22

INTERNATIONAL STANDARD ISO 3538

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Révisée

Road vehicles – Safety glasses – Test methods for optical properties

Véhicules routiers – Vitres de sécurité – Méthodes d'essai des propriétés optiques

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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 3538 was drawn up by Technical Committee ISO/TC 22, *Motor vehicles*, and circulated to the Member Bodies in July 1974.

It has been approved by the Member Bodies of the following countries :

Austria	Iran	Spain
Brazil	Israel	Sweden
Bulgaria	Italy	Switzerland
Canada	Netherlands	Turkey
Czechoslovakia	Poland	United Kingdom
Finland	Portugal	U.S.A.
France	Romania	Yugoslavia
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The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Belgium
Germany

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Road vehicles – Safety glasses – Test methods for optical properties

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies optical test methods relating to the safety requirements for all safety glasses in a road vehicle, whatever the type of glass or other material of which they are composed.

2 REFERENCES

ISO 48, *Vulcanized rubbers – Determination of hardness (Hardness between 30 and 85 IRHD).*

ISO 3536/I, *Road vehicles – Safety glasses – Vocabulary – Part I.*

3 TEST CONDITIONS

Unless otherwise specified, the tests shall be carried out under the following conditions :

Temperature : 20 ± 5 °C

Pressure : 860 to 1 060 mbar

Relative humidity : 60 ± 20 %

4 APPLICATION OF TESTS

For certain types of safety glass, it is not necessary to carry out all the tests specified in this International Standard, when the results, according to the purpose of testing, can be predicted with certainty from a knowledge of the properties of the safety glass concerned.

5 LIGHT TRANSMISSION TEST

5.1 Purpose of test

The purpose of this test is to determine whether the safety glass has a certain regular light transmittance.

5.2 Apparatus

5.2.1 Light source, consisting of an incandescent lamp, the filament of which is contained within a parallellepiped 1,5 mm × 1,5 mm × 3 mm. The voltage at the lamp terminals shall be such that the colour temperature is 2 856 ± 50 K. This voltage shall be stabilized within 1/1 000. The instrument used to check the voltage shall be of appropriate accuracy.

5.2.2 Optical system, consisting of a lens with a focal length *f* of at least 500 mm and corrected for chromatic aberrations. The clear aperture of the lens shall not exceed *f*/20. The distance between the lens and the light source shall be adjusted in order to obtain a light beam which is substantially parallel. A diaphragm shall be inserted to limit the diameter of the light beam to 7 ± 1 mm. This diaphragm shall be situated at a distance of 100 ± 50 mm from the lens on the side remote from the light source. The point of measurement shall be taken at the centre of the light beam.

5.2.3 Measuring equipment. The receiver shall have a relative spectral sensitivity in substantial agreement with the relative spectral luminous efficiency for the CIE[1] standard photometric observer for photopic vision. The sensitive surface of the receiver shall be covered with a diffusing medium and shall have at least twice the cross-section of the light beam emitted by the optical system. If an integrating sphere is used, the aperture of the sphere shall be at least twice the cross-section of the parallel portion of the beam.

The linearity of the receiver and the associated indicating instrument shall be equal to, or better than, 2 % of the effective part of the scale.

The receiver shall be centred on the axis of the light beam.

1) International Commission on Illumination.

5.3 Procedure

Adjust the instrument indicating the response of the receiver to indicate 100 divisions when the safety glass is not inserted in the light path. When no light is falling on the receiver, the instrument shall read zero.

Place the safety glass at a distance from the receiver of approximately fives times the diameter of the receiver.

Insert the safety glass between the diaphragm and the receiver and adjust its orientation in such a way that the angle of incidence of the light beam is equal to $0 \pm 5^\circ$. The regular transmittance shall be measured on the safety glass, and for every point measured, the number of divisions, n, shown on the indicating instrument, shall be read. The regular transmittance τ_r is equal to $n/100$.

5.4 Expression of results

The regular transmittance τ_r shall be determined at any point on the safety glass, in accordance with the method specified above.

6 SECONDARY IMAGE SEPARATION TEST

6.1 Purpose of test

The purpose of this test is to determine the angular separation between the primary and secondary images.

6.2 Field of application

Two types of tests are recognized :

- target test;
- collimation telescope test.

These tests may be used for approval purposes, quality control or product evaluation as appropriate.

6.3 Target test

6.3.1 *Apparatus*

This method involves viewing an illuminated target through the safety glass. The target may be designed in such a way that the test can be carried out on a simple "Go – No Go" basis.

The target shall preferably be in the form of either :

a) an illuminated "ring" target, the outer diameter, D, of which subtends an angle of η minutes of arc at a point situated at x metres (figure 1a)); or

b) an illuminated "ring and spot" target, the dimensions of which are such that the distance, D, from a point on the edge of the spot to the nearest point on the inside of the circle subtends an angle of η minutes of arc at a point situated at x metres (figure 1b));

where

η is the limit value of secondary image separation;

x is the distance from the safety glass to the target (not less than 7 m);

D is given by the formula

$$D = x \tan \eta$$

The illuminated target consists of a light box, approximately 300 mm × 300 mm × 150 mm, the front of which is most conveniently constructed from glass masked with opaque black paper or coated with matt black paint. The box shall be illuminated by a suitable light source. The inside of the box shall be coated with matt white paint.

It may be convenient to use other forms of target, such as shown in figure 4. It is also acceptable to replace the target system with a projection system and to view the resulting images on a screen.

6.3.2 *Procedure*

Mount the safety glass at the designed rake angle on a suitable stand in such a way that the observation is carried out in the horizontal plane passing through the centre of the target.

The light box shall be viewed in a dark or semi-dark room, through each part of the area being examined, in order to detect the presence of any secondary image associated with the illuminated target. Rotate the safety glass as necessary to ensure that the correct direction of view is maintained. A monocular may be used for viewing.

6.3.3 *Expression of results*

Determine whether :

- using target a) (see figure 1), the primary and secondary images of the circle separate, i.e. whether the limit value of η is exceeded, or,

- using target b) (see figure 1), the secondary image of the spot shifts beyond the point of tangency with the inside edge of the circle, i.e. whether the limit value of η is exceeded.

6.4 Collimation telescope test

6.4.1 *Apparatus*

The apparatus consists of a collimator and telescope and may be set up in accordance with figure 3. Any equivalent optical system may, however, be used.

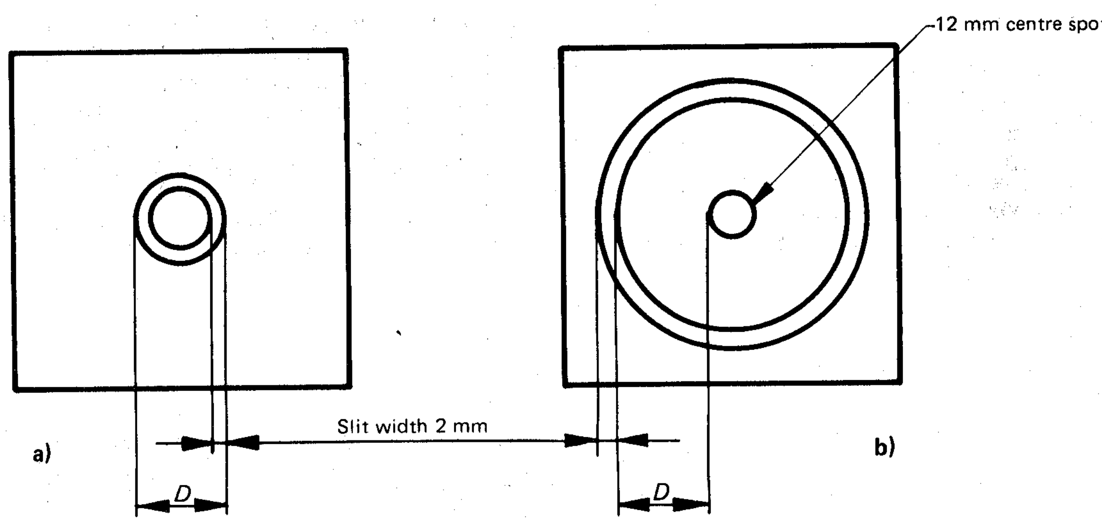


FIGURE 1 — **Dimensions of targets**

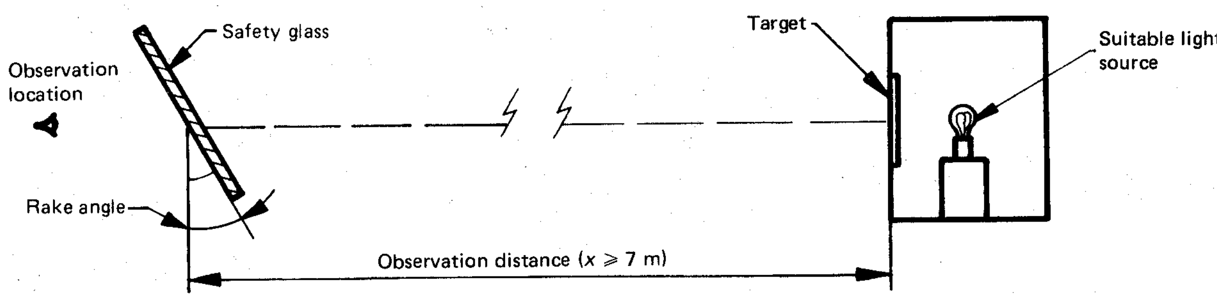
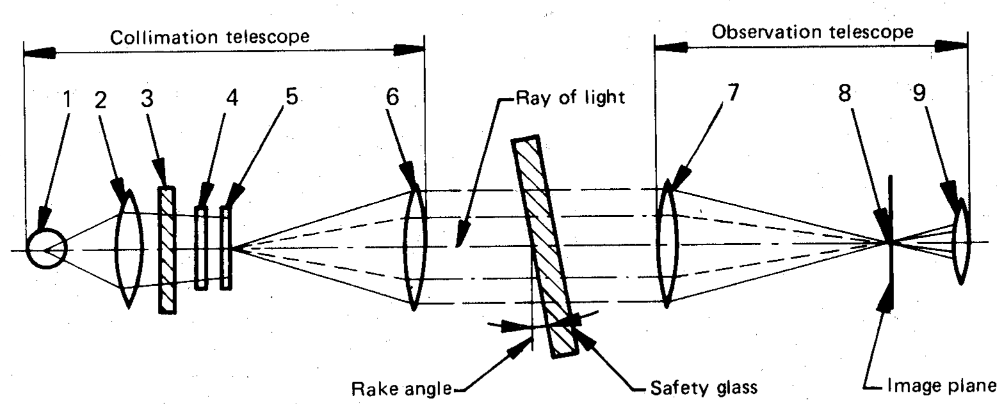


FIGURE 2 — **Arrangement of apparatus**



1) Bulb
2) Condenser, aperture > 8,6 mm
3) Ground-glass screen, aperture > condenser aperture
4) Colour filter with central hole approximately 0,3 diameter; diameter > 8,6 mm
5) Polar co-ordinate plate, diameter > 8,6 mm
6) Achromatic lens, $f \geqslant 86$ mm, aperture 10 mm
7) Achromatic lens, $f \geqslant 86$ mm, aperture 10 mm
8) Black spot, diameter approximately 0,3 mm
9) Achromatic lens, $f = 20$ mm, aperture $\leqslant 10$ mm

FIGURE 3 — **Apparatus for collimation telescope test**

6.4.2 *Procedure*

The collimation telescope forms at infinity the image of a polar co-ordinate system with a bright point at its centre (see figure 4).

In the focal plane of the observation telescope, a small opaque spot with a diameter slightly larger than of the projected bright point is placed on the optical axis, thus obscuring the bright point.

When a sample which exhibits a secondary image is placed between the telescope and the collimator, a second, less bright point appears at a certain distance from the centre of the polar co-ordinate system. The secondary image separation can be read out as the distance between the points seen through the observation telescope (see figure 4).

(The distance between the dark spot and the bright point at the centre of the polar co-ordinate system represents the optical deviation.)

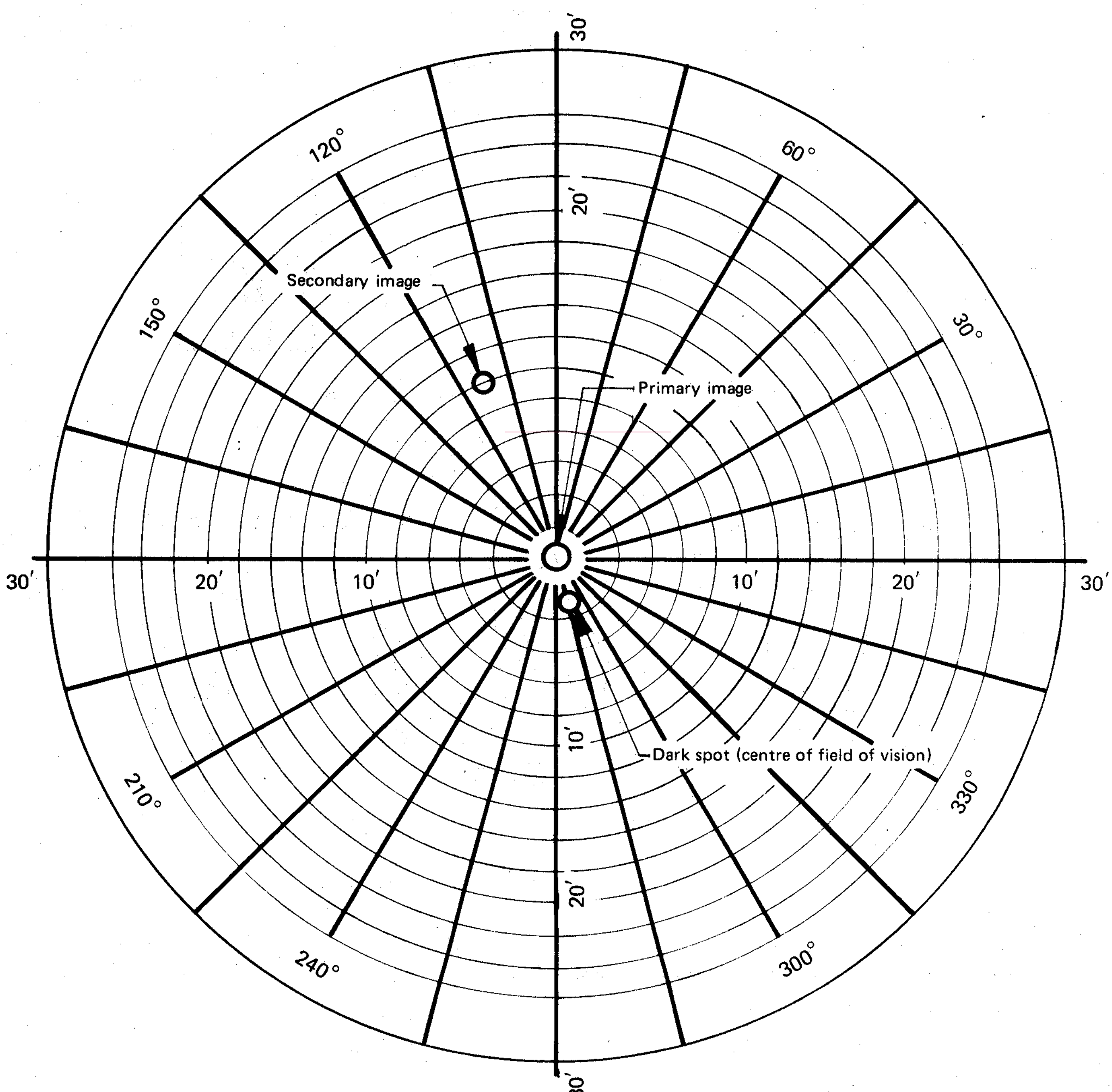


FIGURE 4 — **Example of observation by the collimation telescope test**

6.4.3 *Expression of results*

The safety glass shall first be examined using a simple scanning technique to establish the area giving the most severe secondary image. The worst area shall then be examined using the collimator-telescope system at the appropriate angle of incidence. The maximum secondary image separation shall be measured.

7 OPTICAL DISTORTION TEST

7.1 Purpose of test

The purpose of this test is to determine the optical distortion of the safety glass.

7.2 Field of application

The method specified is a simple projection method which permits a rapid assessment of the optical distortion of a safety glass.

NOTE — A more precise method for product evaluation is under study and will be incorporated in this International Standard as soon as possible.

7.3 Definitions

7.3.1 optical deviation : The angle between the true and the apparent direction of a point viewed through the safety glass, the magnitude of the deviation being a function of the angle of incidence of the line of sight, the thickness and inclination of the glass and the radius of curvature at the point of incidence.

7.3.2 optical distortion in a given direction MM′ : The algebraic difference in angular deviation $\Delta\alpha$ measured between two points M and M′ on the surface of the glass, the distance between them being such that their projections in a plane at right angles to the direction of vision are separated by a given distance Δx (see figure 5).

NOTES

$\Delta\alpha = \alpha_1 - \alpha_2$, i.e. the optical distortion in the direction MM′.

Δx = MC, i.e. the distance between two straight lines parallel to the direction of vision, and passing by the points M and M′.

7.4 Apparatus

This method involves the projection of an appropriate slide (raster) through the safety glass being tested onto a display screen. The change in shape of the projected image caused by the insertion of the glass provides a measure of the distortion.

The precision of this method, with the unaided eye, cannot be better than 0,5 mm.

The apparatus shall consist of :

7.4.1 Projector, of good quality, with a high-intensity point light source, for example :

- focal length at least 90 mm;
- aperture approximately 1/2,5;
- 150 W quartz halogen lamp (if used without a filter);
- 250 W quartz halogen lamp (if a green filter is used).

The projector is shown schematically in figure 6. An 8 mm diameter diaphragm is positioned approximately 10 mm from the front lens of the objective.

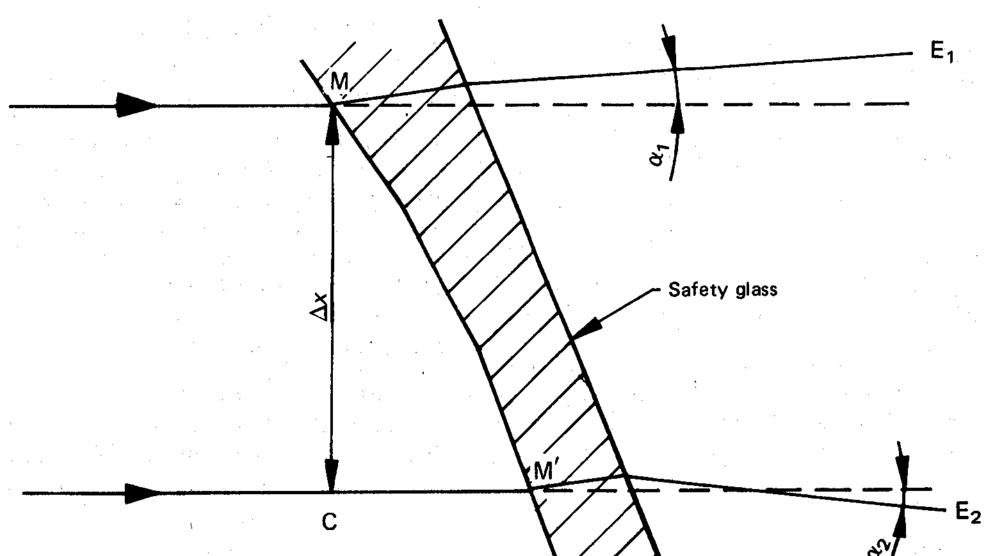


FIGURE 5 — **Diagrammatic representation of optical distortion**

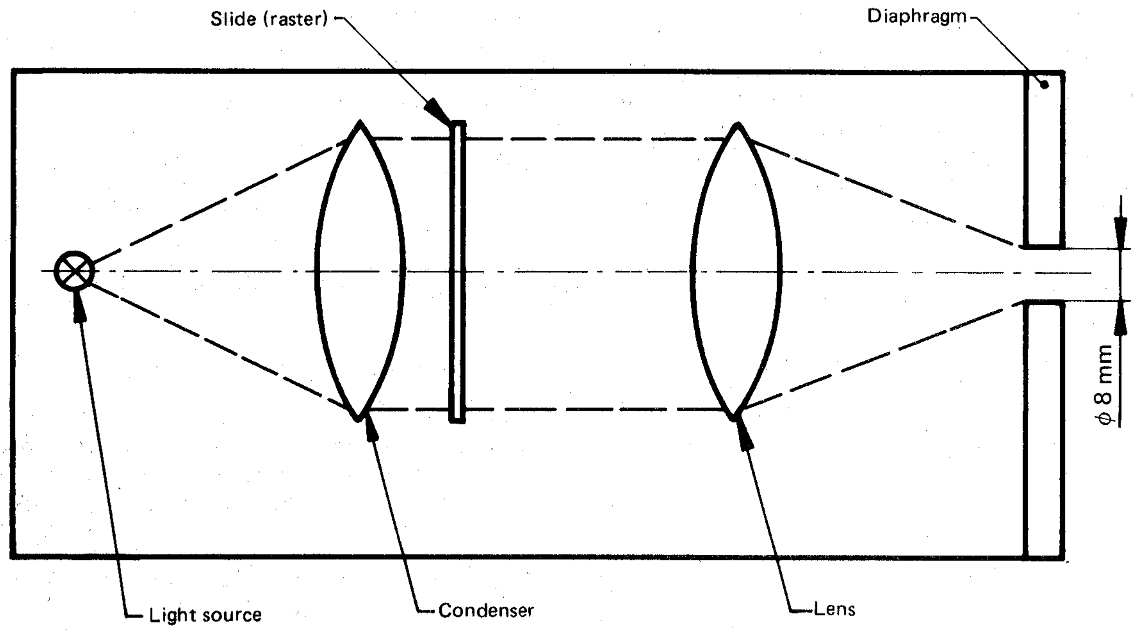


FIGURE 6 – **Optical arrangement of the projector**

7.4.2 Slides (rasters), consisting, for example, of an array of bright circular shapes on a dark background (see figure 7). The slide shall be of sufficiently high quality and contrast to enable measurement to be carried out with a tolerance less than 5 %.

In the absence of the safety glass to be examined, the dimensions of the circular shapes shall be such that when projected these form an array of circles of diameter $\phi = \frac{R_1 + R_2}{R_1} \Delta x$[1] on the screen. These circles shall form a pattern with spacing as shown in figure 8.

7.4.3 Support stand. A support stand permitting vertical and horizontal scanning, as well as rotation of the safety glass, is recommended for this test.

The apparatus may be arranged as shown in figure 9.

If the safety glass under test contains optical faults, the projected image is distorted. A measurement of the change in dimensions permits the calculation for $\Delta\alpha$. For use as a "Go – No Go" method, the distortion of the projected image can be assessed using a checking template.

Figure 10 shows the design for a suitable template. The value of A is calculated from the limit value for the change in deviation $\Delta\alpha$ and the value of R_2 the distance from the safety glass to the display screen

$$A = 0{,}145\ \Delta\alpha \times R_2$$

where

A is in millimetres;

$\Delta\alpha$ is in minutes of arc;

R_2 is in metres.

The relationship between the change in diameter of the projected image Δd and the change in angular deviation $\Delta\alpha$ is given by

$$\Delta d = 0{,}29\ \Delta\alpha \times R_2$$

where

Δd is in millimetres;

$\Delta\alpha$ and R_2 are as given above.

7.5 Procedure

Mount the safety glass on the support stand at the designed rake angle. Project the test image through the area being examined and compare the projected images with a reference on the screen. Rotate the safety glass or move it either horizontally or vertically in order to examine the whole of the specified area.

7.6 Expression of results

Evaluate the optical distortion of the safety glass by measuring the change in deviation in all directions of the distorted image after projection through the safety glass, with regard to the reference raster projected on the test screen.

1) See figures 5 and 9.

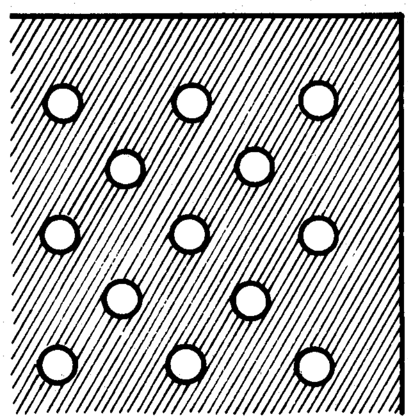


FIGURE 7 – **Enlarged section of the slide**

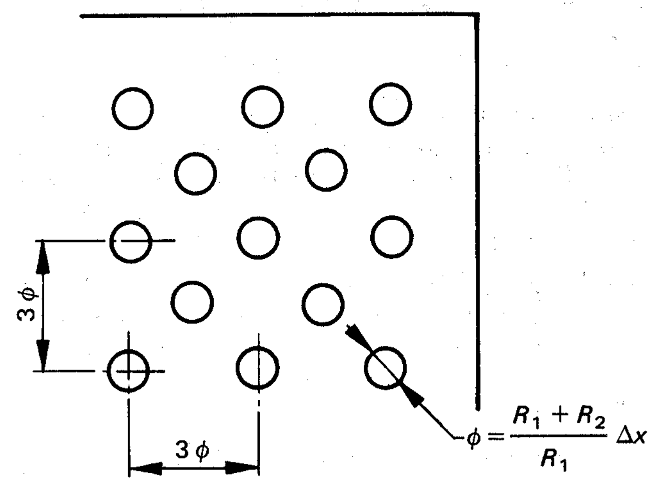
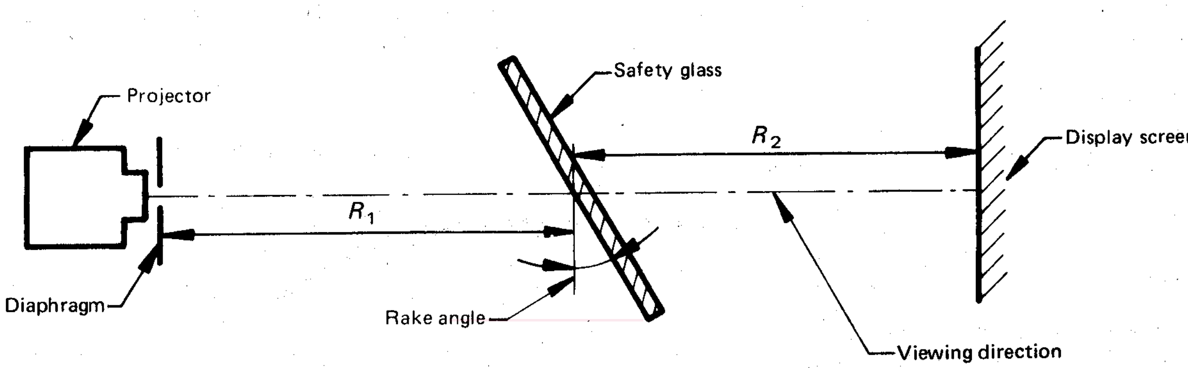


FIGURE 8 – **Arrangement of array of circles obtained by projection of the slide on a screen**



$R_1 = 4$ m

$R_2 = 2$ to 4 m (4 m preferred)

FIGURE 9 – **Arrangement of the apparatus for the optical distortion test**

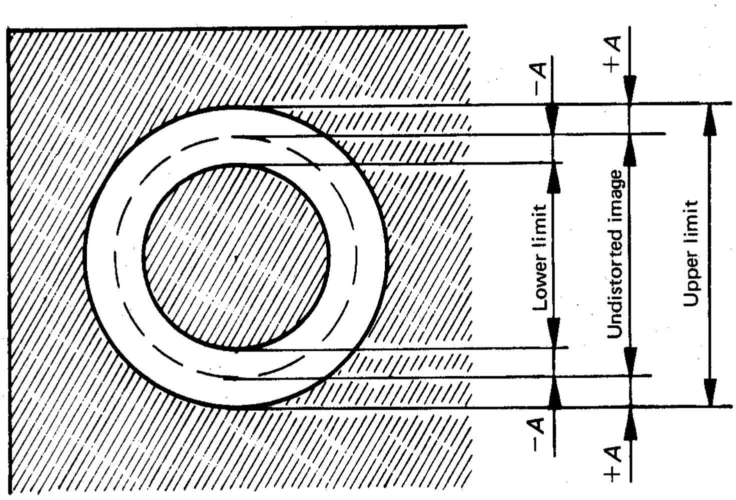


FIGURE 10 – **Design for a suitable checking template**

8 VISIBILITY TEST AFTER FRACTURE

8.1 Purpose of test

The purpose of this test is to determine whether the safety glass allows a certain visibility after fracture. This test shall be carried out on the outside face of the safety glass.

8.2 Apparatus

Instrument capable of causing the glass to break from the impacted surface such as a hammer with a pointed head or an automatic punch.

8.3 Procedure

Fix the test piece tightly on top of a glass of the same shape and dimensions by means of transparent adhesive tape on the periphery, placing a photographic paper between the glasses. The exposure of the photographic paper shall start not later than 10 s after the impact and terminate not later than 3 min after it. Only the deepest lines, representing the initial fracture, shall be taken into consideration.

The points of impact shall be situated as follows (see figure 11) :

Point 1, 30 mm from the edge in one corner or in the part of the safety glass where the radius of curvature of the perimeter is of minimum value.

Point 2, 30 mm from the edge, on one of the medians.

Point 3, at the centre of the primary vision area.

Point 4, for curved glasses, on the longest median at the point of maximum curvature. For curved glasses, the impacts shall be made from the convex side, or, if necessary, from the concave side.

8.4 Expression of results

Evaluate the visibility after fracture by inspection of the photographic record in relation to the number of particles and their sizes within the primary vision area.

Dimensions in millimetres

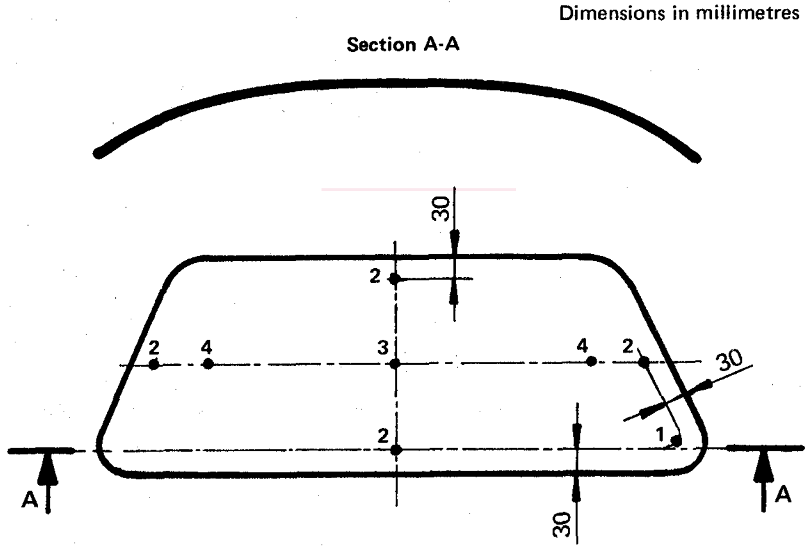


FIGURE 11 — **Points of impact**