INTERNATIONAL STANDARD

ISO 4513

Fourth edition
2022-06

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

Reference number
ISO 4513:2022(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 35, *Lighting and visibility*.

This fourth edition cancels and replaces the third edition (ISO 4513:2010), which has been technically revised.

The main changes are as follows:

— added references to the annexes;

— the variables have been modified;

— editorial changes.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document describes the eyellipse, a statistical representation of driver eye locations, which is used to facilitate design and evaluation of vision in motor vehicles. Examples of eyellipse applications include rearview mirror size and placement, wiped and defrosted areas, pillar size and location, and general exterior field of view. These applications are covered in other SAE and ISO practices.

This revision of the eyellipse is the most significant update to ISO 4513 since its inception. The eyellipses differ from the previous eyellipses in the following ways:

a) the axis angles in plan view and rear view are parallel to vehicle grid;

b) the side view X-axis angle is tipped down more at the front;

c) for the 95th percentile eyellipse (99th shown in parentheses):

   1) the X-axis length is 7,5 (18,9) mm longer,

   2) the Y-axis is 44,6 (63,6) mm shorter,

   3) the Z-axis is 7,4 (10,1) mm longer;

d) the centroid location is generally higher and more rearward;

e) the centroid location in side view is a function of packaging geometry (SgRP, steering wheel location, seat cushion angle, and the presence or absence of a clutch pedal);

f) the eyellipse is no longer positioned according to the driver's torso angle;

g) the eyellipse for seat tracks shorter than 133 mm in length has an X-axis length unchanged from ISO 4513:2003. The Y- and Z-axis lengths, and the centroid location, are based on the new values and equations given in this document;

h) neck pivot (P) and eye (E) points are based on the previous plan view sight lines to rear-view mirrors and A-pillars, but are adjusted to the shape and location of the new eyellipses.

New additions, incorporated as annexes, are summarized as follows.

a) Fixed seat eyellipses for an adult user population at a 50/50 gender mix and 95th and 99th percentile tangent cut-offs are described (see Annex B). Fixed seat eyellipses and their locating formulae given in Annexes B and C are based on data for second row passenger eye locations presented by UMTRI. In addition, a procedure is provided in Annex B for locating an eyellipse in a second row seat that has adjustable seat track travel or adjustable back angle.

b) A procedure is given for calculating adjustable and fixed seat eyellipses for any user population stature and gender mix at selected percentile tangent cut-offs (see Annexes A and C).

Tables providing comparisons between tangent cut-off eyellipses and inclusive eyellipses are given. An inclusive eyellipse can be constructed using these tables (see Annex D).

Eyellipses for Class B vehicles are unchanged from ISO 4513:2003 (see Annex E).

For historical background of ISO 4513 see Annex F.

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

1 Scope

This document establishes the location of drivers' eyes inside a vehicle. Elliptical (eyellipse) models in three dimensions are used to represent tangent cut-off percentiles of driver's eye locations. Procedures are provided to construct 95th and 99th percentile tangent cut-off eyellipses for a 50/50 gender mix, adult user population.

Neck pivot (P) points are defined to establish specific left and right eye points for direct and indirect viewing tasks described in SAE J1050. These P points are defined only for adjustable seat eyellipses.

This document applies to Class A vehicles (passenger cars, multipurpose passenger vehicles and light trucks) as defined in SAE J1100. It also applies to Class B vehicles (heavy trucks).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6549, *Road vehicles — Procedure for H- and R-point determination*

SAE J1100, *Motor Vehicle Dimensions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6549, SAE J1100 and the following apply.

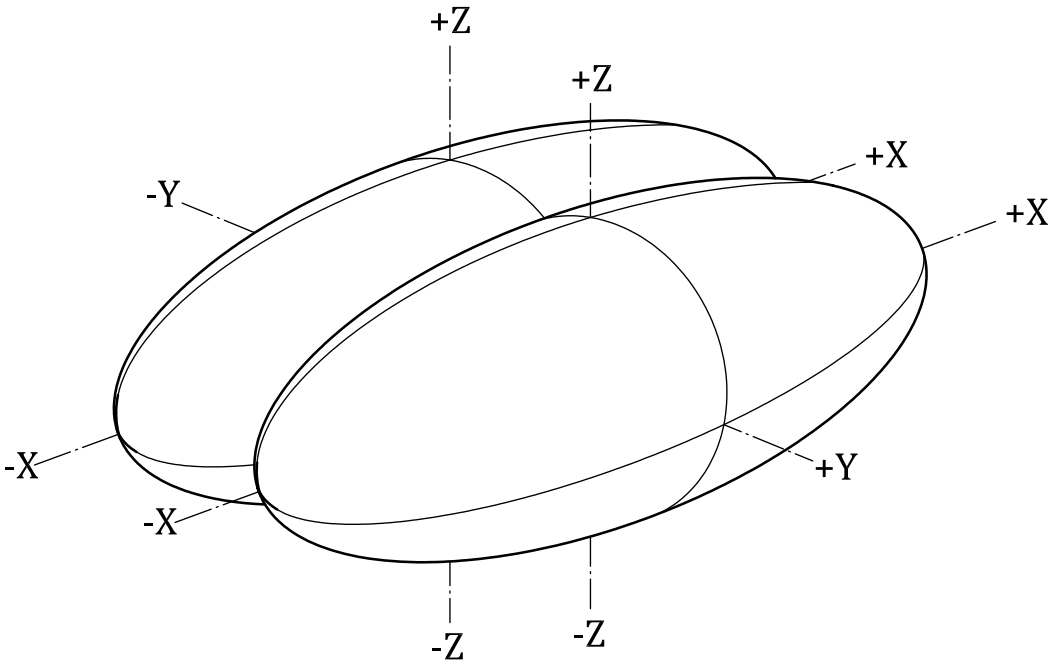
ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
eyellipse
contraction of the words “eye” and “ellipse” used to describe the statistical distribution of eye locations in a three-dimensional space located relative to defined vehicle interior reference points

Note 1 to entry: See Figure 1.



Key

X, Y, Z ellipse axes

Figure 1 — Typical three-dimensional tangent cut-off eyellipse for the left and right eyes

3.2
mid eye centroid
mid-eye point
cyclopean eye point
midpoint between left and right eye points or left and right eyellipse centroids at the centreline of the occupant

3.3
tangent cut-off plane
plane tangent to an eyellipse

Note 1 to entry: When projected at a specified angle or on to a specific target, a tangent cut-off plane can be considered to be a sight plane. In a two-dimensional view, a sight plane can be considered to be a sight line (see Figure D.1).

3.4
tangent cut-off eyellipse
three-dimensional eyellipse derived as the perimeter of an envelope formed by an infinite number of planes dividing the eye locations so that P % of the eyes are on one side of the plane and (100 – P) % are on the other

Note 1 to entry: See Annex D.

3.5
neck pivot point
P point
point at which a driver's head turns on a horizontal plane

Note 1 to entry: See Figure 2.

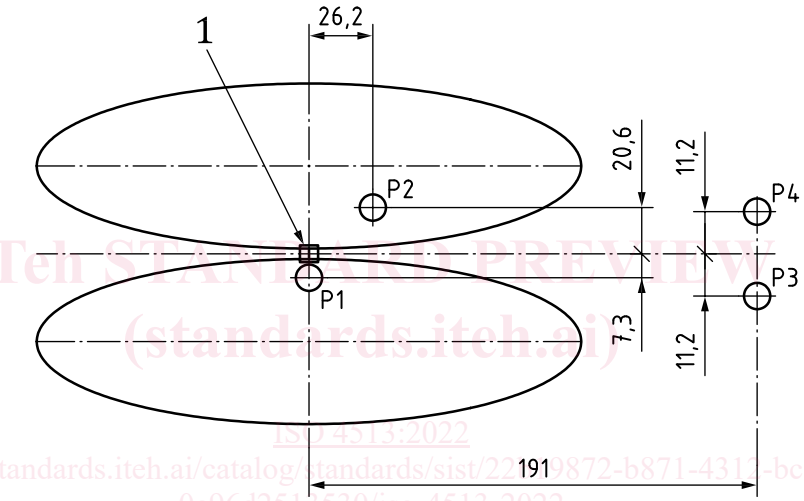
3.6
point P1
point P2
neck (head) pivot points used to position eye points for measuring the driver binocular obstruction due to A-pillars at the left and right side of the vehicle

Note 1 to entry: See Figure 2.

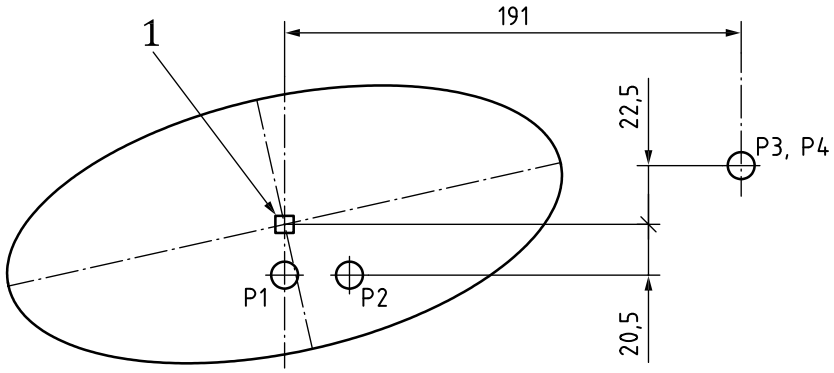
3.7
point P3
point P4
neck (head) pivot points used to position eye points for measuring driver field of view from rear-view mirrors located to the left and right of the driver

Note 1 to entry: See Figure 2.

Dimensions in millimetres



a) Plan view



b) Side view

Key
1 mid-eye centroid

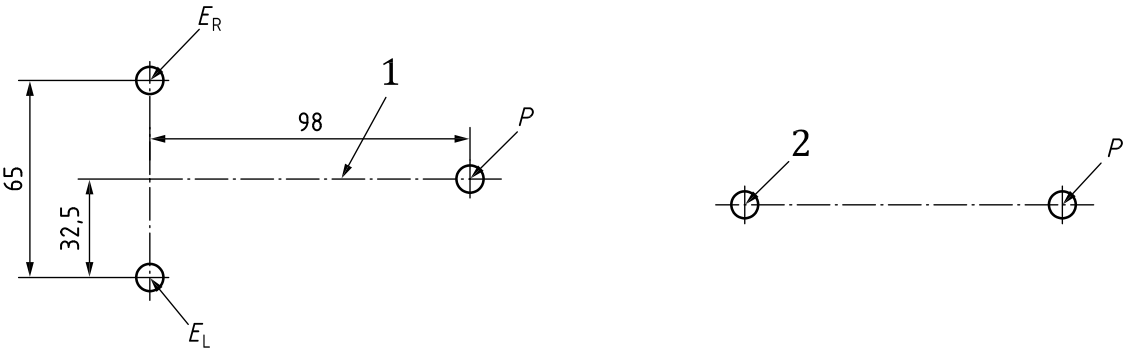
NOTE Eyellipses are shown for reference purposes only.

Figure 2 — P point locations relative to 95th percentile eyellipse mid-eye centroid with seat track travel >133 mm

3.8
eye point
E point
point representing an eye of the driver, used in conjunction with a neck pivot point to describe specific viewing tasks

Note 1 to entry: See Figure 3.

Dimensions in millimetres



a) Plan view **b) Side view**

Key

E_L	left eye
E_R	right eye
P	neck pivot point
1	driver head centreline
2	line, viewed end on, between E_L and E_R

Figure 3 — Neck pivot point and associated eye points

3.9
inclusive eyellipse
eyellipse that contains a specified percentage of drivers' eyes within its boundaries

4 Adjustable seat 95th and 99th percentile tangent cut-off eyellipses for a 50/50 male and female gender mix

4.1 Reference anthropometry

These eyellipses are based on the user populations described in Table 1. Driver eyellipses for a 50/50 gender mix shall be used for designing Class A vehicles.

Table 1 — Reference anthropometry (see Reference [17])

Dimensions in millimetres

Gender	Mean stature	Standard deviation of stature
Male	1 755	74,2
Female	1 618	68,7
NOTE Standard deviations for each gender were estimated by dividing the difference between the 95th and 5th percentiles by the difference in *z*-scores (3,29).		

The 95th and 99th percentile tangent cut-off eyellipses for a 50/50 gender mix are constructed from tables and formulae given in 4.2 to 4.3.2. These eyellipses are applicable to driver and front outboard passenger seat locations.

NOTE 1 See Annex A for an example to determine adjustable seat tangent cut-off eyellipses for any user population stature distribution and gender mix.

NOTE 2 See Annex B for an example to determine fixed seat 95th and 99th percentile tangent cut-off eyellipses for an adult population at a 50/50 gender mix.

NOTE 3 See Annex C for an example to determine fixed seat tangent cut-off eyellipses for any user population stature distribution and gender mix.

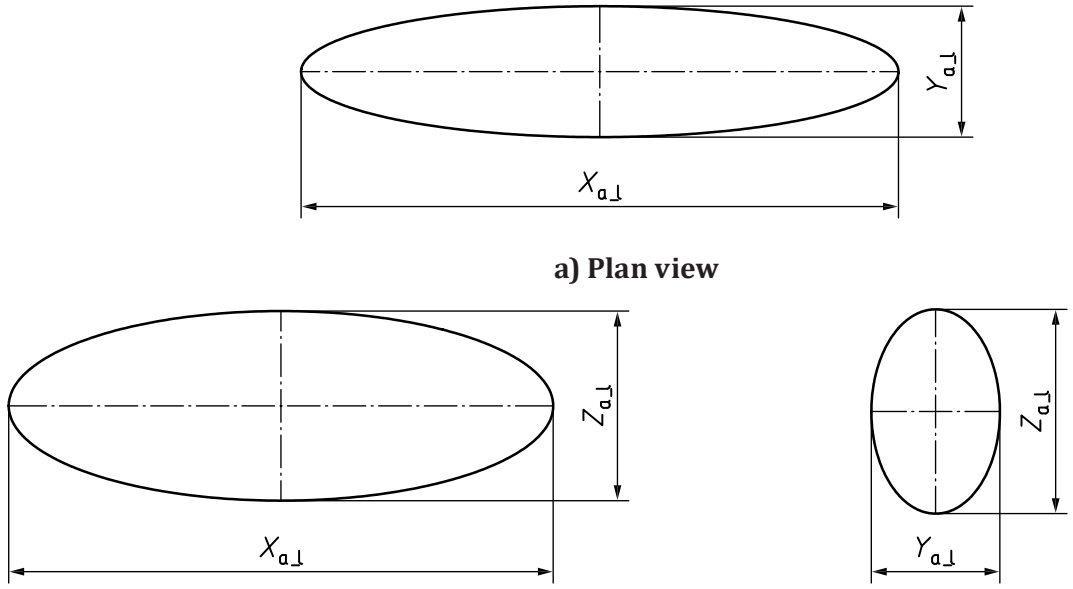
4.2 Axis lengths

Axis lengths are given in Table 2 (see Figure 4).

Table 2 — Left and right eyellipse axis lengths (true view)

Seat track travel (TL23) mm	Percentile	X-axis length mm	Y-axis length mm	Z-axis length mm
>133	95	206,4	60,3	93,4
	99	287,1	85,3	132,1
100 to 133	95	173,8[a]	60,3	93,4
	99	242,1[a]	85,3	132,1

[a] For seat track travels of 100 mm to 133 mm, the eyellipse X-axis length is unchanged from ISO 4513:2003. No new eye position data were collected for these shortened seat track travels.



a) Plan view

b) Side view

c) Rear view

Key

X_{a_l} X-axis length
Y_{a_l} Y-axis length
X_{a_l} X-axis length

Figure 4 — Adjustable seat tangent cut-off eyellipse for one eye, three views

4.3 Axis angles

4.3.1 Rear and plan view angles

The eyellipse is aligned with the vehicle axes in plan view (Z-plane) and rear view (X-plane), but it is tilted down at the front in side view (Y-plane).

4.3.2 Side view angle, β

In side view, the angle, β, in degrees (positive, tipped down at the front from horizontal), of the eyellipse is:

$$\beta = 12{,}0 \tag{1}$$

4.4 Centroid locations

4.4.1 Locating formulae

Formulae (2) to (5) are used to calculate the eyellipse centroid location (see Figure 5).

$$X_c = L_1 + 664 + 0{,}587\, L_6 - 0{,}176\, H_{30} - 12{,}5\, t \tag{2}$$

$$Y_{cL} = W_{20} - 32{,}5 \tag{3}$$

$$Y_{cR} = W_{20} + 32{,}5 \tag{4}$$

$$Z_c = H_8 + 638 + H_{30} \quad (5)$$

where

L_1 is the x-coordinate of the BOFRP (L_1);

L_6 is the x distance from the steering wheel centre to the BOFRP (L_6);

H_{30} is the z distance of the SgRP from the AHP (H_{30});

t is the transmission type (1 with clutch pedal, 0 without clutch pedal);

W_{20} is the y-coordinate of the SgRP (W_{20});

H_8 is the z-coordinate of the AHP (H_8).

4.4.2 Seats with vertical adjustment

For driver seats having vertical adjustment, Formulae (2) to (5) were developed with H30 (and SgRP) positioned at the middle of the vertical adjustment range. Typically, this was 20 mm to 25 mm vertically above the full down H-point travel path (Figure 5). If manufacturers define their SgRP so it is not 20 mm above the driver's full down H-point travel path, the accuracy in locating the vertical position of the eyellipse using the manufacturer's H30 dimension in Formula (5) is reduced. If the H-point vertical adjustment (TH21) is less than 40 mm, then H30 and the eyellipse Z centroid should be located from a point midway between the full up and full down travel path.