

## 23-1 Installation of devices for indirect vision

Refer to: R46 02-S4, 02-S4/C1, R46 03 R81 00-S1, R46 04,04-S1

### 23-1.1 Effective date and Scope:

23-1.1.1 Effective date from 2017/1/1, the new vehicle variants of category symbols M, N1 and L, the installation of devices for indirect vision shall comply with this regulation and using qualified devices for indirect vision which has already conformed "VSTD", except Class VI-A.

23-1.1.1.1 Category symbols M, N1 and L conform to "23 Installation of devices for indirect vision" of "Directions", regard as has conform to this regulation.

23-1.1.2 Effective date from 2017/1/1, the new vehicle variants of category symbols N2 and N3, the installation of devices for indirect vision shall comply with this regulation and using qualified devices for indirect vision which has already conformed "VSTD". Effective date from 2018/1/1, the existing vehicle variants of category symbols N2 and N3 conform to "23 Installation of devices for indirect vision" of "VSTD" shall comply with paragraph 23-1.7.5.6 and 23-1.7.5.12 in addition.

### 23-1.2 Definition:

23-1.2.1 Devices for indirect vision: means devices to observe the traffic area adjacent to the vehicle which cannot be observed by direct vision. These can be conventional mirrors, camera-monitors or other devices able to present information about the indirect field of vision to the driver. The category symbols L use mirror (rear-view mirror) able to provide the field of vision.

23-1.2.1.1 Mirror: means any device intended to give a clear view to the rear and side of the vehicle (usually from rear-view mirror provide this function) or front (usually from front-view mirror provide this function, except for the category symbols L), excluding complex optical systems such as periscopes.

23-1.2.1.2 Interior mirror: means a device, which can be fitted in the passenger compartment of a vehicle.

23-1.2.1.3 Exterior mirror: means a device, which can be mounted on the external surface of a vehicle.

23-1.2.1.4 Rear-view mirror of the category symbols L: means any mirror device can provide for the category symbols L's clear view to the rear and side of the vehicle; excluding complex optical systems such as periscopes.

23-1.2.1.5 "Class of mirror" means all devices having one or more common characteristics or functions. They are classified as follows:

(a) Class I: "Interior rear-view mirror", giving the field of vision defined in paragraph 23-1.7.1;

(b) Class II and III: "Main exterior rear-view mirror", giving the fields of vision defined in paragraphs 23-1.7.2. and 23-1.7.3;

(c) Class IV: "Wide-angle exterior mirror", giving the field of vision defined in paragraph 23-1.7.4;

(d) Class V: "Close-proximity exterior mirror", giving the field of vision defined in paragraph 23-1.7.5;

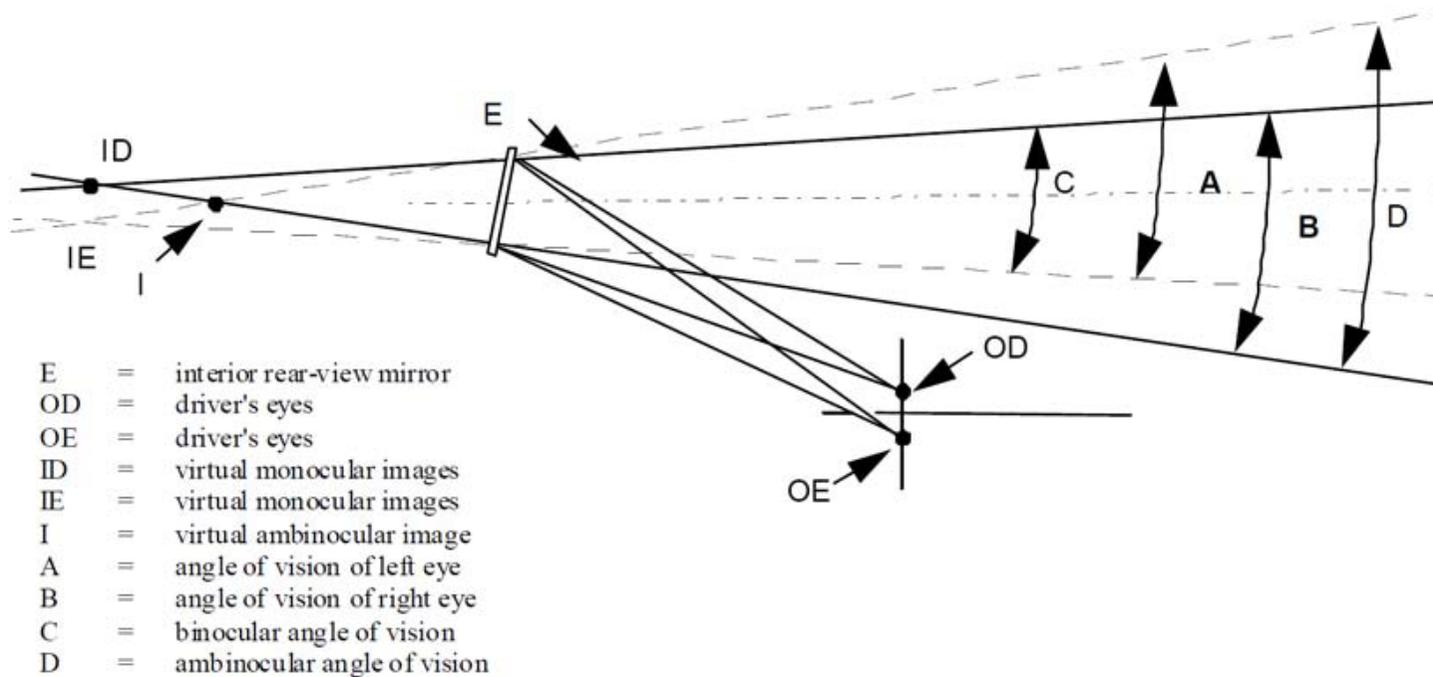
(e) Class VI: "Front mirror", giving the field of vision defined in paragraph 23-1.7.6;

(f) Class VII: Mirrors intended for L category vehicles with bodywork, giving the field of vision defined in paragraph 23-1.7.8.

23-1.2.2 Driver's ocular points: means two points 65 mm apart and 635 mm vertically above point "R" of the driver's seat. The straight line joining these points runs perpendicular to the vertical longitudinal median plane of the vehicle. The center of the segment joining the two ocular points is in the longitudinal vertical plane which shall pass by the center of the seating position of the driver designated by the vehicle manufacturer;

23-1.2.3 Ambinocular vision: means the total field of vision obtained by the superimposition of the monocular fields of view of the right eye and the left eye as below.

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23-1.2.4 Vision support system: means a system to enable the driver to detect and/or see objects in the area adjacent to the vehicle.

23-1.2.5 "Camera-monitor device for indirect vision" means a device as defined in paragraph 23-1.2.1., where the field of vision is obtained by means of a camera-monitor combination as defined in paragraphs 23-1.2.6. and 23-1.2.7.

23-1.2.6 "Camera" means a device that renders an image of the outside world and then converts this image into a signal (e.g. video signal).

23-1.2.7 "Monitor" means a device that converts a signal into images that are rendered into the visual spectrum.

23-1.2.8 "Critical object" means a cylindrical object with a height of 0.50 m and a diameter of 0.30 m.

23-1.2.9 "Critical perception" means the level of perception that can just be obtained under critical conditions via the viewing system used. This corresponds to the situation in which the representative scale of the critical object is multiple times larger than the smallest detail that can be perceived via the viewing system.

23-1.2.10 "Detection distance" means the distance measured from the centre of the lens of the camera to the point at which a critical object can just be perceived.

23-1.2.11 "Smear" is a vertical bright bar displayed on the monitor while sun light or light from other bright light sources is directly hitting into the lens of the camera. Smear is an optical artifact .

23-1.3 Installation of devices for indirect vision shall according to suitable variants and range of principle are as below :

23-1.3.1 The same vehicle category symbol.

23-1.3.2 The same brand and vehicle type.

23-1.3.3 The same chassis brand.

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23-1.3.4 Chassis manufacturers announced that the same chassis vehicle type.

23-1.3.5 If use chassis vehicle instead of completed vehicle for entire or partial testing, which shall according to suitable variants and range of principle are as below :

23-1.3.5.1 The same brand.

23-1.3.5.2 Chassis manufacturers announced that the same chassis vehicle type.

23-1.4 Minimum number of mandatory mirrors:

23-1.4.1 The fields of vision prescribed in paragraph 23-1.7 shall be obtained from the minimum number on mandatory mirrors set out in the following Figure 1. Where the presence of a mirror is not requested on a mandatory base, this means that no other system for indirect vision can be requested on a mandatory base. Figure 1 : The amount of installation devices' table. ( Only Figure 1 was revised. Refer to Figure 1 for revised contents )

23-1.4.2 In case the described field of vision of a front mirror prescribed can be obtained by another device for indirect vision t, this device can be used instead of the relevant mirror or mirrors. In case a camera/monitor device is used, the monitor must exclusively show:  
(a) the field of vision prescribed in paragraph 23-1.7.5 when the close proximity mirror has been substituted,  
(b) the field of vision prescribed in paragraph 23-1.7.6. when the front mirror has been substituted while the vehicle is moving forward with a speed up to 10 km/ h, or  
(c) simultaneously the fields of vision prescribed in paragraphs 23-1.7.5 and 23-1.7.6 when the close proximity mirror and the front mirror have been substituted. In the case of the vehicle is moving forward at a higher speed than 10 km/h or moving backwards, the monitor may be used for other information, provided that the field of vision prescribed in paragraph 23-1.7.5 is permanently displayed.

23-1.4.3 All the vehicles of category symbols L1, L2, L3 and L5 must be fitted with two rear-view mirrors of vehicle category L, one on the left and one on the right of the vehicle.

| Category of vehicle   | Interior mirror<br>(Class I) | Main exterior mirror(s)<br>(Classes III and VII)                            |
|---|------------------------------|---|
| L category motor vehicles fitted with bodywork which partly or wholly encloses the driver | 1 <sup>1/</sup>              | 1, if there is an interior mirror;<br>2, if there is not an interior mirror |

1/ No interior rear-view mirror is required if the visibility conditions referred to in paragraph 15.2.4.1. below cannot be met. In this case two exterior rear-view mirrors are required, one on the left and one on the right hand side of the vehicle.

23-1.5 Position:

23-1.5.1 Vehicle of category symbols M and N

23-1.5.1.1 mirrors shall be so placed that the driver, when sitting in the driving seat in a normal driving position, has a clear view of the road to the rear and side(s) of the vehicle.

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- 23-1.5.1.2 Exterior mirrors shall be visible through the side windows or through the portion of the windscreen that is swept by the windscreen wiper. Nevertheless, for design reasons, this last provision (i.e. the provisions relating the cleaned part of the windscreen) shall not apply to:
- 23-1.5.1.2.1 exterior mirrors on the passenger side and optional exterior mirrors on the driver side of vehicles of categories M2 and M3;
  - 23-1.5.1.2.2 Class VI mirrors.
- 23-1.5.1.3 In the case of any vehicle, which is in chassis/cab form when the field of vision is measured, the minimum and maximum body widths shall be stated by the manufacturer and, if necessary, simulated by dummy headboards. All vehicles and mirror configurations taken into consideration during the tests shall be shown on the type approval certificate for a vehicle with regard to the installation of mirrors.
- 23-1.5.1.4 The prescribed exterior rear-view mirror on the driver side of the vehicle shall be located so as to form an angle of not more than 55 degrees between the vertical longitudinal median plane of the vehicle and the vertical plane which passes through the center of the rear-view mirror and through the center of the straight 65 mm line which joins the driver's two ocular points (see Fig 1).
- 23-1.5.1.5 Mirrors must not project beyond the external bodywork of the vehicle substantially more than is necessary to comply with the requirements concerning fields of vision.
- 23-1.5.1.6 Where the bottom edge of an exterior mirror is less than 2 m above the ground when the vehicle is laden, this rear-view mirror shall not project more than 250 mm beyond the overall width of the vehicle when not fitted with the rear-view mirror. However, for Class VI-A mirror mounted on M2 and M3, where the bottom edge of Class VI-A mirror is less than 1.8 m above the ground, this Class VI-A mirror shall not project out of the overall width of the vehicle, and if it's equipped with impact buffering design (to make it shrunk or extended), Class VI-A mirror shall not project more than 50 mm from the vehicle.
- 23-1.5.1.7 Class V and Class VI mirrors shall be mounted on vehicles in such a way that, regardless of their position after adjustment, no part of these mirrors or their holders is less than 2 m from the ground when the vehicle is under a load corresponding to its technically permissible maximum laden mass.. In this case an other device for indirect vision is not requested.
- 23-1.5.1.8 Subject to the requirements of paragraphs 23-1.5.1.5, 23-1.5.1.6. and 23-1.5.1.7, mirrors may project beyond the permissible maximum widths of vehicles.
- 23-1.5.2 Vehicle of category L:
- 23-1.5.2.1 rear-view mirrors must be mounted or adjusted in such a way that the distance of the center of the reflective surface, as measured in a horizontal plane, is at least 280 mm outward from the longitudinal vertical plane passing through the center of the steering head of the vehicle. Before the measurement, the handlebar shall be placed in the straight ahead position and the mirror(s) shall be adjusted to its (their) normal position.
  - 23-1.5.2.2 All Class VII mirrors shall be attached in such a way that they remain in a stable position under normal vehicle driving conditions.

23-1.6 mirror(s) shall be kept firm and stable.

23-1.6.1 In case of vehicles of category symbols M and N, the interior rear-view mirror shall be such that the driver can adjust it when in his

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driving position. The exterior rear-view mirror on the driver's side shall be capable of adjustment from inside the vehicle, the door being closed, although the window may be open. The former requirements do not apply to exterior mirrors which, after having been knocked out of alignment, can be returned to their former position without the need for adjustment.

23-1.6.2 In case of vehicles of categories L1 and L3, mirror(s) shall be such that the driver can adjust it (them) in the normal driving position.

#### 23-1.7 Vehicle's vision of mirrors

##### 23-1.7.1 Interior mirrors (Class I):

The field of vision shall be such that the driver can see at least a 20m-wide flat horizontal portion of the road centered on the vertical longitudinal median plane of the vehicle, from 60 m behind the driver's ocular points (see Figure 2) to the horizon.

##### 23-1.7.2 Main exterior mirrors (Class II) :

23-1.7.2.1 Exterior mirror (Class II) on the driver's side, the field of vision must be such that the driver can see at least a 5 m wide, flat, horizontal portion of the road, which is bounded by a plane which is parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle on the driver's side of the vehicle and extends from 30 m behind the driver's ocular points to the horizon. In addition, the road must be visible to the driver over a width of 1 m, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle starting from a point 4 m behind the vertical plane passing through the driver's ocular points (see Figure 3).

23-1.7.2.2 Exterior mirror (Class II) on the passenger's side. The field of vision must be such that the driver can see at least a 5 m wide, flat, horizontal portion of the road, which is bounded on the passenger's side by a plane parallel to the median longitudinal vertical plane of the vehicle and passing through the outermost point of the vehicle on the passenger's side and which extends from 30 m behind the driver's ocular points to the horizon. In addition, the road must be visible to the driver over a width of 1 m, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle starting from a point 4 m behind the vertical plane passing through the driver's ocular points (see Figure 3).

##### 23-1.7.3 Main exterior mirrors Class III

23-1.7.3.1 Exterior mirror (Class III) on the driver's side. The field of vision must be such that the driver can see at least a 4 m wide, flat,

horizontal portion of the road, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle on the driver's side of the vehicle and extends from 20 m behind the driver's ocular points to the horizon. In addition, the road must be visible to the driver over a width of 1 m, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle starting from a point 4 m behind the vertical plane passing through the driver's ocular points (see Figure 4).

23-1.7.3.2 Exterior mirror (Class III) on the passenger's side. The field of vision must be such that the driver can see at least a 4 m wide

flat, horizontal portion of the road which is bounded by a plane parallel to the median longitudinal vertical plane passing through the outermost point of the vehicle on the passenger's side and which extends from 20 m behind the driver's ocular points to the horizon. In addition, the road must be visible to the driver over a width of 1 m, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle starting from a point 4

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m behind the vertical plane passing through the driver's ocular points (see Figure 4).

23-1.7.4 Wide-angle exterior mirrors (Class IV):

23-1.7.4.1 Wide-angle: exterior mirror on the driver's side. The field of vision must be such that the driver can see at least a 15 m wide, flat, horizontal portion of the road, which is bounded by a plane parallel to the median longitudinal vertical plane of the vehicle and passing through the outermost point of the vehicle on the driver's side and which extends from at least 10 m to 25 m behind the driver's ocular points. In addition, the road must be visible to the driver over a width of 4.5 m, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle starting from a point 1.5 m behind the vertical plane passing through the driver's ocular points (see Figure 5).

23-1.7.4.2 Wide-angle: exterior mirror on the passenger's side. The field of vision must be such that the driver can see at least a 15 m wide, flat, horizontal portion of the road, which is bounded by a plane parallel to the median longitudinal vertical plane of the vehicle and passing through the outermost point of the vehicle on the passenger's side and which extends from at least 10 m to 25 m behind the driver's ocular points. In addition, the road must be visible to the driver over a width of 4.5 m, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle starting from a point 1.5 m behind the vertical plane passing through the driver's ocular points (see Figure 5).

23-1.7.5 Close-proximity: exterior mirror (Class V)

The field of vision must be such that the driver can see a flat horizontal portion of the road along the side of the vehicle, bounded by

the following vertical planes (see Figures 6A and 6B):

23-1.7.5.1 The plane parallel to the median longitudinal vertical plane of the vehicle which passes through the outermost point of the vehicle cab on the passenger's side;

23-1.7.5.2 in the transverse direction, the parallel plane passing at a distance of 2 m in front of the plane mentioned in paragraph 23-1.1.7.5.1.

23-1.7.5.3 to the rear, the plane parallel to the vertical plane passing through the driver's ocular points and situated at a distance of 1.75 m behind that plane;

23-1.7.5.4 to the front, the plane parallel to the vertical plane passing through the driver's ocular points and situated at a distance of 1 m in front of that plane. If the vertical transverse plane passing through the leading edge of the vehicle bumper is less than 1 m in front of the vertical plane passing through the driver's ocular points, the field of vision shall be limited to that plane.

23-1.7.5.5 In case the field of vision described in Figures 6A and 6B can be perceived through the combination of the field of vision from a Class IV wide-angle mirror and that of a Class VI front mirror, the installation of a Class V close proximity mirror is not compulsory.

23-1.7.5.6 On the passenger side only, the field of vision shall also be such that the driver can see a flat horizontal portion of the road along the side of the vehicle which is outside the field defined in paragraphs 23-1.7.5.1 to 23-1.7.5.4 above but within the field bounded by the following vertical planes; the front of this field of vision may be rounded off with a radius of 2,000 mm (see Figures 6C and 6D):

23-1.7.5.7 In the transverse direction, the parallel plane passing at a distance of 4.5 m in front of the plane mentioned in paragraph

- 23-1.7.5.1. above.
- 23-1.7.5.8 To the rear, the plane parallel to the vertical plane passing through the driver's ocular points and situated at a distance of 1.75 m behind that plane.
- 23-1.7.5.9 To the front, the plane parallel to the vertical plane passing through the driver's ocular points and situated at a distance of 3 m in front of that plane. This field of vision may be partially provided by a front mirror (Class VI).
- 23-1.7.5.10 The field of vision prescribed in paragraphs 23-1.7.5.6. to 23-1.7.5.9. above may be partially provided by a "wide-angle" exterior mirror (Class IV) or a combination of a close-proximity exterior mirror (Class V) and a front mirror (Class VI).
- 23-1.7.5.11 The area prescribed in paragraphs 23-1.7.5.6. to 23-1.7.5.9. above may be viewed using a combination of direct view and indirect vision devices(Class IV,V,VI).
- 23-1.7.5.11.1 If an indirect vision device of Class IV is used to provide a part of the field of vision prescribed in paragraphs 23-1.7.5.6 to 23-1.7.5.9, it shall be adjusted in a way that it simultaneously provides the field of vision prescribed in paragraph 23-1.7.4.2.
- 23-1.7.5.11.2 If an indirect vision device of Class V is used to provide a part of the field of vision prescribed in paragraphs 23-1.7.5.6 to 23-1.7.5.9, it shall be adjusted in a way that it simultaneously provides the field of vision prescribed in paragraphs 23-1.7.5.1 to 23-1.7.5.4.
- 23-1.7.5.11.3 If an indirect vision device of Class VI is used to provide a part of the field of vision prescribed in paragraphs 23-1.7.5.6 to 23-1.7.5.9, it shall be adjusted in a way that it simultaneously provides the field of vision prescribed in paragraph 23-1.7.6.1.
- 23-1.7.5.12 The field of vision prescribed in paragraphs 23-1.7.5.1 to 23-1.7.5.4 may be viewed using a combination of a close-proximity exterior mirror (Class V) and a "wide-angle exterior mirror (Class IV). In such cases the close-proximity exterior mirror (Class V) shall provide at least 90 per cent of the field of vision prescribed in paragraphs 23-1.7.5.1 to 23-1.7.5.4 and the Class IV mirror shall be adjusted in a way that it simultaneously provides the field of vision prescribed in paragraph 23-1.7.4.2.
- 23-1.7.5.13 Paragraphs 23-1.7.5.6. to 23-1.7.5.12 shall not apply to a vehicle where any part of the Class V mirror, or its holder, is less than 2.4 m above the ground, regardless of its position after adjustment.
- 23-1.7.5.14 Paragraphs 23-1.7.5.6. to 23-1.7.5.12 shall not apply to a vehicle of category M2 or M3.
- 23-1.7.6 Front mirror (Class VI)
- 23-1.7.6.1 The field of vision shall be such that the driver can see at least a flat horizontal portion of the road, which is bounded by:
- (a) a transverse vertical plane through the outermost point of the front of the vehicle,
  - (b) a transverse vertical plane 2,000 mm in front of the plane defined in (a),
  - (c) a longitudinal vertical plane parallel to the longitudinal vertical median plane going through the outermost side of the vehicle at the driver's side and,
  - (d) a longitudinal vertical plane parallel to the longitudinal vertical median plane 2000 mm outside the outermost side of the vehicle opposite to the driver's side.
- The front of this field of vision opposite to the driver's side may be rounded off with a radius of 2 000 mm (see figure 7)
- The provisions for front mirrors are compulsory for forward controlled vehicles of categories N2 > 7.5 t and N3.

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If vehicles of these categories cannot fulfill the requirements by using a front mirror or a camera/monitor device, a vision support system shall be used. In the case of a vision support system this device must be able to detect an object of 50 height and with a diameter of 30 cm within the field defined in figure 7.

Forward control means a configuration in which more than half of the engine length is rearward of the foremost point of the windshield base and the steering wheel hub in the forward quarter of the vehicle length.

23-1.7.6.2 However, if the driver can see, taking into account the obstructions by the A-pillars, a straight line 300 mm in front of the vehicle at a height of 1,200 mm above the road surface, a front mirror of Class VI is not mandatory.

(1) and which is situated between a longitudinal vertical plane parallel to the longitudinal vertical median plane going through the outermost side of the vehicle at the driver's side.

(2) a longitudinal vertical plane parallel to the longitudinal vertical median plane 900 mm outside the outermost side of the vehicle opposite to the driver's side.

23-1.7.6.3 For the purpose of paragraphs 23-1.7.6.1 and 23-1.7.6.2 parts permanently attached to the vehicle that are situated both above the driver's eye points and in front of the transverse vertical plane passing through the foremost surface of the vehicle's front bumper shall not be taken into account when defining the front of the vehicle.

23-1.7.7 Front mirror of cab-over-type vehicle (Class VI-A): cab-over-type vehicle shall install a front mirror of class VI-A except the vehicle having front mirror of class VI.

23-1.7.8 L-category mirror (Class VII) (see Figure 8).

23-1.7.8.1 Exterior rear-view mirror on the driver's side. The field of vision must be such that the driver can see at least a 2.50 m wide, flat, horizontal portion of the road, which is bounded by a plane parallel to the median longitudinal vertical plane and passing through the outermost point of the vehicle on the driver's side of the vehicle and extends from 10 m behind the driver's ocular points to the horizon.

23-1.7.8.2 Exterior rear-view mirror on the passenger's side. The field of vision must be such that the driver can see at least a 4 m wide flat, horizontal portion of the road which is bounded by a plane parallel to the median longitudinal vertical plane passing through the outermost point of the vehicle on the passenger's side and which extends from 20 m behind the driver's ocular points to the horizon.

23-1.7.9 In the case of mirrors consisting of several reflecting surfaces which are either of different curvature or make an angle with each other, at least one of the reflecting surfaces must provide the field of vision and have the dimensions.

23-1.7.10 Obstructions

23-1.7.10.1 Interior rear-view mirror (Class I)

The field of vision may be reduced by the devices such as, in particular, sun visors, rear windscreen wipers and heating elements, these devices shall not cover more than 15% of vision except headrests, body and components of bodywork such as window columns of rear split doors. This requirement shall be tested by projection on to a vertical plane at right angles to the longitudinal centreplane of the vehicle. The degree of obstruction shall be measured with the headrests adjusted to their lowest possible position and with the sun visors folded back.

23-1.7.10.2 Exterior mirrors (Classes II, III, IV, V, VI and VII)

In the fields of vision specified above, obstruction due to the bodywork and its components, such as other cab mirrors, door handles, outline marker lights, direction indicators and front and rear bumpers, as well as reflective-surface cleaning

components, shall not be taken into account if they are responsible for a total obstruction of less than 10 per cent of the specified field of vision. In the case of a vehicle designed and constructed for special purposes where, due to its special features, it is not possible to meet this requirement, the obstruction of the required field of vision of a Class VI mirror caused by the special features may be more than 10 per cent but not more than necessary for its special function.

23-1.8 Devices for indirect vision other than mirrors

23-1.8.1 A device for indirect vision shall give such performances that a critical object can be observed by the driver over the entire required field of vision, taking into account the critical perception according the procedure of paragraph 23-1.9 .Alternatively, the determination of the displayed object size shall be performed according to paragraph 27.11 of “Devices for indirect vision“ of this VSTD..

23-1.8.2 Obstruction of the driver's direct view caused by the installation of a device for indirect vision shall be restricted to a minimum.

23-1.8.3 Installation requirements for the monitor

The viewing direction of the monitor shall roughly be the same direction as the one for the main mirror.

23-1.8.4 Vehicles may be equipped with additional devices for indirect vision.

23-1.8.5 The provisions of this Regulation do not apply to the surveillance camera-monitor-recording devices defined in paragraph 23-1.2.12. Exterior surveillance cameras either shall be mounted at least 2 m above the ground when the vehicle is under a load corresponding to its announced mass, or, if their lower edge is less than 2 m from the ground, shall not project more than 50 mm beyond the overall width of the vehicle measured without this device and have a radii of curvature of not less than 2.5 mm.

23-1.9 Calculation of the distance detection of camera/monitor device

23-1.9.1 Determination of the smallest discernable detail. The smallest discernable detail of the naked eye shall be defined according to standard ophthalmologic tests like the Landolt C test or the Triangle Orientation Discrimination (TOD) test. The smallest discernable detail at the centre of the viewing system can be determined using the Landolt C test or the TOD test. In the rest of the viewing area the smallest discernable detail may be estimated from the centrally determined smallest discernable detail and the local image deformation. For instance, in the case of a digital camera the smallest discernable detail at a given pixel location (in the monitor) scales inversely with the solid angle of the pixel.

23-1.9.1.1 Landolt-C test : In the Landolt-C test, test symbols are judged by the subject under test. In accordance with this test the smallest discernable detail is defined as the visual angle of the gap size of the Landolt C symbol at threshold size and is expressed in arcmin. The threshold size corresponds to the size at which the subject judges the orientation correctly in 75 percent of the trials. The smallest discernable detail is determined in a test involving a human observer. A test chart containing test symbols is placed in front of the camera and the observer judges the orientation of test symbols from the monitor. From the threshold gap size of the Landolt C test symbol  $d$  (m) and the distance between the test pattern and the camera  $D$  (m) the smallest discernable detail  $\omega_c$  (arcmin) is calculated as follows:

$$\omega_c = \frac{d}{D} \cdot \frac{180 \cdot 60}{\pi}$$

23-1.9.1.2 TOD test : The Landolt C test can be used to determine the smallest discernable detail of the camera-monitor system.

However, for sensor systems it is more suitable to use the TOD (Triangle Orientation Discrimination) method which is similar to the Landolt C method, but involves equilateral triangular test patterns. The Triangle Orientation Discrimination method is described in detail by Bijl & Valeton (1999), who provide practical guidelines on how to perform a TOD measurement. In the method, triangular test patterns (see Figure 1) are viewed through the viewing system under test. Each triangle can have one out of four possible orientations (apex up, left, right or down) and the observer indicates/guesses for each triangle its orientation. When this procedure is repeated for many (randomly oriented) triangles of different sizes the fraction of correct responses can be plotted (see Figure 2), and increases with test pattern size. The threshold is defined as the point at which the fraction correct crosses the 0.75 level and can be obtained by fitting a smooth function through the data (see Bijl & Valeton, 1999). Critical perception is reached when the critical object diameter equals two times the width of the triangle at threshold size. The smallest discernable detail ( $\omega_c$ ) is equal to 0.25 times the width of the triangle at threshold size. This means that, from the threshold triangle width  $w$  (in m) and the distance between test pattern and the camera  $D$  (in m) the smallest discernable detail  $\omega_c$  (in arcmin) is calculated as follows:

$$\omega_c = \frac{w}{4 \cdot D} \cdot \frac{180 \cdot 60}{\pi}$$

23-1.9.2 Determination of the critical viewing distance of the monitor. For a monitor having certain dimensions and properties, the distance to the monitor can be calculated within which the detection distance is dependent only on the performances of the camera. The critical viewing distance  $r_{\text{mcrit}}$  is defined as the distance at which the smallest discernable detail displayed on the monitor spans 1 arc min measured from the eye (the acuity threshold of a standard observer).

$$r_{\text{mcrit}} = \frac{\delta \cdot 60 \cdot 180}{\pi}$$

where:

$r_{\text{mcrit}}$  : critical viewing distance of the monitor (m)

$\delta$ : size of the smallest discernable detail on the monitor (m)

23-1.9.3 Determination of the distance detection

23-1.9.3.1 For maximum detection distance within the critical viewing distance where, due to then installation, the distance eye-monitor is less than the critical viewing distance, the maximum attainable detection distance is defined as:

$$r_{\text{dclose}} = \frac{D_0 \cdot 60 \cdot 180}{\omega_c \cdot \pi \cdot f}$$

where:

$r_{\text{dclose}}$ : detection distance (m)

$D_0$  : diameter of the critical object (m) according to paragraph 23-1.2.8.; for the calculation of  $r_{dclose}$  for class V and VI devices, a representative value of 0,30 m shall be used

f: threshold increasing factor, which is equal to 8

$\omega_c$ : smallest discernable detail (arcmin)

23-1.9.3.2 For detection distance greater than the critical viewing distance. Where, due to the installation, the distance eye-monitor is more than the critical viewing distance, the maximum obtainable detection distance is defined as:

$$r_{dfar} = \frac{r_{mcrit}}{r_m} r_{dclose} \quad (m)$$

where:

$r_{dfar}$ : detection distance for distances larger than the critical viewing distance (m)

$r_{dclose}$ : detection distance for distances smaller than the critical viewing distance (m)

$r_m$ : viewing distance, i.e. distance between eye and monitor (m)

$r_{mcrit}$ : critical viewing distance (m)  $\omega_{eye} = 1$

23-1.9.4 Secondary functional requirements : Based on the installation conditions, a verification shall be made to discover whether the entire device can still satisfy the functional requirements listed in paragraph 23-1.10.2. of these Directions, especially the glare correction, the maximum and the minimum luminance of the monitor. It shall also be verified the degree to which the glare correction will be addressed and the angle at which sunlight can strike a monitor and these shall be compared to the corresponding measuring results from the system measurements. This can be either based on a CAD-generated model, a determination of the angles of light for the device when mounted on the relevant vehicle, or by carrying out relevant measurements on the relevant vehicle as described in paragraph 23-1.10.2.2 of this Direction.

Chart 1 :The amount of installation devices' table

| Vehicle category | Interior mirror   | Exterior mirrors             |   |  |   |   |  |
|------------------|---|------------------------------|---|--|---|---|--|
|                  | Interior mirror Class I   | Main mirror (large) Class II | Main mirror (small) Class III   | Wide-angle mirror Class IV   | Close-proximity mirror Class V  | Front mirror Class VI   | Front mirror of cab-over-type vehicle class VI-A                                       |
| M1               | <b>Compulsory</b><br>Unless the vehicle is fitted with anything other than safety glazing material in the | <b>Optional</b>              | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side<br>Class II mirrors | <b>Optional</b><br>1 on the driver's side and / or 1 on the passenger's side | <b>Optional</b><br>1 on the driver's side and 1 on the passenger's side<br>(both must be fitted | <b>Optional</b><br>(must be fitted at least 2 m above the ground) | <b>Optional</b><br>1 front mirror; except the vehicle having front mirror of class VI. |

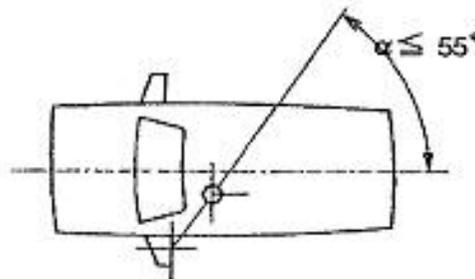
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|         |  |   |  |  |  |   |  |
|---------|--|---|--|--|--|---|--|
|         | field of vision prescribed in paragraph 23-1.7.1   |   | may be fitted as an alternative.   |  | at least 2 m above the ground)   |   |  |
| M2      | <b>Optional</b>  | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | Not permitted  | <b>Optional</b><br>1 on the driver's side and / or 1 on the passenger's side   | <b>Optional</b><br>1 on the driver's side and 1 on the passenger's side (both must be fitted at least 2 m above the ground)  | <b>Optional</b><br>(must be fitted at least 2 m above the ground)                 | <b>Compulsory</b><br>1 front mirror; except the vehicle having front mirror of class VI. |
| M3      | <b>Optional</b>  | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | Not permitted  | <b>Optional</b><br>1 on the driver's side and / or 1 on the passenger's side   | <b>Optional</b><br>1 on the driver's side and 1 on the passenger's side (both must be fitted at least 2 m above the ground)  | <b>Optional</b><br>(must be fitted at least 2 m above the ground)                 | <b>Compulsory</b><br>1 front mirror; except the vehicle having front mirror of class VI. |
| N1      | <b>Compulsory</b><br>Unless the vehicle is fitted with anything other than safety glazing material in the field of vision prescribed in paragraph 23-1.7.1 | <b>Optional</b>   | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side<br>Class II mirrors may be fitted as an alternative. | <b>Optional</b><br>1 on the driver's side and / or 1 on the passenger's side   | <b>Optional</b><br>1 on the driver's side and 1 on the passenger's side (both must be fitted at least 2 m above the ground)  | <b>Optional</b><br>(must be fitted at least 2 m above the ground)                 | <b>Optional</b><br>1 front mirror; except the vehicle having front mirror of class VI.   |
| N2□7.5t | <b>Optional</b>  | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | Not permitted  | <b>Compulsory:</b><br>For both sides if a Class V mirror can be fitted<br><b>Optional:</b><br>For both sides together if not | <b>Compulsory:</b><br>( See the note ) 1 on the passenger's side<br><b>Optional:</b> 1 on the driver's side (both must be fitted at least 2 m above the ground). A | <b>Optional</b><br>1 front mirror (must be fitted at least 2 m above the ground). | <b>Compulsory</b><br>1 front mirror; except the vehicle having front mirror of class VI. |

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|           |                 |   |               |   |   |  |  |
|-----------|-----------------|---|---------------|---|---|--|--|
|           |                 |   |               |   | tolerance of +10 cm may be applied.   |  |  |
| N2 > 7.5t | Optional        | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | Not permitted | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | <b>Compulsory,</b><br>(See the note) 1 on the passenger's side<br><b>Optional</b><br>1 on Driver's side (both must be fitted at least 2 m above the ground) | <b>Compulsory,</b><br>1. front mirror (must be fitted at least 2 m above the ground) | <b>Compulsory</b><br>1 front mirror; except the vehicle having front mirror of class VI. |
| N3        | <b>Optional</b> | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | Not permitted | <b>Compulsory</b><br>1 on the driver's side and 1 on the passenger's side | <b>Compulsory,</b><br>(See the note) 1 on the passenger's side<br><b>Optional</b><br>1 on driver's side (both must be fitted at least 2 m above the ground) | <b>Compulsory,</b><br>1. front mirror (must be fitted at least 2 m above the ground) | <b>Compulsory</b><br>1 front mirror; except the vehicle having front mirror of class VI. |

- Note: 1. Class V and Class VI mirrors shall be mounted on vehicles in such a way that, regardless of their position after adjustment, no part of these mirrors or their holders is less than 2 m from the ground when the vehicle is under a load corresponding to its technically permissible maximum laden mass. These mirrors shall not, however, be mounted on vehicles the cab height of which is such as to prevent compliance with this requirement. In this case an other device for indirect vision is not requested.
2. In case the field of vision described in Figures 6a and 6b can be perceived through the combination of the field of vision from a Class IV wide-angle mirror and that of a Class VI front mirror, the installation of a Class V close proximity mirror is not compulsory.
3. Optional, no requirements for the field of vision.



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Figure 1: Angle between the vertical longitudinal median plane of the vehicle and the vertical plane which passes through the centre of the rear-view mirror and line which joins the driver's two ocular points

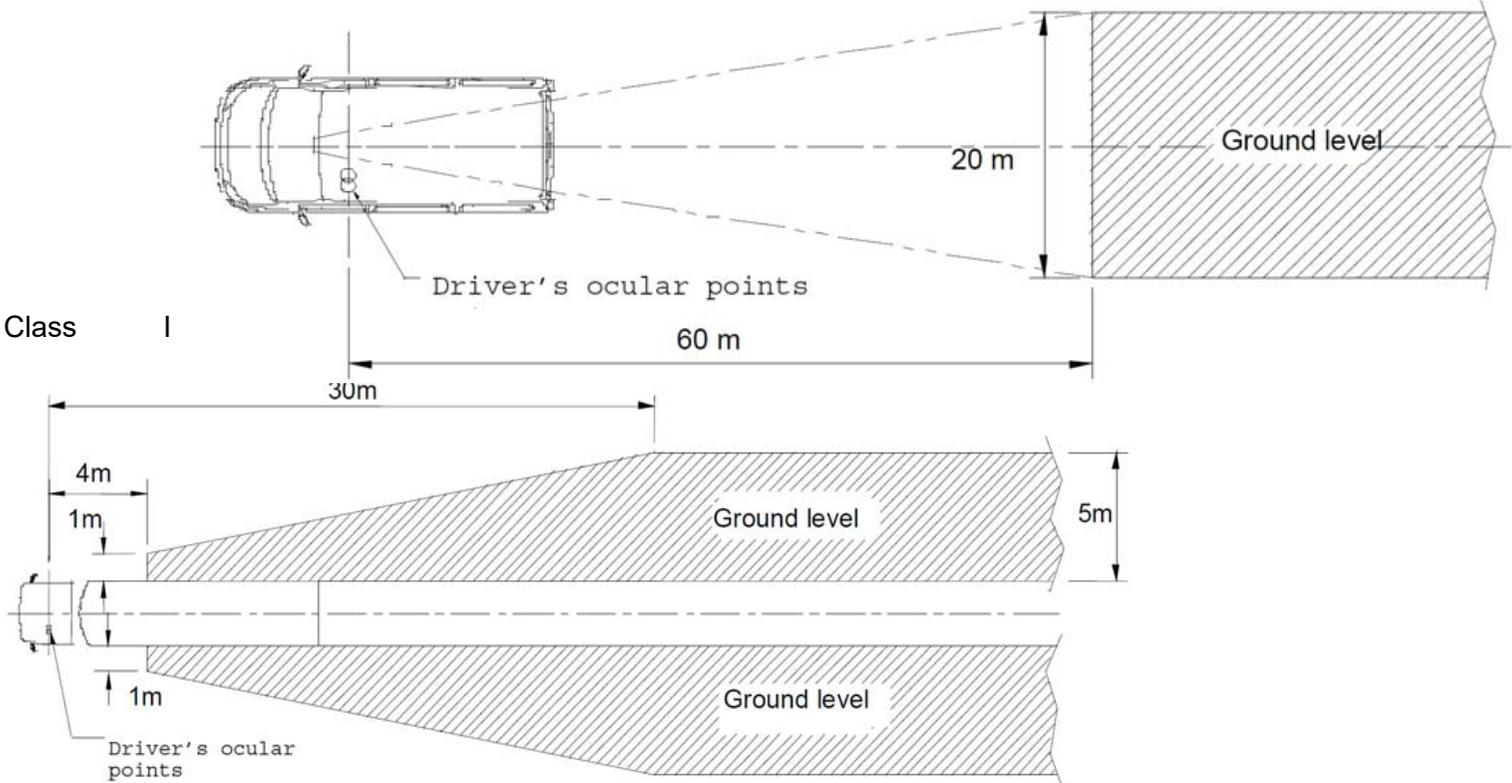


Figure 2: Field of vision of mirror

Figure3: Field of vision of ClassII mirrors

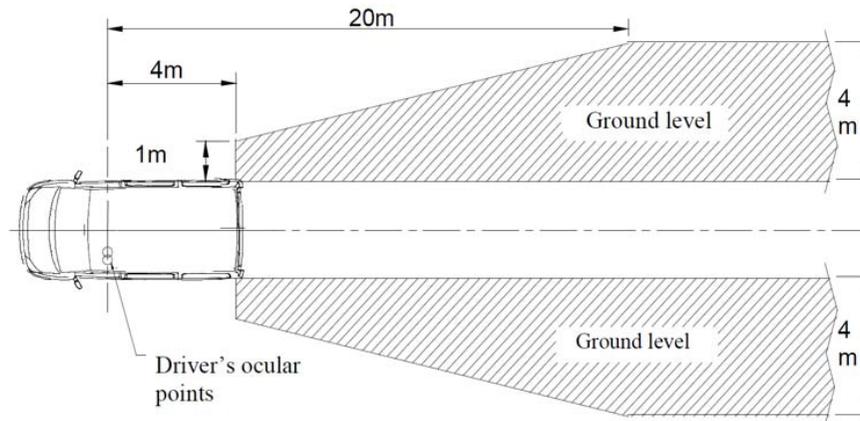


Figure 4: Field of vision of Class III mirrors

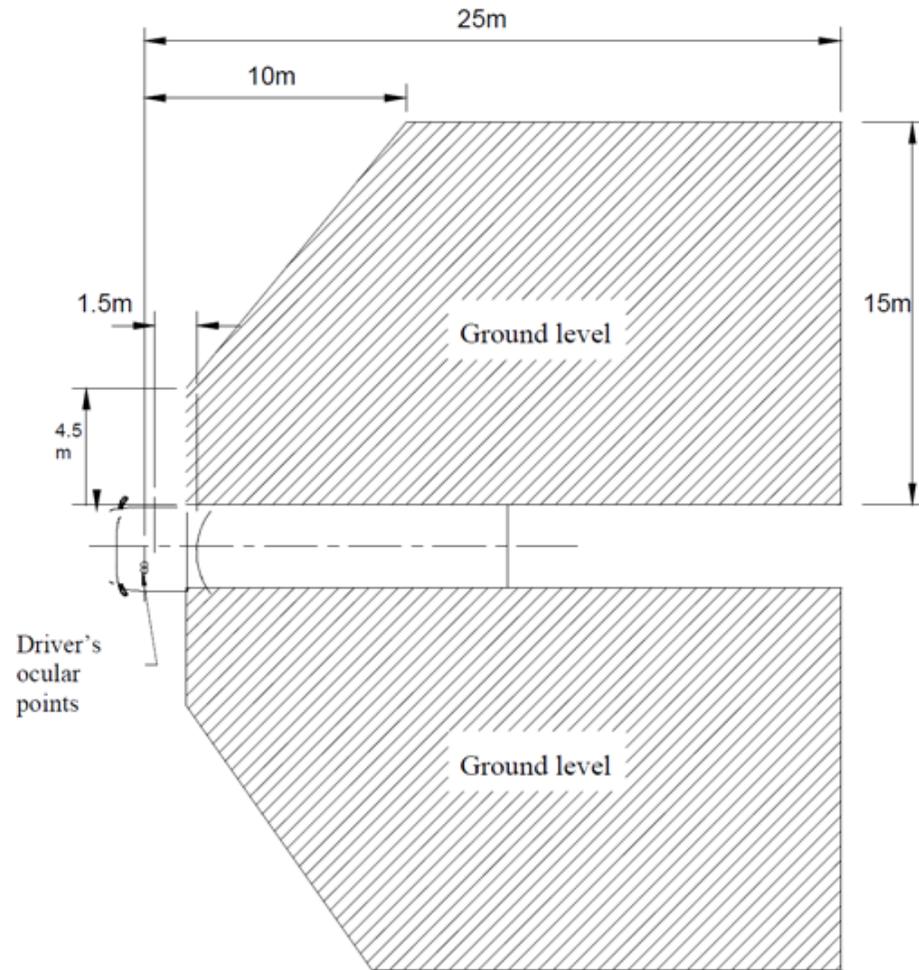


Figure 5: Field of vision of Class IV wide-angle mirrors

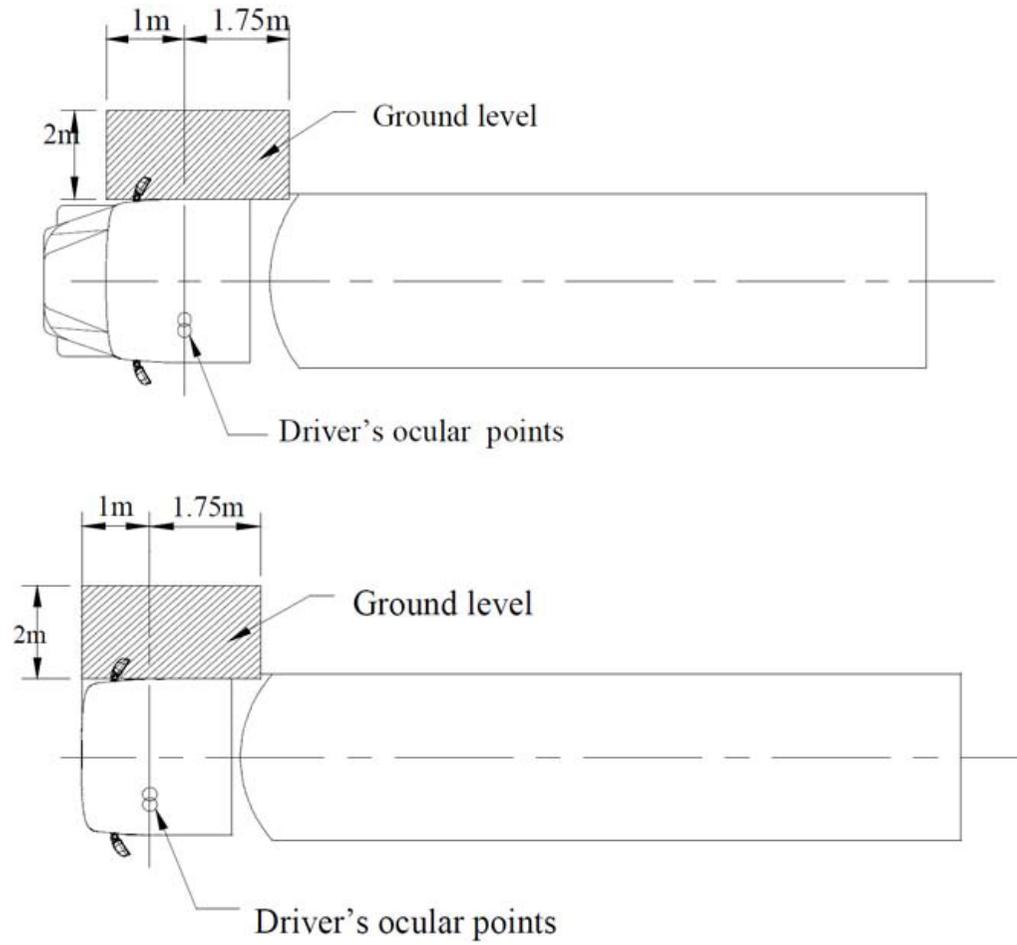
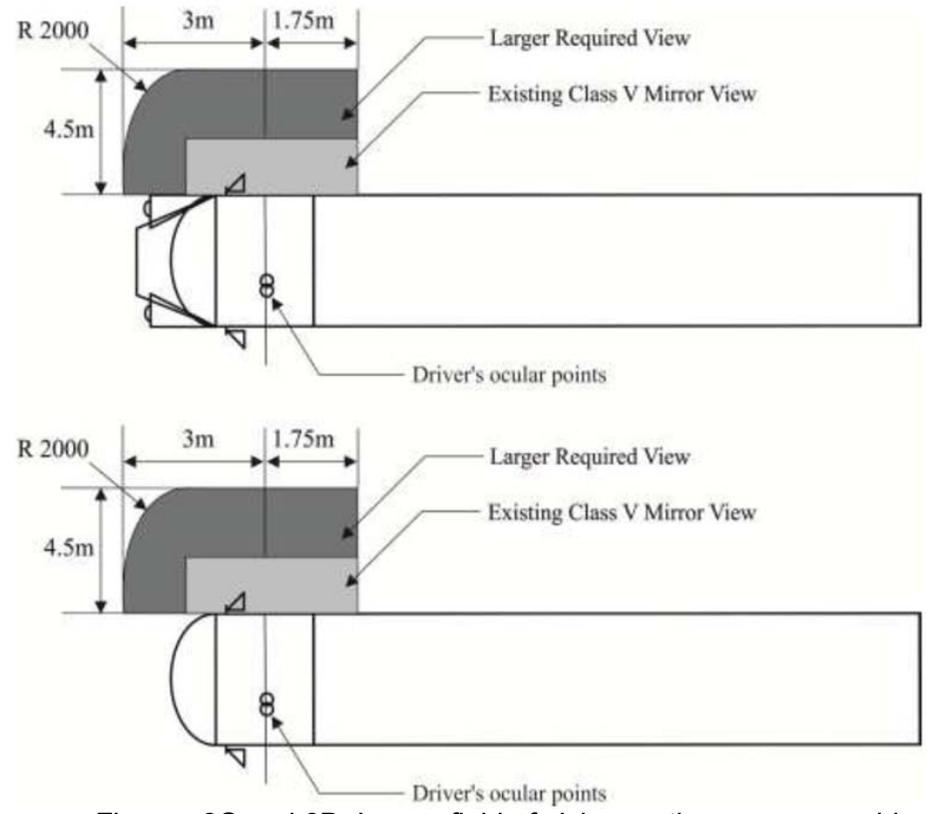


Figure 6A and 6B: Field of vision of Class V close-proximity mirror



Figures 6C and 6D: Larger field of vision on the passenger side

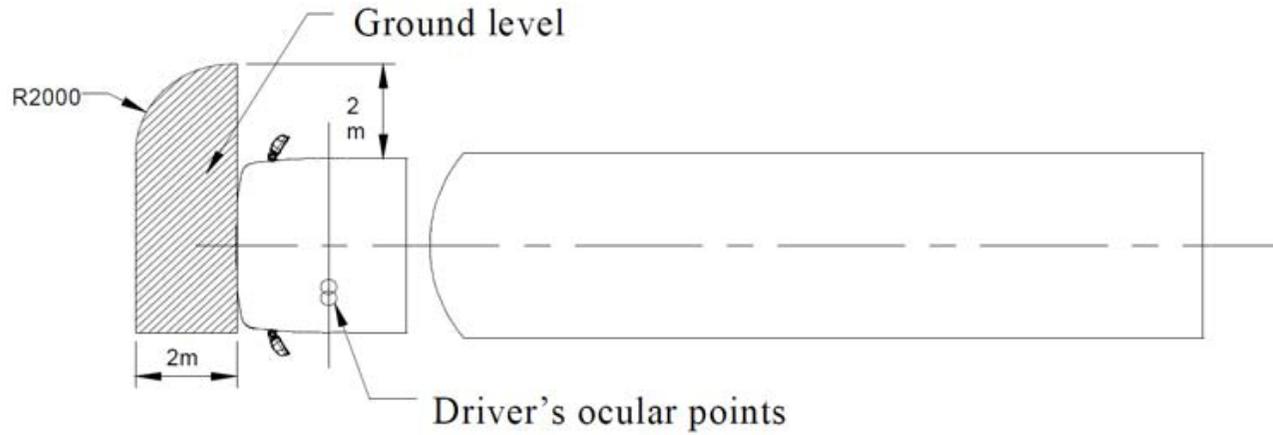


Figure 7: Field of vision of Class VI front mirror

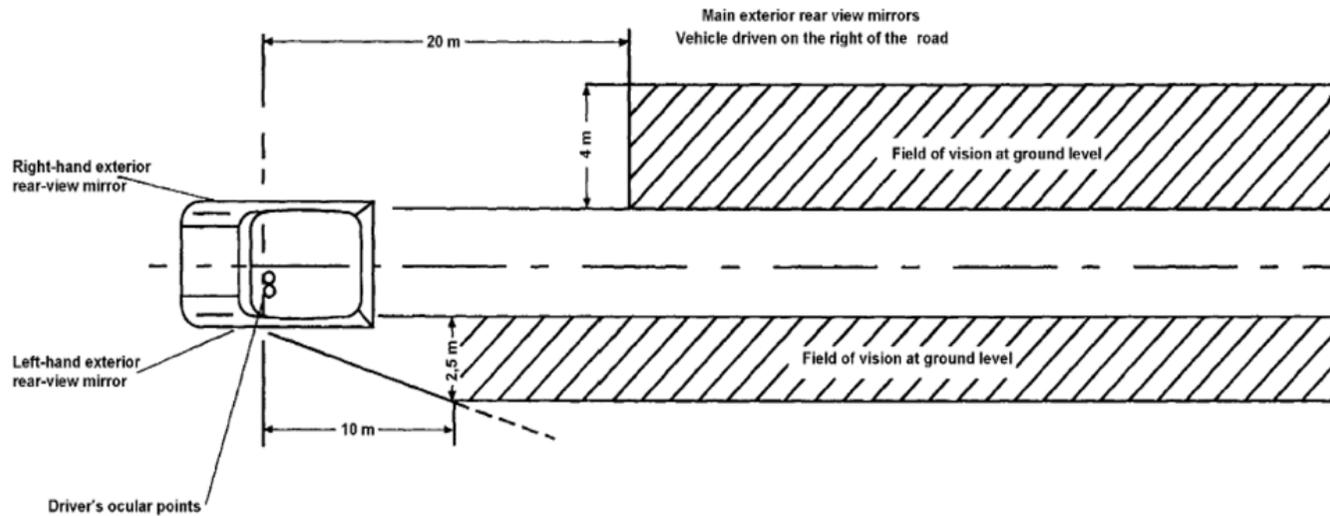


Figure 8: Field of vision of Class VII mirrors

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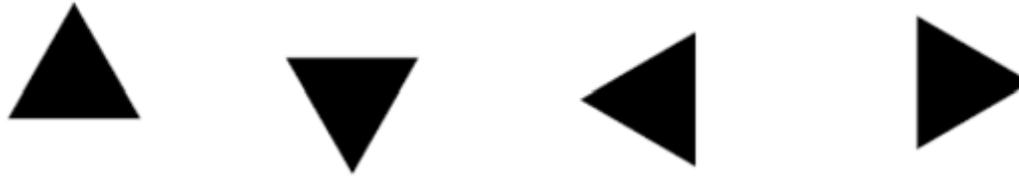


Figure 9: Triangular test patterns used in the Triangle Orientation Discrimination (TOD) method

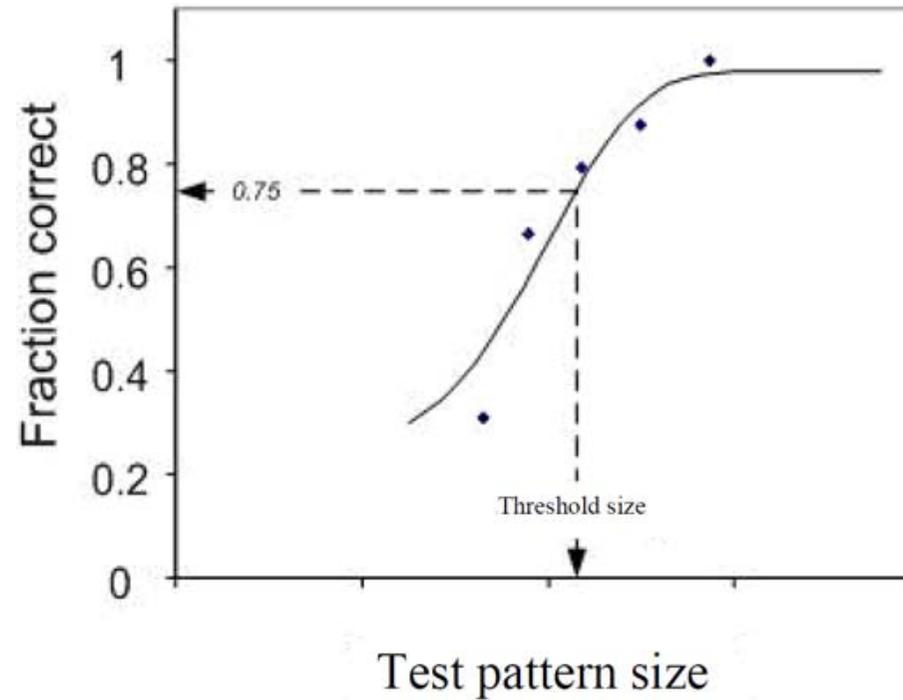


Figure 10: Typical relationship between the size of the triangle and the fraction of correct responses.