data of drivers' eye locations and represent a population mix, primarily of U.S.A. licensed drivers, with a male-to-female ratio of one-to-one.

The eyellipse templates are the perimeters of envelopes formed by an infinite number of planes dividing the eye positions so that P % of the eyes are on one side of the plane and $(100 - P)$ % are on the other.

It should be noted that the 95th percentile eyellipse does not include 95 % of the drivers' eye locations. For example, if a plane seen as a straight line in the side view is drawn tangent to the upper edge of the 95th percentile eyellipse, then 95 % of the driver eye locations will be below the line and 5 % of the driver eye locations will be above the line (figure 3). Conversely, if a plane seen as a straight line in the side view is drawn tangent to the lower edge of the 95th percentile eyellipse, then 95 % of the driver eye locations will be above the line and 5 % of the driver eye locations will be below the line. These straight lines or sight lines are drawn from the object in the driver's field of view tangent to the eyellipse contour.

A.2 This International Standard is based on an original study, involving drivers with a straight-ahead viewing task without head-turning. A subsequent study has provided a method of accounting for driver viewing targets that are located at extreme lateral angles from the forward line of sight and accommodates a head movement up to 60° after an eye movement of up to 30°.

In a third study, an eyellipse locator line has been developed to position the eyellipse in the driver work space for back angles ranging from 5 to 40° in 1° increments.

Six plan and side view eyellipse templates are included in this International Standard, representing six specific normal driving and riding seat track travel (ISO-L23) lengths ranging from a minimum of 102 mm to a maximum of 165 mm in 12 or 13 mm increments. (See annex B — table 2 or 3.)

The eyellipse template contours and the eyellipse locator line template shape can be constructed from data in annex B.

ANNEX B

MATHEMATICAL DESCRIPTION OF THE EYELLIPSES AND THE EYELLIPSE LOCATOR LINE — ADJUSTABLE SEAT

B.1 EYELLIPSE CONTOURS

The eyellipse contours may be constructed from the following data (see figure 4).

B.1.1 Centroid location

Centroid offsets are measured from the X-X, Y-Y, and Z-Z datum lines and are given in table 2.

TABLE 2 — **Left and right eyellipse centroids**

Values in millimetres

H-point travel	*X* mean[1)]	*Z* mean[1)]	*Y* mean (left eye)	*Y* mean (right eye)
102	+ 1,8	− 5,6	− 6,4	+ 58,0
114	− 4,6	− 6,4	− 5,6	+ 58,9
127	− 10,7	− 7,1	− 5,1	+ 59,0
140	− 17,0	− 7,6	− 4,3	+ 59,7
152	− 20,3	− 8,4	− 4,1	+ 60,2
165	− 22,9	− 8,4	− 4,1	+ 60,5

1) Includes both left and right eyes.

B.1.2 Ellipse axis length

B.1.2.1 *Major axis*

Since the ellipse axis is tilted approximately the same amount in both side and plan views, the length of the major axis in both side and plan view is essentially the same for a given seat travel. The values are given in table 3.

TABLE 3 — **Eyellipse major axis lengths — Plan and side view**

Values in millimetres

H-point travel	Major axis length, for tangent cutoff		
	90 %	95 %	99 %
102	109	147	216
114	122	160	229
127	135	173	241
140	147	185	254
152	155	193	262
165	160	198	267

B.1.2.2 *Minor axes*

The minor axes for the side and plan view are given in table 4.

TABLE 4 — **Eyellipse minor axis lengths**

Values in millimetres

View	Minor axis length, for tangent cutoff		
	90 %	95 %	99 %
Side	77	86	122
Plan	82	105	149

B.1.3 Orientation

The ellipses are tilted in both side and plan views. The side view angle is − 6,4° (tilted downward looking forward). The plan view angle is 5,4° (tilted inward looking forward).

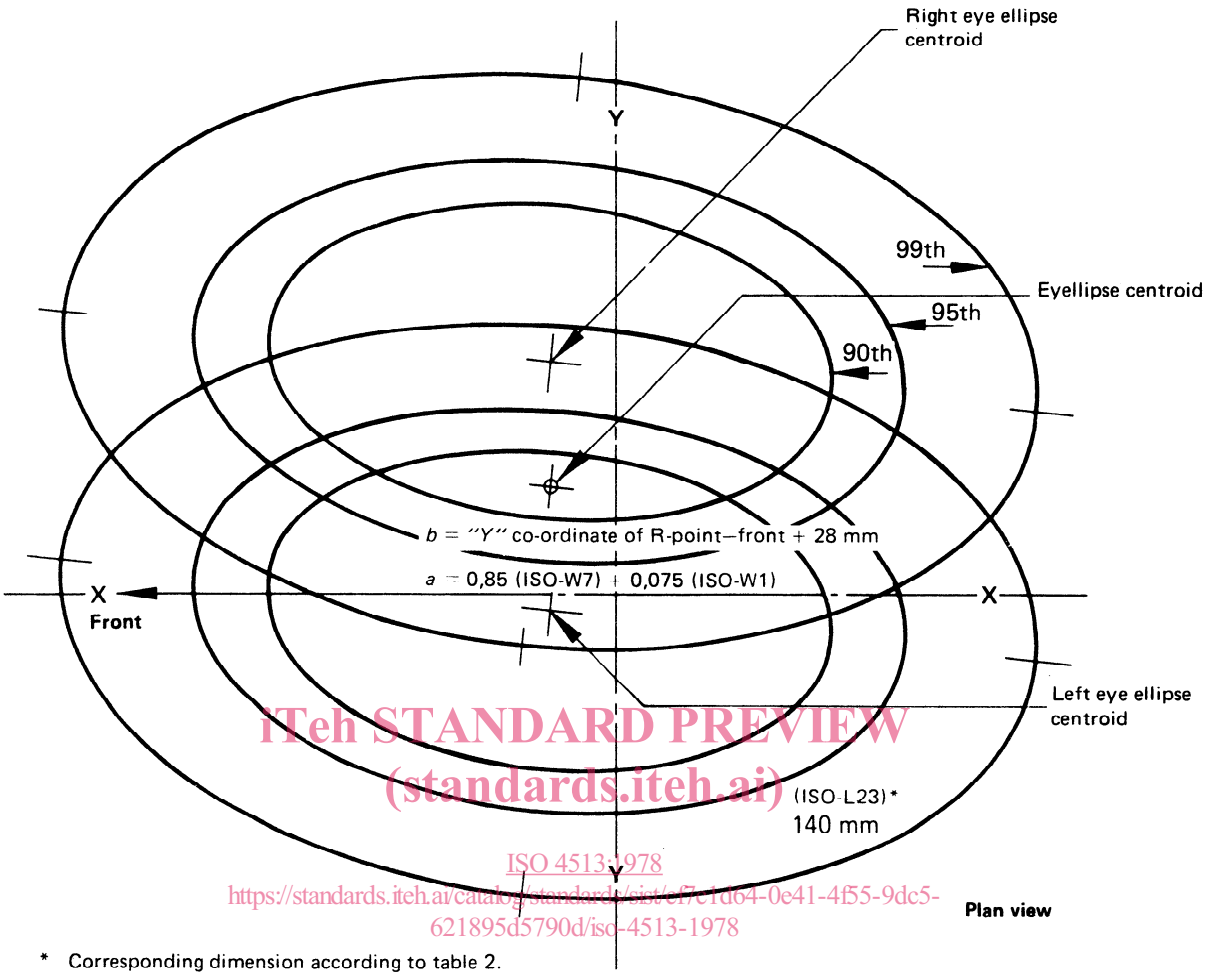
B.2 EYELLIPSE LOCATOR LINE

The eyellipse locator line may be constructed from the following data.

Table 5 describes the horizontal and vertical displacement of the side view X-X, Z-Z datum lines of the eyellipse relative to the X-X, Z-Z intersection of the horizontal and vertical datum lines for back angle–front (ISO-L40) ranging from 5 to 40°. (See 6.2.3 and 6.2.4 and figures 2 and 3.)

TABLE 5 – **Eyellipse locator line – Adjustable seat – Horizontal (*X*) and vertical (*Z*) displacement of the X-X and Z-Z datum lines of the eyellipse related to a point 635 mm above the R-point for back angles (ISO-L40) ranging from 5 to 40°**

Back angle–front (ISO-L40) degrees	Horizontal displacement *X* mm	Vertical displacement *Z* mm
5,0	− 186,4	27,6
6,0	− 176,5	27,3
7,0	− 166,6	27,0
8,0	− 156,8	26,5
9,0	− 147,1	25,9
10,0	− 137,4	25,1
11,0	− 127,8	24,3
12,0	− 118,3	23,3
13,0	− 108,8	22,2
14,0	− 99,4	21,0
15,0	− 90,0	19,7
16,0	− 80,7	18,3
17,0	− 71,5	16,7
18,0	− 62,3	15,0
19,0	− 53,2	13,2
20,0	− 44,2	11,3
21,0	− 35,2	9,3
22,0	− 26,3	7,2
23,0	− 17,5	4,9
24,0	− 8,7	2,5
25,0	0,0	0,0
26,0	8,6	− 2,6
27,0	17,2	− 5,4
28,0	25,8	− 8,2
29,0	34,2	− 11,2
30,0	42,6	− 14,3
31,0	50,9	− 17,5
32,0	59,2	− 20,8
33,0	67,4	− 24,3
34,0	75,6	− 27,9
35,0	83,6	− 31,5
36,0	91,6	− 35,4
37,0	99,6	− 39,3
38,0	107,5	− 43,3
39,0	115,3	− 47,5
40,0	123,0	− 51,8



* Corresponding dimension according to table 2.

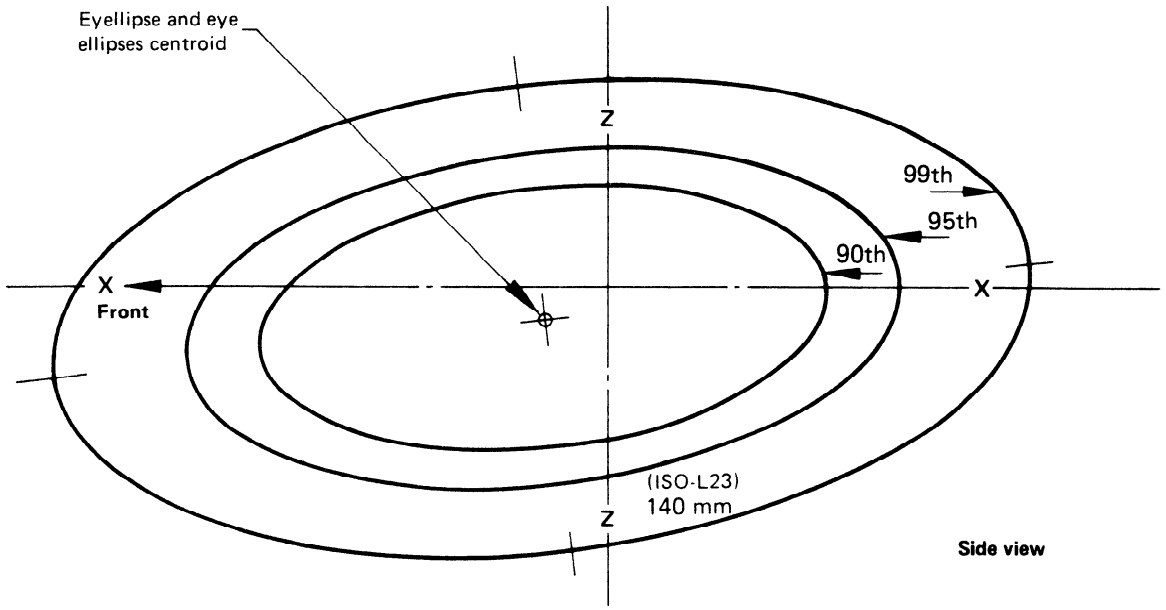


FIGURE 1 — **Eyellipse template**