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Third edition
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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

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 4513 was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 17, *Visibility*.

This third edition cancels and replaces the second edition (ISO 4513:2003), which has been technically revised.

Introduction

This International Standard 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 International Standard;

h) neck pivot (P) and eye (E) points are based on the previous plan view sight lines to rearview 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 equations 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).

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

1 Scope

This International Standard 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 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 International Standard 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 referenced documents are indispensable for the application 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 following terms given in ISO 6549 apply:

a) H-point;

b) seating reference point, SgRP.

For the purposes of this document the following terms given in SAE J1100 apply:

1) ball of foot reference point (BOFRP);

2) accelerator heel point (AHP);

NOTE For applications using the H-point machine described in ISO 6549, the term “operator heel point” is used instead of “accelerator heel point”.

3) Class A and Class B vehicles;

4) H-point travel path, TL23, TH21;

5) A19 — Seat track rise;

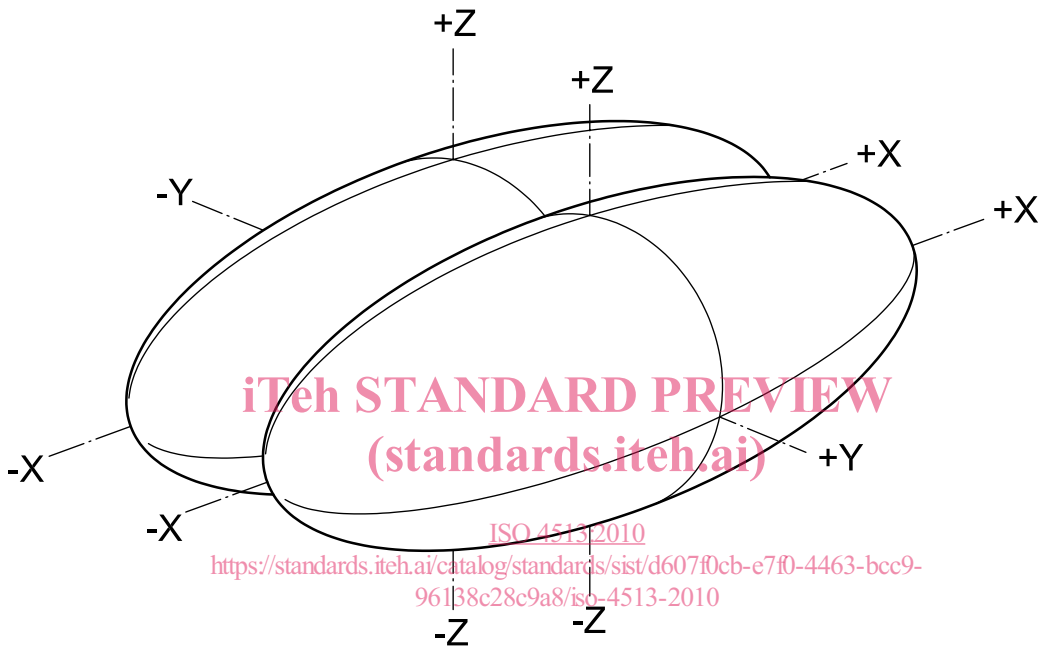
6) H30 — Seat height;

7) L6 — Ball of foot reference point (BOFRP) to steering wheel centre.

For the purposes of this document the following definitions apply.

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

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

3.3
tangent cut-off plane
plane tangent to an eyellipse

NOTE 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

See Annex D.

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

See Figure 2.

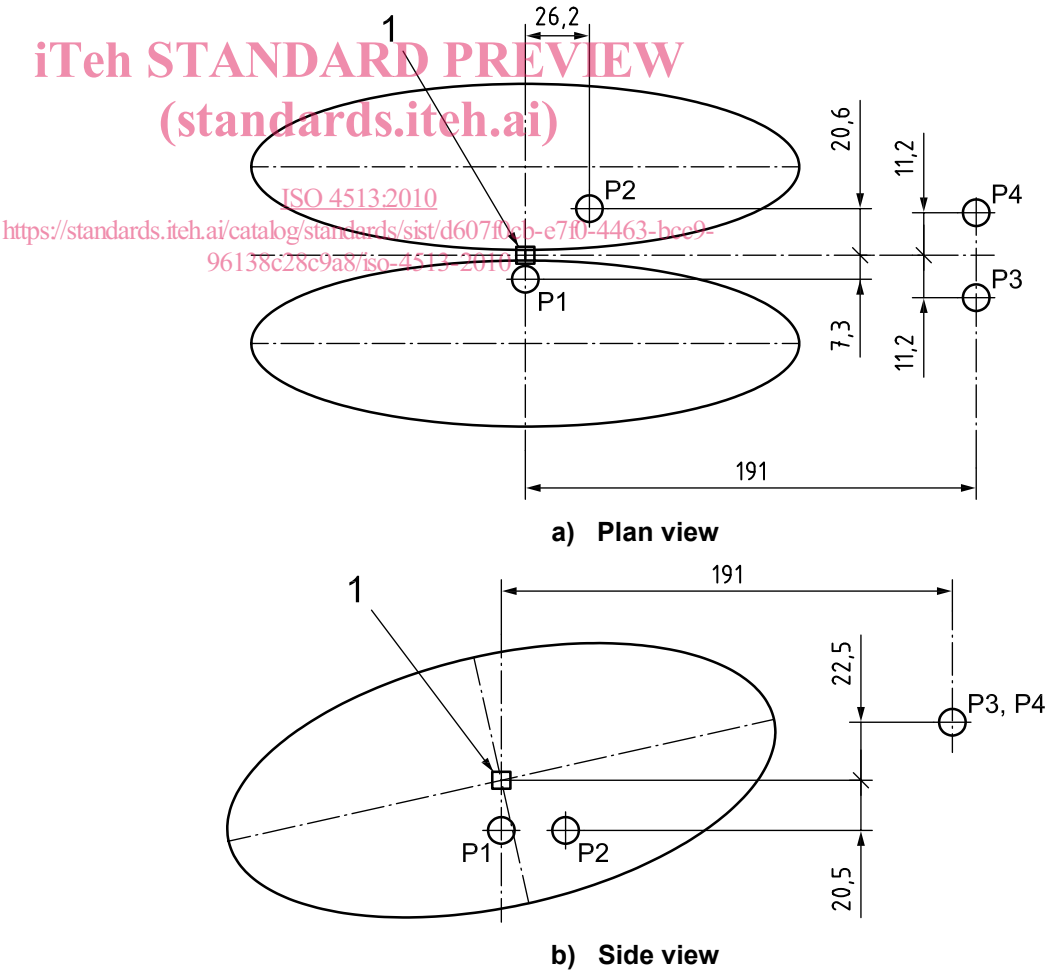
3.6
point P1
point P2
neck (head) pivot points used to position eye points for measuring the driver binocular obstruction due to A-pillars at the left and right side of the vehicle

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 rearview mirrors located to the left and right of the driver

See Figure 2.

Dimensions in millimetres



Key
1 mid-eye centroid

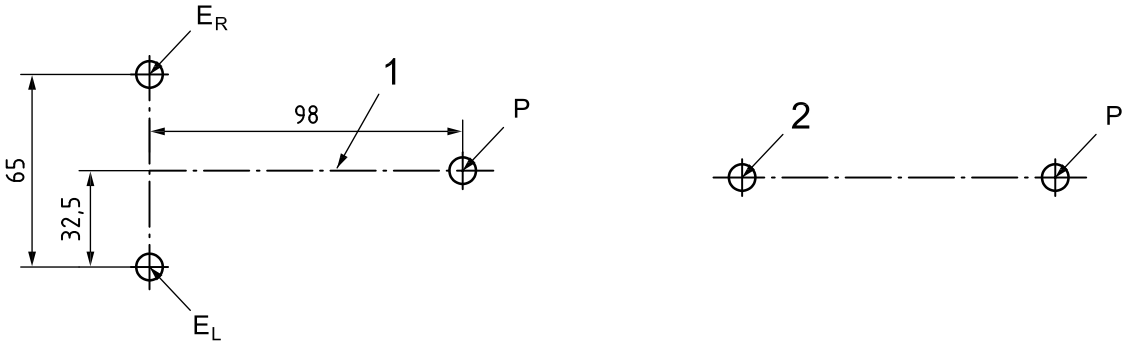
NOTE Eyellipses are shown for reference purposes only.

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

See Figure 3.

Dimensions in millimetres



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

Key

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

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 equations given in 4.2 to 4.3.2. These eyellipses are applicable to driver and front outboard passenger seat locations.

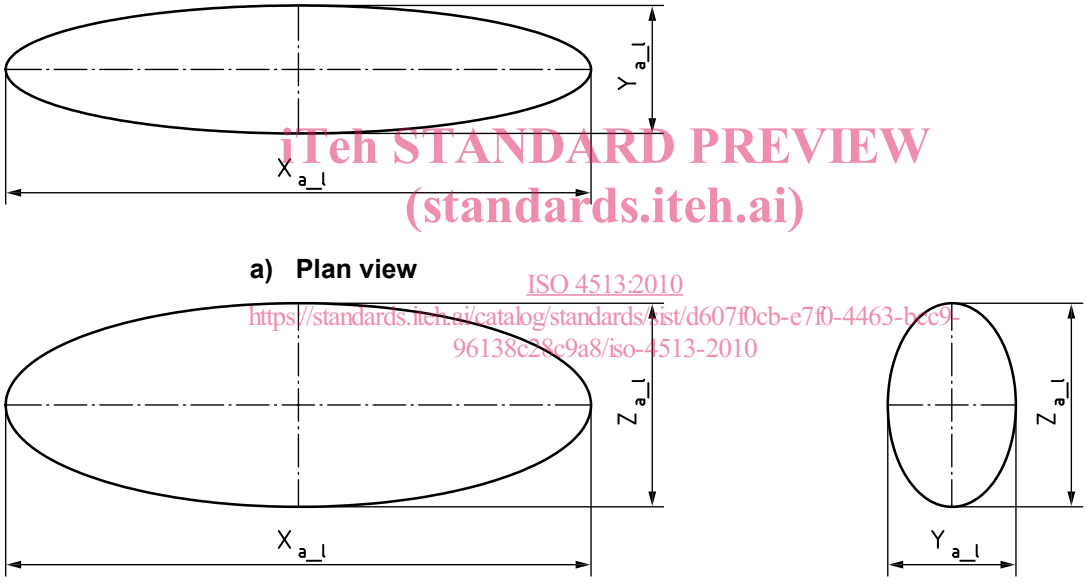
4.2 Axis lengths

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
Z_{a_l} Z-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:

$$\beta = 12{,}0 \quad (1)$$

4.4 Centroid locations

4.4.1 Locating equations

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

$$X_c = L1 + 664 + 0{,}587\ L6 - 0{,}176\ H30 - 12{,}5\ t \quad (2)$$

$$Y_{cL} = W20 - 32{,}5 \quad (3)$$

$$Y_{cR} = W20 + 32{,}5 \quad (4)$$

$$Z_c = H8 + 638 + H30 \quad (5)$$

where

L1 is the x-coordinate of the BOFRP;

L6 is the x distance from the steering wheel centre to the BOFRP;

H30 is the z distance of the SgRP from the AHP;

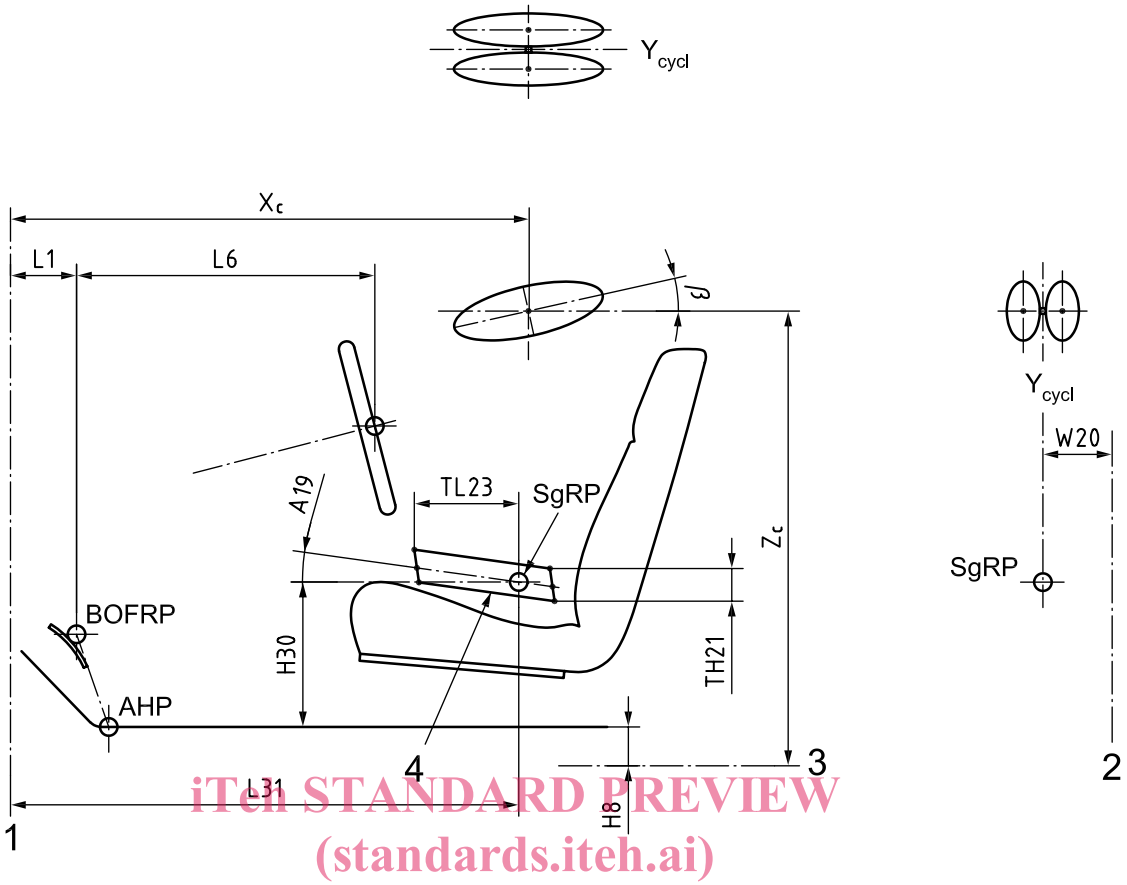
t is the transmission type (1 with clutch pedal, 0 without clutch pedal);

W20 is the y-coordinate of the SgRP;

H8 is the z-coordinate of the AHP.

4.4.2 Seats with vertical adjustment

For driver seats having vertical adjustment, Equations (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 Equation (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.



Key

A19	seat track rise	TL23	seat track travel
AHP	accelerator heel point	W20	y-coordinate of the SgRP
BOFRP	ball of foot reference point	X_c	x-coordinate of the eyellipse centroid location
H8	z-coordinate of the AHP	Y_{cycl}	mid-eye y-coordinate
H30	z distance of the SgRP from the AHP	Z_c	z-coordinate of the eyellipse centroid location
L1	x-coordinate of the BOFRP	β	side view angle
L6	x distance from the steering wheel centre to BOFRP	1	zero X grid
L31	x-coordinate of the SgRP	2	zero Y grid
SgRP	seating reference point	3	zero Z grid
TH21	H-point vertical adjustment	4	H-point travel path

Figure 5 — Eyellipse package factors, side view axis angle and centroid location

4.4.3 Left, right, mid-eye centroids

The distance between the left eye centroid, Y_{cL}, and right eye centroid, Y_{cR}, is 65 mm. The mid-eye (cyclopean eye), Y_{cycl}, is located on the occupant centreline at W20.

5 Eyellipse locating procedure, Class A vehicles

The steps in the procedure are:

a) determine seat characteristics A19, W20, H30, TL23;

b) determine H8 and L6;